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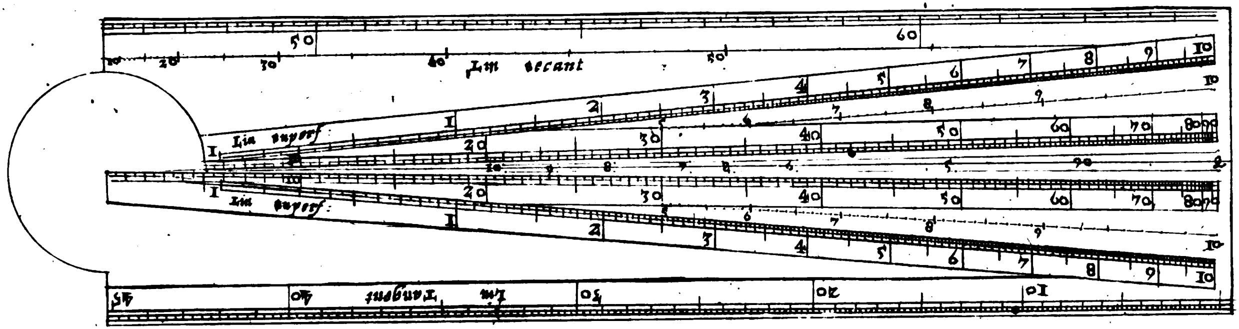


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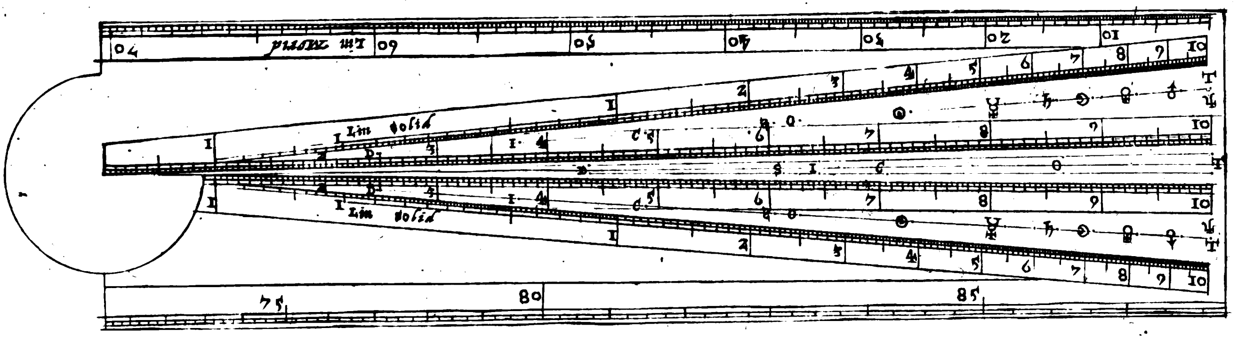


The
DESCRIPTION
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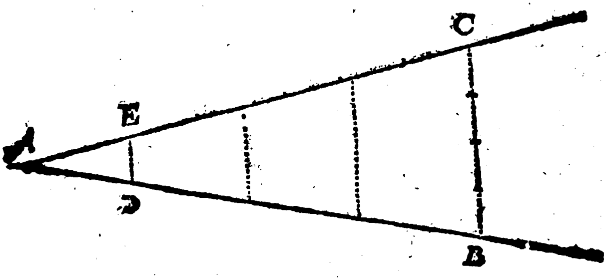
such as are Studius of ye Mathematicall Prac:
tis. By
Edmond Gunter somtime Professor
of Astronemy in Gresham Collidg
LONDON.
Printed by W. J.
1636.
Are to be
sold by James
Boller at the
signe of the
Marigold in Pauls
Church yard
1636

# THE DESCRIPTION AND VSE OF THE *SECTOR, CROSSE-STAFFE,* and other INSTRUMENTS:

VVith a Canon of Artificiall Sines and Tangents, to a *Radius* of 10000.0000. parts, and the vse thereof in *Astronomie, Navigation, Dialling*, and *Fortification, &c.*

*The second Edition much augmented.*

By EDM. GUNTER sometime Professor of Astonomie in *Gresham Colledge* in *London*.




LONDON,
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1636.

# HONORATISSIMO

DOMINO *Dn.* *JOHANNI*
COMITI de BRIDGEWATER,
VICECOMITI de BRACKLEY,
BARONI de ELLESMERE,
EQVITI ORDINIS HONO-
RATISSIMI QVI DICITVR
BALNEI, Dº PRÆSIDENTI
WALLIÆ LIMITVMQ; NEC
NON REGIÆ MAIESTATI A
SACRIS CONSILIIS. &c.

Lucubrationes has suas Mathematicas

D. D. D.

EDM. GUNTER.

# THE CONTENTS Of the first booke of the *Sector*.

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The contents of the second booke of the *Sector*



*Meridian*

## The contents of the third book of the Sector.

## The Contents of the first Booke of the *Crosse-Staffe.*



## The Contents of the second Booke of the *Crosse-Staffe.*

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*In*

The Contents of the third Booke of the *Crosse-Staffe.*

Chap.

---

The Contents of the generall vse of the *Canon,* and Table of *Logarithmes.*

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## *The use of the Canon.*

THis CANON hath like vse as Tables of right *Sines* and *Tangents* set forth by others, but the practise somewhat more easie. For keeping their rules, and working by these Tables, you may vse addition instead of their multiplication, and subtraction in stead of their division, and so resolve al sphæricall triangles without the helpe of *Secants* or *versed sines.*

If any desire the like of right-lined Triangles, he may adjoyne the *Logarithmes* of my old Collegue & worthy friend M. *Henrie Briggs.* For both proceed from the same ground, and so require the same maner of workes; as I often shew in my publique Lectures at *Gresham* College: where I rest.

*Friend to all that are studious of Mathematicall practise,*

E. G.

FINIS.

# THE FIRST BOOKE OF THE SECTOR.

## CHAP. I.

*The description, the making, and the generall vse of the Sector.*

A *Sector* in *Geometrie*, is a figure comprehended of two right lines containing an angle at the center, and of the circumference assumed by them. This *Geometricall instrument* hauing two legs containing all variety of angles, and the distance of the feete, representing the subtenses of the circumference, is therefore called by the same name.

It containeth 12 seuerall lines or scales, of which 7 are generall, the other 5 more particular. The first is the scale of *Lines* diuided into a 100 equall parts, and numbred by 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

The second, the lines of *Superficies* diuided into 100 vnequall parts, and numbred by 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

3. The third, the lines of *Solids*, diuided into 1000 vnequall parts, and numbred by 1. 1. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

4. The fourth, the lines of *Sines* and *Chords*, diuided into 90 degrees, and numbred with 10. 20. 30. vnto 90.

These foure, lines of *Lines*, of *Superficies*, of *Solids*, and of *Sines*, are all drawne from the center of the *Sector* almost to the end of the legs. They are drawne on both the legs, that euery line may haue his fellow. All of them are of one length, that they may answere one to the other. And euery one hath his parallells, that the eye may the better distinguish the diuisions. But of the parallells those onely which are inward-most containe the true diuisions.

There are three other generall lines, which because they are infinite are placed on the side of the *Sector*.

5. The first a line of *Tangents*, numbred with 10. 20. 30. 40 50. 60. signifying so many degrees from the beginning of the line, of which 45. are equall to the whole line of *Sines*, the rest follow as the length of the *Sector* will beare.

6. The second, a line of *Secants*, diuided by pricks into 60 degrees, is the same with that of the line of *Tangents*, to which it is joyned.

7. The third, is the *Meridian* line, or line of *Rumbs*, diuided vnequally into degrees, of which the first 70 are almost equall to the whole line of *Sines*, the rest follow vnto 85 according to the length of the *Sector*.

Of the particular lines inserted among the generall, because there was void space.

8. The first are the lines of *Quadrature* placed betweene the lines of *Sines*, and noted with 10. 9. 8. 7. S. 6. 5. 90. Q.

9. The second, the lines of *Segments* placed betweene the lines of *Sines* and *Superficies*, diuided into 50 parts, and numbred with 4. 6. 7. 8. 9. 10.

10. The third, the lines of *Inscribed Bodies in the same Sphere*, placed betweene the scales of *Lines*, and noted with *D. S. I. C. O. T.*

11. The

11. The fourth, the lines of *Equated bodies*, placed betwen the lines of *Lines* and *Solids*, and noted with *D.I.C.S.O.T.*

12. The fift, are the lines of *Mettalls*, inserted with the lines of *Equated bodies* (there being roome sufficient) and noted with these Characters ☉.♄.☽.♀.♂.♃.

There remaine the edges of the *Sector*, and on the one I haue set a line of *Inches*, which are the twelfth parts of a foote English: on the other a lesser line of *Tangents*, to which the *Gnomon* is *Radius*.

## 2 Of the making of the Sector.

LEt a *Ruler* be first made either of brasse or of wood, like unto the former figure, which may open and shut vpon his center. The head of it may be about the twelfth part of the whole length, that it may beare the moueable foote, and yet the most part of the divisions may fall without it. Then let a moueable *Gnomon* be set at the end of the moueable foote, and there turne vpon an *Axis*, so as it may sometime stand at a right angle with the feete, and sometimes be inclosed within the feet. But this is well knowne to the workeman.

For drawing of the lines. Vpon the center of the *Sector*, and semidiameter somewhat shorter then one of the feet, draw an occult arke of a circle, crossing the closure of the inward edges of the *Sector* about the letter *T*.

In this arke, at one degree on either side from the edge, draw right lines from the Center fitting them with *Parallels*; and deuide them into an hundred equall parts, with subdiuisions into 2. 5. or 10. as the line will beare, but let the numbers set to them, be onely 1. 2. 3. 4. &c. vnto 10. as in the example. These lines so diuided, I call the lines or scales of *Lines*, and they are the ground of all the rest.

2. In this Arke at 5 degrees on either side, from the edge neere *T*, draw other right lines from the Center, and fit them with Parallels. These shall serue for the lines of *Solids*.

Then on the other side of the *Sector* in like manner; vpon the Center & equall Semidiameter, drawe another like Arke of a circle: and here againe at one degree neere on either side from the edge neere the letter *Q* draw right lines from the center, and fit them with parallells. These shall serue for the lines of *Sines*.

At 5 Degrees on either side from the edge neere *Q*, draw other right lines from the center, and fit them with parallells: these shall serue for the lines of *Superficies*.

These foure principall lines being drawne, and fitted with parallells, wee may draw other lines in the middle betweene the edges and the lines of *Lines*, which shall serue for the lines of *inscribed bodies*, and others betweene the edges and the *Sines* for the lines of *quadrature*. And so the rest as in the example.

## 3. *To diuide the lines of* Superficies.

Seeing the *Superficies* doe hold in the proportion of their *homologall* sides duplicated. by the 29 Pro. 6. lib. *Euclid.* If you shall find meane proportionalls between the whole side, and each hundred part of the like side, by the 13 Pro. 6 lib. *Euclid.* all of them cutting the same line, that line so cut shall containe the diuisions required. wherefore vpon the center *A* and Semidiameter equall to the line of *Lines*, describe a Semicircle *A C B D*, with *A B* perpendicular to the diameter *C D*. And let the Semidiameter *A D* be divided as the line of *Lines* into an hundred parts, & *A E* the one halfe of *A C* diuided also into an hundred parts so shall the diuisions in *A E* be the centers from whence you shall describe the semicircles *C* 10. *C* 20. *C* 30. &c. diuiding the line *A B* into an hundred vnequall parts: & this line *A B* so diuided shall be the line of *Superficies*, and must be transferred into the *Sector*. But let the numbers set to them bee onely 1. 2. 3. vnto 10. as in the example.

Or these lines of *Superficies* may otherwise be transferred into the *Sector*, out of the line of *Lines*, by a table of square rootes: For the roote taken out of the line of *Lines* shall giue the square in the lines of *Superficies*.

As, to inscribe the diuision of 25 in the lines of *Superficies*; put six ciphers to 25 and make it 25000000 then finde the sq. roote of this number, which will be 5000.

Take therefore 5000, out of the line of *Lines* (supposing the whole line to be 10000) and it will giue the true distance betweene the center, and the points of 25. in the lines of *Superficies*.

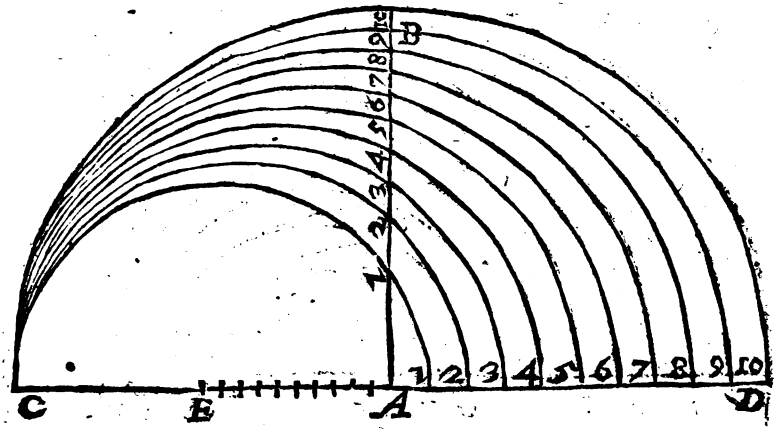
So, for the diuision of 30, put to 6 ciphers, and make it 30000000, whose sq. root is 5477. This (taken out of the line of *Lines*) shall giue the place for the points of 30, in the lines of *Superficies*. And the like reason holdeth for all the rest, according to this following Table.

If any please to make vse of a *Diagonal* Scale, equall to the line of *Lines*, he may put viij ciphers to the number proposed, and make the Table of Roots to v. places: So, his worke will be more exact.

*A Table of Square Rootes for the diuision of the Lines of* Superficies.

# A Table of Square Roots for division of the Line of Superficies.

| Sq. | Root. | Sq. | Root. | Sq. | Root. | Sq. | Root. | Sq. | Root. | Sq. | Root. | Sq. | Root. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 15 | 3873 | 30 | 5477 | 45 | 6708 | 60 | 7746 | 75 | 8660 | 90 | 9487 |
| | 707 | | 3937 | | 5523 | | 6745 | | 7778 | | 8689 | | 9513 |
| 1 | 1000 | 16 | 4000 | 31 | 5568 | 46 | 6782 | 61 | 7810 | 76 | 8718 | 91 | 9539 |
| | 1225 | | 4062 | | 5612 | | 6819 | | 7842 | | 8746 | | 9565 |
| 2 | 1414 | 17 | 4123 | 32 | 5657 | 47 | 6856 | 62 | 7874 | 77 | 8775 | 92 | 9592 |
| | 1581 | | 4183 | | 5701 | | 6892 | | 7906 | | 8803 | | 9618 |
| 3 | 1732 | 18 | 4243 | 33 | 5744 | 48 | 6928 | 63 | 7937 | 78 | 8832 | 93 | 9644 |
| | 1871 | | 4301 | | 5788 | | 6964 | | 7969 | | 8860 | | 9670 |
| 4 | 2000 | 19 | 4359 | 34 | 5831 | 49 | 7000 | 64 | 8000 | 79 | 8888 | 94 | 9695 |
| | 2121 | | 4416 | | 5874 | | 7036 | | 8031 | | 8916 | | 9721 |
| 5 | 2236 | 20 | 4472 | 35 | 5916 | 50 | 7071 | 65 | 8062 | 80 | 8944 | 95 | 9747 |
| | 2345 | | 4528 | | 5958 | | 7106 | | 8093 | | 8972 | | 9772 |
| 6 | 2449 | 21 | 4582 | 36 | 6000 | 51 | 7141 | 66 | 8124 | 81 | 9000 | 96 | 9798 |
| | 2550 | | 4637 | | 6042 | | 7176 | | 8155 | | 9028 | | 9823 |
| 7 | 2646 | 22 | 4690 | 37 | 6083 | 52 | 7211 | 67 | 8185 | 82 | 9055 | 97 | 9849 |
| | 2739 | | 4743 | | 6124 | | 7246 | | 8216 | | 9083 | | 9874 |
| 8 | 2828 | 23 | 4796 | 38 | 6164 | 53 | 7280 | 68 | 8246 | 83 | 9110 | 98 | 9899 |
| | 2915 | | 4848 | | 6205 | | 7314 | | 8276 | | 9138 | | 9925 |
| 9 | 3000 | 24 | 4899 | 39 | 6245 | 54 | 7348 | 69 | 8307 | 84 | 9165 | 99 | 9950 |
| | 3082 | | 4950 | | 6285 | | 7382 | | 8337 | | 9192 | | 9975 |
| 10 | 3162 | 25 | 5000 | 40 | 6325 | 55 | 7416 | 70 | 8367 | 85 | 9219 | 100 | 10000 |
| | 3240 | | 5050 | | 6364 | | 7450 | | 8396 | | 9247 | | |
| 11 | 3317 | 26 | 5099 | 41 | 6403 | 56 | 7483 | 71 | 8426 | 86 | 9274 | | |
| | 3391 | | 5148 | | 6442 | | 7517 | | 8456 | | 9300 | | |
| 12 | 3464 | 27 | 5196 | 42 | 6481 | 57 | 7550 | 72 | 8485 | 87 | 9327 | | |
| | 3536 | | 5244 | | 6519 | | 7583 | | 8515 | | 9354 | | |
| 13 | 3606 | 28 | 5291 | 43 | 6557 | 58 | 7616 | 73 | 8544 | 88 | 9381 | | |
| | 3674 | | 5338 | | 6595 | | 7648 | | 8573 | | 9407 | | |
| 14 | 3742 | 29 | 5385 | 44 | 6633 | 59 | 7681 | 74 | 8602 | 89 | 9434 | | |
| | 3808 | | 5431 | | 6671 | | 7714 | | 8631 | | 9460 | | |
| 15 | 3873 | 30 | 5477 | 45 | 6708 | 60 | 7746 | 75 | 8660 | 90 | 9487 | | |

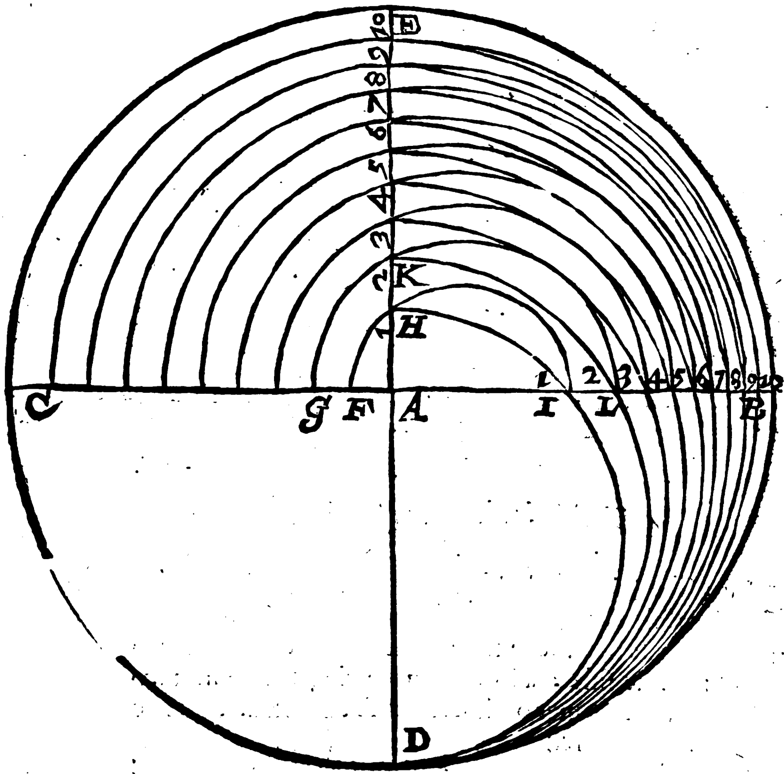



## 4 To diuide the lines of Solids.

SEing like Solids do hold in the proportion of their *homologall* sides triplicated, if you shall finde two meane proportionalls betweene the whole side & each thousand part of the like side: all of them cutting the same two right lines, the former of those lines so cut, shall containe the diuisions required.

Wherefore vpon the center *A*, & Semidiameter equall to the line of *Lines*, describe a circle and diuide it into 4 equall parts *C E B D*, drawing the crosse diameters *C B*, *E D*. Then diuide the semidiameter *A C*, first into 10 equall parts, and between the whole line *A D* & *A F*, the tenth part of *A C*, seeke out two meane proportionall lines *A I* and *A H*: againe betweene *A D* and *A G* being two tenth parts of *A C*, seeke out two meane proportionalls *A L* and *A K*, and so forward in the rest. So shall the line *A B*, be diuided into 10 vnequall parts.

Secondly




Secondly, diuide each tenth part of the line *AC* into 10 more, and betweene the whole line *AD*, and each of them, seeke out two meane proportionalls as before: So shall the line *AB* be diuided now into an hundred vnequall parts.

Thirdly, If the length will beare it, subdiuide the line *AC* once againe, each part in ten more: and betweene the whole line *AD* and each subdiuision, seeke two meane

meane proportionalls as before. So should the line *A B* be now diuided into 1000 parts. But the ruler being short, it shall suffice, if those 10 which are nearest the center be expressed, the rest be vnderstood to be diuided, though actually they be diuided into no more then 5 or 2, and this line *A B* so diuided shall be the line of *Solids*, and must be transferred into the *Sector*: But let the numbers set to them be onely 1. 1. 1. 2. 3. &c. vnto 10 as in the example.

Or these lines of *Solids* may otherwise be transferred, into the *Sector*, out of the line of *Lines* (or rather, out of a *Diagonall* scale equall to the line of *Lines*) by a table of *Cubique Roots*. For the Root, taken out of the line of *Lines*, shall giue the cube in the lines of *Solids*.

As to inscribe the diuision of 125 in the lines of *Solids*; put xij. ciphers to 125, and make it 125000000000000: Then find the cubique Root, of the number, which will be 50000. Take therefore 50000 out of the line of *Lines*, (such as the whole line is 100000) and it will giue the true distance betweene the points of 125 in the lines of *Solids*.

So, for the diuision of 300, put to xij. ciphers more and make it 300000000000000, whose cubique Root is 66943 This, taken out of the line of *Lines*, shall giue the place for the points of 300 in the lines of *Solids*. And the like reason holdeth for all the rest, according to the ensuing Table.

## A Table of Cubique Rootes.

# A Table of Cubique Rootes

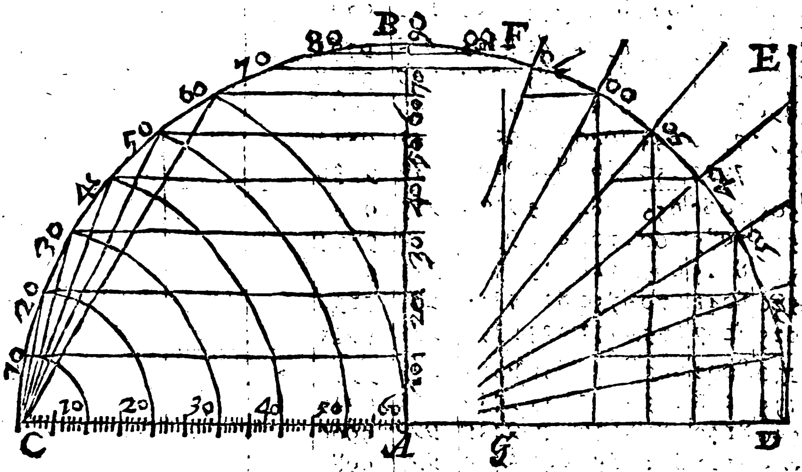
| Cube. | Root. | Cube. | Root. | Cube. | Root. | Cube. | Root. | Cube | Root |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 20 | 2714 | 50 | 3684 | 125 | 5000 | 275 | 6502 |
| | 794 | 21 | 2758 | 52 | 3732 | 130 | 5065 | 280 | 6542 |
| 1 | 1000 | 22 | 2802 | 54 | 3779 | 135 | 5129 | 285 | 6580 |
| | 1144 | 23 | 2843 | 56 | 3825 | 140 | 5192 | 290 | 6619 |
| 2 | 1259 | 24 | 2884 | 58 | 3870 | 145 | 5253 | 295 | 6656 |
| | 1357 | 25 | 2924 | 60 | 3914 | 150 | 5313 | 300 | 6694 |
| 3 | 1442 | 26 | 2962 | 62 | 3957 | 155 | 5371 | 305 | 6731 |
| | 1518 | 27 | 3000 | 64 | 4000 | 160 | 5428 | 310 | 6767 |
| 4 | 1587 | 28 | 3036 | 66 | 4041 | 165 | 5484 | 315 | 6804 |
| | 1650 | 29 | 3072 | 68 | 4081 | 170 | 5539 | 320 | 6839 |
| 5 | 1709 | 30 | 3107 | 70 | 4121 | 175 | 5593 | 325 | 6875 |
| | 1765 | 31 | 3141 | 72 | 4160 | 180 | 5646 | 330 | 6910 |
| 6 | 1817 | 32 | 3174 | 74 | 4198 | 185 | 5698 | 335 | 6945 |
| | 1866 | 33 | 3207 | 76 | 4235 | 190 | 5748 | 340 | 6979 |
| 7 | 1912 | 34 | 3239 | 78 | 4272 | 195 | 5798 | 345 | 0713 |
| | 1957 | 35 | 3271 | 80 | 4308 | 200 | 5848 | 350 | 7047 |
| 8 | 2000 | 36 | 3301 | 82 | 4344 | 205 | 5896 | 355 | 7080 |
| | 2040 | 37 | 3332 | 84 | 4379 | 210 | 5943 | 360 | 7119 |
| 9 | 2080 | 38 | 3361 | 86 | 4414 | 115 | 5990 | 365 | 7146 |
| | 2117 | 39 | 3391 | 88 | 4447 | 220 | 6036 | 370 | 7179 |
| 10 | 2154 | 40 | 3419 | 90 | 4481 | 225 | 6089 | 375 | 7211 |
| 11 | 2223 | 41 | 3448 | 92 | 4514 | 230 | 6126 | 380 | 7243 |
| 12 | 2289 | 42 | 3476 | 94 | 4546 | 235 | 6171 | 385 | 7274 |
| 13 | 2351 | 43 | 3503 | 96 | 4578 | 240 | 6214 | 390 | 7306 |
| 14 | 2410 | 44 | 3530 | 98 | 4610 | 245 | 6257 | 395 | 7337 |
| 15 | 2466 | 45 | 3556 | 100 | 4641 | 250 | 6299 | 400 | 7368 |
| 16 | 2519 | 46 | 3583 | 105 | 4717 | 255 | 6341 | 405 | 7398 |
| 17 | 2571 | 47 | 3608 | 110 | 4791 | 360 | 6382 | 410 | 7428 |
| 18 | 2620 | 48 | 3634 | 115 | 4862 | 265 | 6423 | 415 | 7459 |
| 19 | 2668 | 49 | 3659 | 120 | 4931 | 270 | 6463 | 420 | 7488 |
| 20 | 2714 | 50 | 3684 | 125 | 5000 | 275 | 6502 | 425 | 7518 |

# *For division of the Lines of Solids.*

| Cube. | Root. | Cube. | Root. | Cube. | Root. | Cube. | Root. |
|---|---|---|---|---|---|---|---|
| 425 | 7518 | 575 | 8315 | 725 | 8983 | 875 | 9564 |
| 430 | 7547 | 580 | 8339 | 730 | 9004 | 880 | 9582 |
| 435 | 7576 | 585 | 8363 | 735 | 9024 | 885 | 9600 |
| 440 | 7605 | 590 | 8387 | 740 | 9045 | 890 | 9619 |
| 445 | 7634 | 595 | 8410 | 745 | 9065 | 895 | 9636 |
| 450 | 7663 | 600 | 8434 | 750 | 9085 | 900 | 9654 |
| 455 | 7691 | 605 | 8457 | 755 | 9105 | 905 | 9672 |
| 460 | 7719 | 610 | 8480 | 760 | 9125 | 910 | 9690 |
| 465 | 7747 | 615 | 8504 | 765 | 9145 | 915 | 9708 |
| 470 | 7774 | 620 | 8527 | 770 | 9165 | 920 | 9725 |
| 475 | 7802 | 625 | 8549 | 775 | 9185 | 925 | 9743 |
| 480 | 7829 | 630 | 8572 | 780 | 9205 | 930 | 9761 |
| 485 | 7856 | 635 | 8595 | 785 | 9224 | 935 | 9778 |
| 490 | 7883 | 640 | 8617 | 790 | 9244 | 940 | 9795 |
| 495 | 7910 | 645 | 8640 | 795 | 9263 | 945 | 9813 |
| 500 | 7937 | 650 | 8662 | 800 | 9283 | 950 | 9830 |
| 505 | 7963 | 655 | 8684 | 805 | 9302 | 955 | 9847 |
| 510 | 7989 | 660 | 8706 | 810 | 9321 | 960 | 9864 |
| 515 | 8015 | 665 | 8728 | 815 | 9340 | 965 | 9881 |
| 520 | 8041 | 670 | 8750 | 820 | 5359 | 970 | 9898 |
| 525 | 8067 | 675 | 8772 | 825 | 9378 | 975 | 9915 |
| 530 | 8092 | 680 | 8793 | 830 | 9397 | 980 | 9932 |
| 535 | 8118 | 685 | 8815 | 835 | 9416 | 985 | 9949 |
| 540 | 8143 | 690 | 8836 | 840 | 9435 | 990 | 9966 |
| 545 | 8168 | 695 | 8857 | 845 | 9454 | 995 | 9983 |
| 550 | 8193 | 700 | 8879 | 850 | 9472 | 1000 | 10000 |
| 555 | 8217 | 705 | 8900 | 855 | 9491 | | |
| 560 | 8242 | 710 | 8921 | 860 | 9509 | | |
| 565 | 8267 | 715 | 8942 | 865 | 9529 | | |
| 570 | 8291 | 720 | 8962 | 870 | 9546 | | |
| 575 | 8315 | 725 | 8983 | 875 | 9564 | | |

## 5 *To diuide the lines of* Sines *and* Tangents *on the side of the Sector.*

VPon the center *A*, and semidiameter equall to the line of *Lines*, describe a semicircle *A B C D*, with *A B*, perpendicular to the diameter *C D*. Then diuide the quadrants *C B*, *B D*, each of them into 90. and subdiuide each degree into 2 parts. For so, if streight lines be drawne parallell to the diameter *C D*, through these 90, and their subdiuisions they shall diuide the perpendicular *A B* vnequally into 90.




And this line A B so diuided shall be the line of *Sines*, and must be transferred into the *Sector*. The number set to them are to be 10. 20. 30. &c. vnto 90 as in the example.

If now in the point *D*, vnto the diameter *C D*, we shall raise a perpendicular *D E*. and to it drawe streight lines from the center *A*, through each degree of the quadrant

drant D B these streight lines shalbe secants, and this perpendicular so diuided by them shall be the line of *Tangents*, & must be transferred vnto the side of the *Sector*. The number set to them, are to be 10. 20. 30. &c. as in the example.

If betweene A and D, another streight line *G F*, be drawne parallell to D E, it will be diuided by those lines from the center in like sort as D B is diuided, and it may serue for a lesser line of *Tangents*, to be set on the edge of the *Sector*.

If the compasses shall be extended, from *C*, to each degree of the *Quadrant*, *C B*, and those extents transferred into one line (*C A*) this line *C A* so diuided into 60 (or rather, into 90. *gr*) shall be a line of *Chords*, and may be set on some voyd place of the *Sector*.

These lines of *Sines* and *Tangents*, may yet otherwise be transferred into the *Sector* out of the line of *Lines*, (or rather out of a diagonall Scale equall to the line of *Lines*,) by tables of Sines and Tangents.

For the *Sine* of 90. gr. being equall to the whole *Line* of *lines* of 100000 parts, the *Sine* of 30 gr. will be equall to 50000 (halfe the *Line* of *lines*;) and the *Sine* of 45. gr. equall to 70710 parts of the *line* of *lines*, accord to the vsuall table of *Sines*.

In like manner the Tangent of 45 g. being equall to the whole *Line* of *lines*, the *tang*. of 40 deg. will be equall to 83910 parts of the *Line* of *lines*: and the *tang*. of 50 degr. equall to 119175, that is, to one *Radius* (or whole *Line*) and 19175 parts more of the same line of *lines*, according to the old table of *Tangents*.

And (vpon the same ground) the *Secant* of 40 gr. will be equall to 130540, that is, one *Radius*, and 30540. parts of the *Line* of *lines*: and the *Secant* of 50 degr. equall to 155572, and so the rest, according to the like Table of *Secants*.

The *Line* of *Chords* may also be divided by help of the Table of *Sines*, and *line* of *lines*. For the double *sine* of

 halfe

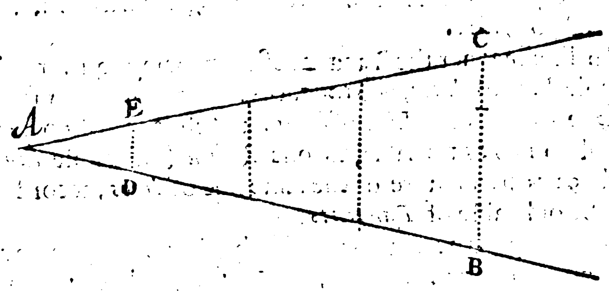
halfe the ark, taken out of the *line* of *lines*, will giue the *chord*.

As, if the *Ark* proposed were 60 gr. The halfe of this Ark is 30. degr. and the *sine* thereof 50000, which being doubled make 100000, the whole *line* of *lines*, equall to a *chord* of 60 degr.

So, for the *chord* of 90 degr. The halfe *ark* is 45 degres, and the *sine* thereof 70710. which being doubled, make 1414240. (that is,) one *Radius* and 41420 parts of the *line of lines*, equall to the *chord* of 90 gr. required.

## 6 *To shew the ground of the Sector.*

LEt A B, A C, represent the leggs of the *Sector*: then seing these two A B, A C, are equall, and their sections A D, A E, also equall, they shall be cut proportionally: and if we draw the lines B C, D E, they will be parallell by the second Pro. 6 lib. of *Euclid*, and so the Triangles A B C. A D E, shalbe equiangle; by reason of the common angle at A, and the equall angles at the base, and therefore shall haue the sides proportionall about those equall angles, by the 4 Pro. 6 lib. of *Euclid*.



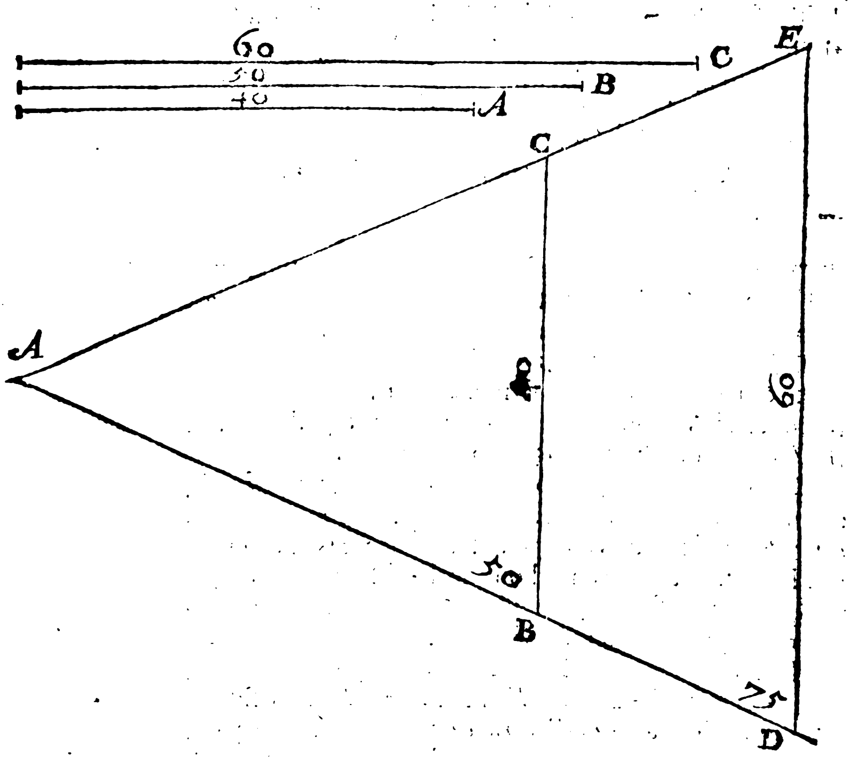

The side A D, shalbe to the side A B, as the basis D E, vnto the parallell basis BC, and by conuersion AB, shall be vnto A D, as B C, vnto D E: and by permutation A D, shall be vnto D E, as A B, to B C. &c. So that if A D, be be the fourth part of the side A B, then D E, shall also be the fourth part of his parallell basis B C. The like reason holdeth in all other sections.

## 7 To shew the generall vse of the Sector.

THere may some cōclusions be wrought by the *Sector*, euen then when it is shut, by reason that the lines are all of one length: but generally the vse hereof consists in the solution of the *Golden rule*, where three lines being giuen of a known denomination, a fourth proportionall is to be found. And this solution is diuerse in regard both of the *lines*, and of the *entrance* into the worke.

The solution in regard of the *lines* is sometimes *simple*, as when the worke is begun and ended vpon the same *lines*. Sometimes it is compound, as when it is begun on one kind of lines, and ended on another. It may be begun vpon the lines of *Lines*; & finished vpon the lines of *Superficies*. It may begin on the *Sines*, and end on the *Tangents*.

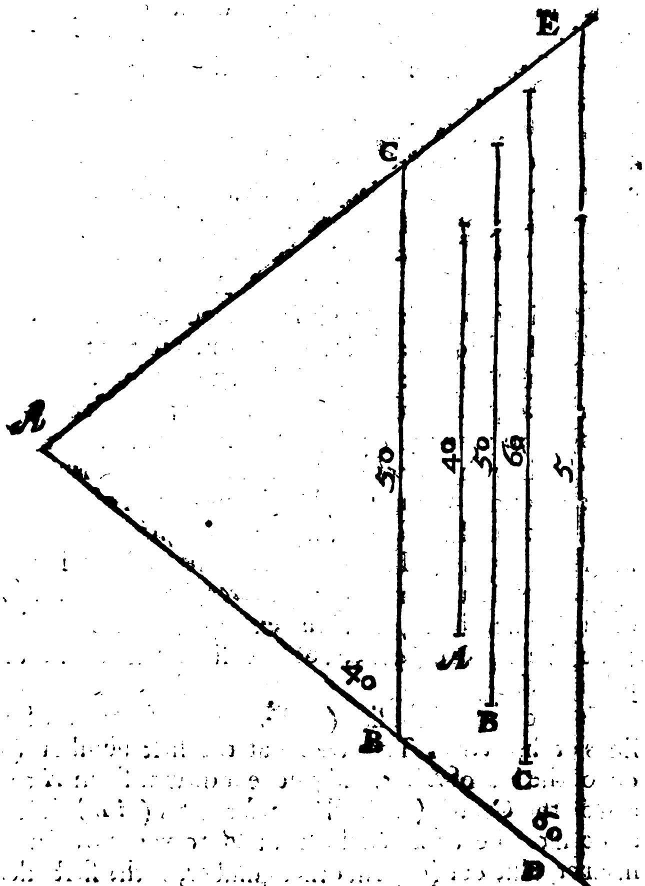
The solution in regard of the *entrance* into the worke, may be either with a *parallell* or else *laterall* on the side of the Sector, I cal it *parallell entrance*, or entring with a parallell, when the two lines of the first denomination are applied in the parallells, and the third line, and that which is sought for, are on the side of the *Sector*. I call it *laterall entrance*, or entring on the side of the *Sector*, when the two lines of the first denomination are on the side of the *Sector*, and the third line and that which is to be found out, doe stand in the parallells.




As for example, let there be giuen three lines *A*, *B*, *C*, to which I am to find a fourth proportionall. let A, measured in the line of *lines*, be 40, B 50, and C 60, and suppose the question be this. If 40 *Monthes* giue 50 *pounds*, what shall 60? Here are lines of two denominatiõs, one of *months* another of *pounds*, and the first with which I am to enter must be that of 40 *monthes*. If then I would *enter with a parallell*, first I take A, the line of 40, and put it ouer as a *parallell* in 50, reckoned in the line of *lines*, on either side of the *Sector* from the center, so as it may be the Base of an *Isoscheles* triangle B A C, whose sides A B, A C are equal to B, the line of the second denomination.

Then

Then the Sector being thus opened, I take C the line of 60, betweene the feete of the compasses, and carrying them parallell to B C, I finde them to crosse the lines A B, A C, on the side of the Sector in D and E, numbred with 75, wherefore I conclude the line A D, or A E, is the fourth proportionall and the correspondent number 75 which was required.




But

But if I would *inter on the side* of the *Sector*, then would I dispose the lines of the first denomination A and C, in the line of *Lines*, on both sides of the *Sector*, in A B, A C, & in A D, A E, so as they should all meete in the center A, and then taking B the line of the second denomination put it ouer as a *parallell* in B C, that it may be the Basis of the Isoscheles triangle B A C, (whose sides A B, A C, are equall to A, the first line of the first denomination,) for so the *Sector* being thus opened, the other *parallell* from D to E, shall be the fourth proportionall which was required, and if it be measured with the other lines, it shal be 75, as before.

In both this manner of operations, the two first lines do serue to opē the *Sector* to his due angle, the difference betweene them is especially this that in *parallell entrance*, the two lines of the first denomination, are placed in the parallells B C, D E, & in *laterall entrance* they are placed on both sides of the *Sector*, in A B, A D and in A C, A E.

Now in *simple solution* which is begun and ended, vpon the same kinde of lines, it is all one which of the two latter lines be put in the secōd or third places. As in our exāple we may say, as 40 are to 50, so 60 vnto 75, or else as 40 are to 60, so 50 vnto 75. And hence it cometh that we may enter both with a *parallell*, & on the sides two manner of wayes at either entrance, and so the most part of questions may be wrought 4 seuerall wayes, though in the propositions following, I mention onely that which is most conuenient. If any haue not the *Sector*, he may make vse of the former figure, as in our example, where we haue 3 numbers giuen (40. 50. 60.) to finde the fourth Proportionall.

First, draw a right line (*A D*) to represent one of the lines of the *Sector*. Then take out the first number (40) out of the line of *Lines*, and pricke it downe from *A* to *B*; and on the Center (*A*,) and Semidiameter (*A B*) describe an occult arke of a circle from *B* towards *C*. In like manner, take out (60) the other number, of the first denominion

minion) and pricke it downe from *A* to *D*. And on the center (*A*,) and Semidiameter (*A D*) describe a second arke of a circle, from *D* toward *E*. That done, take the third number (50) and inscribe it into the first arke from *B* to *C*; and laying the ruler to the center (*A*) and the point *C*, draw the right line (*A C*,) out in length, till it cutt the second arch in the point *E*. So the distance from *D* to *E* (taken and measured in the same scale with the third number) will giue the 75 for the fourth proportionall.

Thus much for the generall vse of the *Sector*, which being considered and well understood, there is nothing hard in that which followeth.

# CHAP. II.

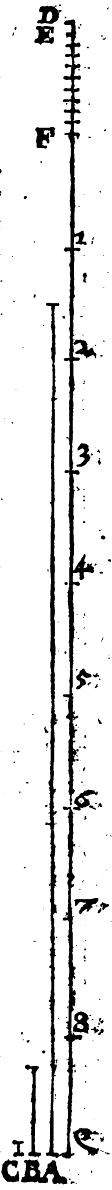
## *The vse of the Scale of Lines*

### 1 *To set downe a Line, resembling any giuen parts or fraction of parts.*

THe lines of *Lines* are diuided actually into 100 parts, but we haue put onely 10 numbers in them. These we would haue to signifie either themselues alone, or ten times themselues, or an hundred times themselues, or a thousand times themselues, as the matter shall require. As if the numbers giuen be no more then 10, then we may thinke the lines onely diuided into 10 parts according to the number set to them. If they be more then 10, and not more then 100, then either line shall containe 100 parts, and the numbers set by them shall be in value 10. 20. 30, &c. as they are diuided actvally. If yet they be more then 100, then euery part must be thought to be diuided into 10, and either line shall be 1000 parts, and the numbers set to them shall be in value 100. 200. 300, and so forward still increasing themselues by 10.

This being preſuppoſed, we may number the parts and fraction of parts giuen in the line of *lines*; and taking out the diſtance with a paire of compaſſes, ſet it by, for the line ſo taken ſhall reſemble the number giuen.

In this manner may we ſet downe a line reſembling 75, if either we take 75 out of the hundred parts, into which one of the line of *lines* is actually diuided, and note it in A, or 7½ of the firſt 10 parts, and note it in B, or onely ¾ of one of thoſe hundred parts, and note it in C. Or if this be either to great or to ſmall, we may run a Scale at pleaſure, by opening the compaſſe to ſome ſmall diſtance, and running it ten times ouer, then opening the compaſſe to theſe ten, run them ouer nine times more, & ſet figures to them as in this example, and out of this we may take what parts we will as before.

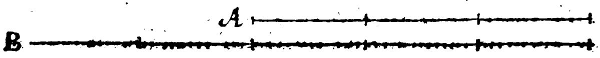



To this end I haue diuided the line of inches on the edge of the *Sector*, ſo as one inch containeth 8 parts, a nother 9, another 10, &c. according as they are figured, and as they are diſtant from the other end of the *Sector*, that ſo we might haue the better eſtimate.

2. *To encreaſe a line in a giuen proportion.*

3. *To diminiſh a line in a giuen proportion.*

TAke the line giuen with a paire of compaſſes, and open the *Sector*, ſo as the feete of the compaſſes may ſtand in the points of the number giuen, then keeping the *Sector* at this angle, the parallell diſtance of the points of the number required, ſhall giue the line required.




Let *A* be a line giuen to be increaſed in the proportion of 3 to 5. Firſt I take the line *A*, with the compaſſes, and open the *Sector* till I may put it ouer in the poynts

of

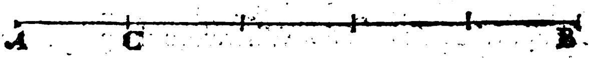
of 3 and 3, so the parallell betweene the poynts of 5 & 5, doth giue me the line *B*, which was required.

In like manner, if *B*, be a line giuen to be diminished in the proportiō of 5 to 3, I take the line *B* & to it open the *Sector* in the poynts of 5, so the parallell betweene the poynts of 3, doth giue me the line *A*, which was required.

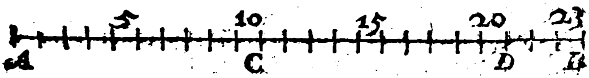
If this manner of worke doth not suffice, we may multiplie or diuide the numbers giuen by 2, or 3, or 4. &c. And so worke by their numbers *equimultiplices*, as for 3 and 5; we may open the *Sector* in 6 and 10, or else in 9 and 15, or else in 12 and 20, or in 15 and 25, or in 18 and 30. &c.

## 4. *To diuide a line into parts giuen.*

Take the line giuen, and open the *Sector* according to the length of the said line in the points of the parts, whereinto the line should be diuided, then keeping the *Sector* at this angle, the parallell distance betweene the points of 1 and 1 shall diuide the line giuen into the parts required.




Let A B, be the line given to be diuided into fiue parts, first I take this line A B, and to it open the *Sector* in the point of 5 and 5, so the parallell betweene the points of 1 and 1, doth giue me the line A C, which doth diuide it into the parts required.

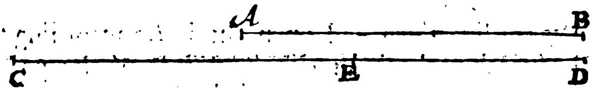



Or let the like line A B, be to be diuided into twenty three parts. First I take out the line and put it vpon the

*Sector* in the points of 23, then may I by the former proposition diminish it in A C, C D, in the proportion of 23, to 10, and after that diuide the line A C into 10, &c, As before.

## 5 *To finde a proportion betweene two or more right lines giuen.*

TAke the greater line giuen, and according to it open the *Sector* in the points of 100 and 100, then take the lesser lines seuerally, & carry them parallell to the greater, till they stay in like points, so the number of points wherein they stay, shall shew their proportion vnto 100.




Let the lines giuen be *AB*, *CD*, first I take the line *CD*, and to it open the *Sector* in the points of 100, and 100, then keeping the *Sector* at this angle, I enter the lesser line *AB*, parallell to the former, and finde it to crosse the lines of *Lines* in the points of 60. Wherefore the proportion of *AB* to *CD*, is as 60 to 100.

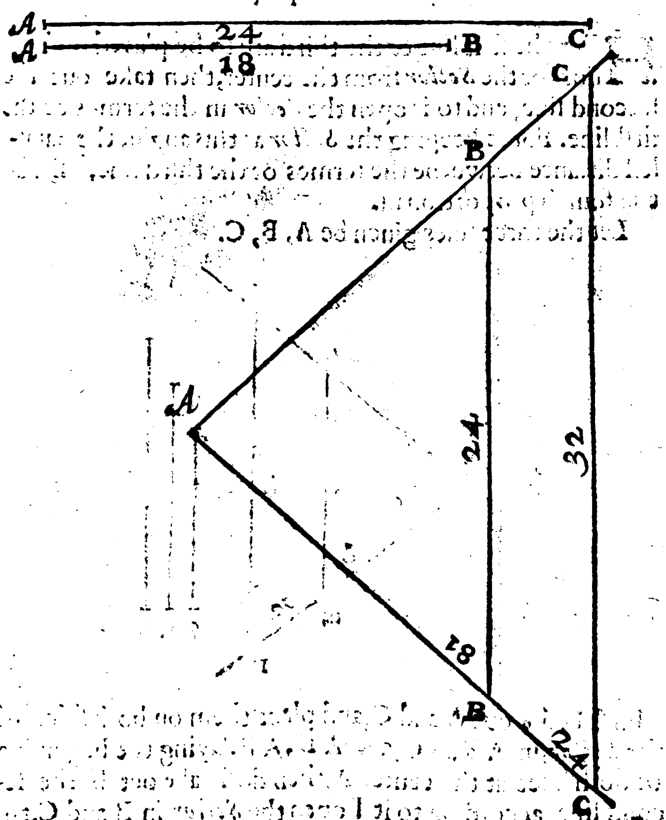
Or if the line *CD*, be greater then can be put ouer in the poynts of 100, then I admit the lesser line *AB*, to be 100, and cutting of *CE* equall to *AB*, I finde the proportion of *CE*, vnto *ED* to be as 100 almost to 67; wherefore this way ẏ proportiō of *AB* vnto *CD*, is as 100 vnto almost 167

this proposition may also not vnfitly be wrought by any other number, that admits seuerall diuisions, and namely, by the numbers of 60. And so the lesser line will be found to be 36, which is as before in lesser numbers, as 3 vnto 5. It may also be wrought without opening the *Sector*. For if the lines betweene which we seek a proportion, be applyed to the lines of *Lines*, (or any other Scale of equall parts) there will be such proportion found between them

them, as betweene the lines to which they are equall.

## 6 *Two lines being giuen to finde a third in continuall proportion.*

FIrst place both the lines giuen, on both sides of the *Sector* from the Center, and marke the termes of of their extension, then take out the second line againe, and to it open the *Sector*, in the termes of the first line, so keeping the *Sector* at this angle, the parallell distance betweene the termes of the second line, shall be the third proportionall.



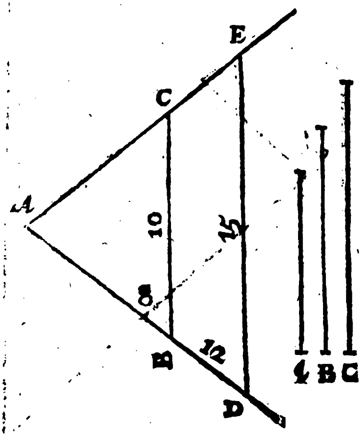

Let

Let the two lines giuen be A B, A C, which I take out and place on both sides of the *Sector*, so as they all meete in the center A, let the termes of the first line be B and B, the termes of the second C and C. Then doe I take out AC the second line againe, and to it open the *Sector* in the termes B B. So the parallell betweene C and C doth giue me the third line in continuall proportion. For as *AB* is vnto *AC*, so B B, equall to *AC*, is vnto *CC*.

## 7 Three lines being giuen to finde the fourth in discontinuall proportion.

HEre the first line & the third are to be placed on both sides of the *Sector* from the center, then take out the seccond line, and to it open the *Sector* in the termes of the first line. For so keeping the *Sector* at this angle, the parallell distance betweene the termes of the third line, shalbe the fourth proportionall.

Let the three lines giuen be A, B, C.




First I take out A and C, and place them on both sides of the *Sector*, in A B, A C, and A D, A E, laying the beginning of both lines at the center A, then do I take out B the second line, according to it I open the *Sector* in B and C, the termes

termes of the first line: so the parallell betweene D and E, doth giue me the fourth proportionall which was required.

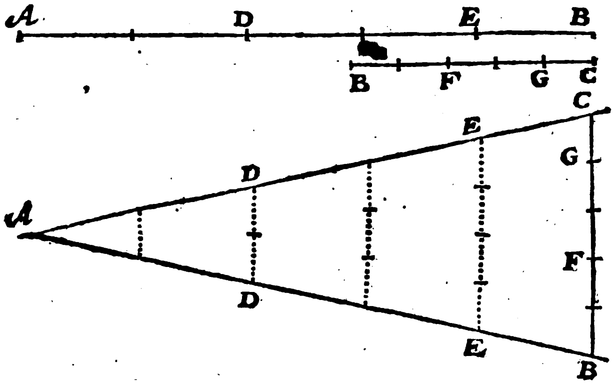
As in *Arithmetique*, it sufficeth if the first and third number giuen be of one denomination, the second & the fourth which is required be of another. For one and the same denomination is not required necessarily in them all. So in *Geometrie*, it sufficeth if the sides A B, A D, resembling the first and third lines giuen be measured in one Scale, and the parallells B C, D E be measured in another. Wherefore knowing the proportion of A the first line, and C the third line, by the fift *prop*. before. Which is here as 8 to 12, & descẽding in lesser nũbers is as 4 to 6, or as 2 to 3, or ascending into greater numbers, as 16 vnto 24 or 18 to 27, or 20 to 30, or 30 to 45, or 40 to 60 &c. If the *Sector* be opened in the points of 8 and 8, to the quantity of *B*, the second line giuen, then a parallell betweene 12 and 12, shall giue D E, the fourth line required. So likewise if it be opened in 4 and 4, then a parallell betweene 6 and 6, or if in 16 and 16, then a parallell betweene 24 and 24 shall giue the same D E. And so in the rest.

### 8 *To deuide a line in such sort as another line is before diuided*

First take out the line giuen, which is already diuided, and laying it on both sids of the *Sector* from the center, mark how farre it extendeth. Then take out the second line which is to be diuided, and to it open the *Sector* in the termes of the first line. This done, take out the parts of the first line, and place them also on the same side of the *Sector* from the center. For the parallells taken in the termes of these parts, shal be the correspondent parts in the line which is to be diuided

Let *A B*, be a line diuided in *D* and *E*, and *B C*, the line which I am to diuide in such sort, as *A B* is diuided.

First I take out the line *A B*, and place it on the line of *Lines* in *A B*, *A C*, both from the center *A*, then take I out the second *B C*, and to it open the *Sector* in *B* and *C*, the termes of the first line. The *Sector* thus opened to his due angle, I take out *A D* and *A E*, the parts of the first line *A B*, and place them also on both the sides of the *Sector A D*, *A E*, so the parallell *D D*, giueth me *B F*, and the parallell *E*, *E*, giueth me B *G*, and now the line B *C*, is diuided in *F* & *G* as is the other line *A* B, in D and *E*, which is that which was




required.

If the line *A* B, were longer then one of the sides of the Ruler, then should I finde what proportion it hath to his parts *A* D, *A E*, and that knowne I may worke as before in the former proposition.

### 9 *Two numbers being giuen to finde a third in continuall proportion.*

First reckon the two numbers giuen on both sides of the lines of *Lines* from the center, and marke the termes to which either of them extendeth, then take out a line resembling the second number againe, and to it open the *Sector* in the termes of the first number, for so keeping the *Sector* at this angle, the parallell distance betweene the termes of the second laterall number, being measured in the same Scale

Scale, from whence his parallell was taken, shall giue the third number proportionall.

Let the two numbers giuen be 18, 24, these being resembled in lines, the worke will be in a manner all one, with that in the sixt *Prop.* and so the third proportionall number will be found to be 32.

## 10. *Three numbers being giuen to find a fourth in discontinuall proportion.*

THe solution of this proposition, is in a manner all one with that before in the seuenth *Prop.* onely there may be some difficulty in placing of the numbers. To avoyd this, we must remember that three numbers being giuen, the question is annexed but to one, and this must allwayes be placed in the third place, that which agrees with this third number in denomination, shalbe the first number, and that which remaineth the second number. This being considered, reckon the first, and third numbers, which are of the first denomination on both sides of the lines of *Lines* from the center, and marke the termes to which either of them extendeth, then take out a line resembling the second number, and to it open the *Sector* in the termes of the first number, for so keeping the *Sector* at this angle, the parallell distance betweene the termes of the third laterall number, being measured in the same Scale from whence his parallell was taken, shall giue the fourth number proportionall.

As if a question were proposed in this manner 10 yards cost 8 ℔, how many yards may we buy for 12 ℔? heere the question is annexed to 12; and therefore it shall be the third number, and because 8 is of the same denomination, it shall be the first number, then 10 remaining, it must be the second number, so will they stand in this order, 8, 10, 12. These being resembled in lines, the worke will be in a manner the same, with that in the seventh *Prop.* and the fourth proportionall number will be found to be 15. For as 8 are to 10, so 12 unto 15.

And this holdeth in direct proportion, where, as the first number is to the second, so the third to the fourth. So that if the third number be greater then the first, the fourth will be greater then the second, or if the third number be lesse then the first, the fourth will be lesse then the second, but in *reciprocall* proportion, commonly called the *Backe rule*, where by how much the first number is greater then the third, so much the second will be lesse then the fourth, or by how much the first number is lesse then the third, so much the second will be greater then the fourth. The manner of working must be contrary, that is; the *Sector* is to be opened in the termes of the third number, and the parallell resembling the number required, is to be found betweene the termes of the first number, the rest may be obserued as before, as for example.

*If twelue men would raise a frame in ten dayes, in how many dayes would eight men raise the same frame? Here, because the fewer men would require longer time, though the numbers be 12, 10, 8, yet the fourth proportionall will be found to be 15.*

*So if 60 yards, of three quarters of a yard in bredth, would hang round about a roome, & it were required to know how many yards of halfe a yard in bredth, would serue for the same roome. The fourth proportionall would be found to be 90.*

*So if to make a foote superficiall, 12 inches in bredth doe require 12 inches in length, & the bredth being 16 inches, it were required to know the length. Here, because the more breadth, the lesse length, the fourth proportionall will be found to be 9.*

*So if to make a Solid foote, a base of 144 inches, require 12 inches in hight, and a base giuen being 216 inches, it were required to know how many inches it shall haue in hight. The fourth proportionall would be found to be 8.*

This last proposition of finding a fourth proportionall number

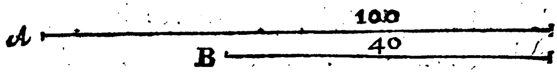
number, may be wrought also by the lines of *Superficies*, and by the lines of *Solids*.

# CHAP. III.

## *The vse of the lines of Superficies.*

### 1 *To finde a proportion betweene two or more like* Superficies.

TAke one of the sides of the greater *Superficies* giuen, and according to it open the *Sector* in the points of 100 and 100, in the lines of *Superficies*, then take the like sides of the lesser *Superficies* seuerally, and carry them parallell to the former, till they stay in like points, so the number of points wherein they stay, shall shew their proportion vnto 100.

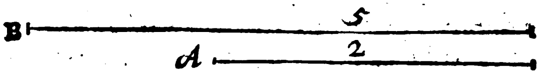



Let *A* and B, be the sides of like *Superficies*, as the sides of two squares, or the diameters of two circles, first I take the side *A*, and to it open the *Sector* in the points of 100, then keeping the *Sector* to this angle, I enter the lesser side B, parallell to the former, and finde it to crosse the lines of *Superficies* in the points of 40, wherefore the proportion of the *Superficies*, whose side is *A*, to that whose side is B, is as 100 vnto 40, which is in lesser number, as 5 vnto 2.

This proposition might haue beene wrought by 60, or any other number that admits seuerall diuisions. It may also be wrought without opening the *Sector*, for if the sides of the *Superficies* giuen, be applied to the lines of *Superficies* beginning alwayes at the center of the *Sector*, there will be such proportion found betweene them, as betweene the number of parts whereon they fall.

2 *To augment a Superficies in a giuen Proportion.*
3 *To diminish a Superficies in a giuen Proportion.*

TAke the side of the *Superficies*, and to it open the *Sector* in the points of the numbers giuen; then keeping the *Sector* at that angle, the parallell distance between the points of the number required, shall giue the like side of the *Superficies* required.




Let *A* be the side of a Square to be augmented in the proportion of 2 to 5. First I take the side *A*, and put it ouer in the lines of *Superficies*, in 2 and 2; so the parallell between 5 and 5, doth giue me the side *B*, on which if I should make a Square, it would haue such proportion to the square of *A*, as 5 vnto 2.

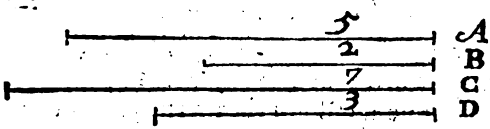
In like manner if *B* were the semidiameter of a circle to be diminished in the proportion of 5 unto 2, I would take out *B*, and put it ouer in the lines of *Superficies*, in 5 and 5; so the parallell betweene 2 and 2 would giue me *A*; on which Semidiameter if I should make a circle, it would be lesse then the circle made upon the Semidiameter *B*, in such proportion as 2 is lesse then 5.

For varietie of worke the like caution may be here observed to that which we gaue in the third *Proportion* of *Lines*.

4 *To adde one like Superficies to another.*
5 *To subtract one like Superficies from another.*

FIrst, the proportion betweene like sides of the *Superficies* giuen, is to be found by the first *Prop.* of *Superficies*, then adde or subtract the numbers of those proportions, and

and accordingly augment or diminish by the former *Proposition.*

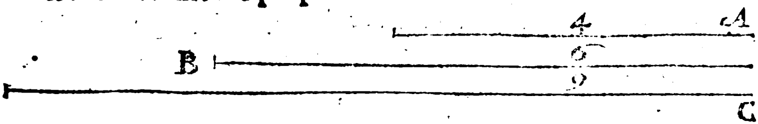



As if *A* and *B* were the side of two Squares, and it were required to make a third Square equall to them both. First the proportion betweene the Squares of *A* and *B*, would be found to be as 100 unto 40, or in the lesser numbers as 5 to 2; then because 5 and 2 added doe make 7, I augment the side *A* in the proportion of 5 to 7, and produce the side *C*, on which if I make a square, it will be equall to both the squares of *A* and *B*, which was required.

In like manner *A* and *B* being the sides of two Squares, if it were required to subtract the square of *B* out of the square of *A*, and to make a square equall to the remainder, here the proportion being as 5 to 2, because 2 taken out of 5, the remainder is 3, I would diminish the side *A* in the proportion of 5 to 3, and so I should produce the side *D*, on which if I make a square, it will be equal to the remainder when the square of B is taken out of the square of *A*, that is, the two squares made vpon *B* & *D*, shall be equall to the first square made vpon the side *A*.

## 6 *To finde a meane proportionall betweene two lines given.*

First find what proportion is betweene the lines giuen, as they are lines, by the fifth *Prop.* of *Lines*, then open the *Sector* in the lines of *Superficies*, according to his number, to the quantitie of the one, and a parallell taken betweene the points of the number belonging to the other line shall be the meane proportionall.



Let the lines given be A and C. The proportion betweene them as they are lines will be found by the fifth *propofit.* of *lines* to be as 4 to 9. Wherefore I take the line C, and put it over to the lines of *Superficies* betweene 9 and 9, and keeping the *Sector* at this angle, his parallell between 4 and 4 doth give me B for the meane proportionall. Then for proofe of the operation I may take this line B, and put it over betweene 9 and 9: so his parallell betweene 4 & 4, shall give me the first line A. Whereby it is plaine that these three lines doe hold in continuall proportion, and therefore B is a meane proportionall betweene A and C the extremes given.

Vpon the finding out of this meane proportion depend many Corollaries, as

*To make a Square equall to a Superficies giuen.*

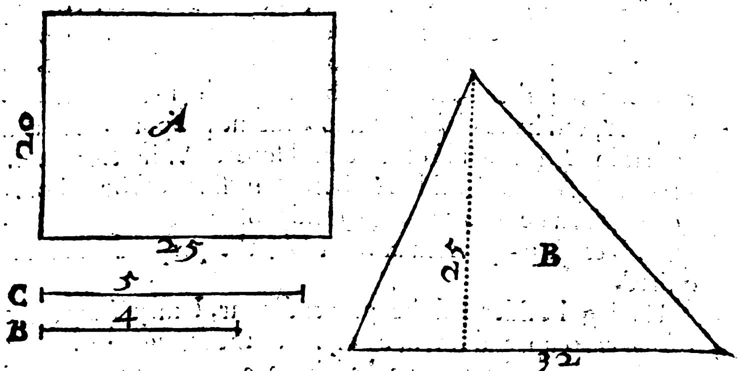
IF the *Superficies* giuen be a rectangle parallelogram, a meane proportionall betweene the two vnequall sides shall be the side of his equall square.

If it shall be a triangle, a meane proportion betweene the perpendicular and halfe the base shall be the side of his equall square. If it shall be any other right-lined figure, it may be resolued into triangles, and so a side of a square found equall to euery triangle; and these being reduced into one equall square, it shall be equall to the whole right-lined figure giuen.

*To finde a proportion betweene Superficies, though they be unlike one to the other.*

IF to every *Superficies* we find the side of his equall square, the proportion betweene these squares, shall be the proportion betweene the *Superficies* given.

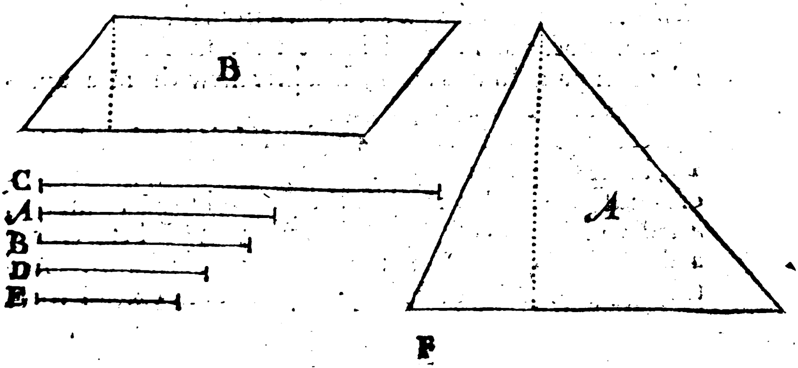
Let




Let the *Superficies* given, be the oblonge *A*, and the triangle *B*. First between the vnequall sides of *A*, I finde a meane proportionall, and note it in *C*: this is the side of a square equall unto *A*. Then betweene the perpendicular of B, and halfe his base, I finde a meane proportionall, and note it in B: this is the side of a Square equall to *B*: but the proportion between the squares of *C* and B, will be found by the first *Prop.* of *Superficies* to be as 5 to 4: and therefore this is the proportion between those given *Superficies*.

## *To make a Superficies like to one Superficies and equall to another.*

LEt the one *Superficies* given be the *triangle* A, and the other the *Rhomboides* B; and let it be required to make an-



other *Rhomboides* like to B, and equall to the *triangle A.*

First between the perpendicular and the base of *B*, I find a meane proportionall, and note it in B, as the side of his equall square: then betweene the perpendicular of the triangle *A*, and halfe his base, I find a meane proportionall, and note it in *A*, as the side of his equall square. Wherefore now as the side B is to the side *A*, so shall the sides of the Rhomboides giuen be to *C* and *D*, the sides of the Rhomboides required, & his perpendicular also to *E*, the perpendicular required.

Hauing the sides and the perpendicular, I may frame the *Rhomboides* up, and it will be equall to the triangle *A*.

If the *Superficies* giuen had been any other right-lined figures, they might haue been resolved into triangles, and then brought into squares as before.

Many such Corollaries might haue been annexed, but the meanes of finding a meane proportionall being knowne, they all follow of themselues.

### 7. To finde a meane proportionall betweene two numbers giuen.

FIrst reckon the two numbers giuen on both sides of the Lines of *Superficies*, from the center, and mark the termes whereunto they extend; then take a line out of the Line of *Lines*, or any other scale of equall parts resembling one of those numbers giuen, and put it ouer in the termes of his like number in the lines of *Superficies*; for so keeping the *Sector* at this angle, the parallell taken from the termes of the other number and measured in the same scale from which the other parallell was taken, shall here shew the meane proportionall which was required.

Let the numbers giuen be 4 and 9. If I shall take the line *A*, in the *diagram* of the sixt *Prop.* resembling 4 in a scale of equall parts, and to it open the *Sector* in the termes of 4 and 4. in the lines of *Superficies*, his parallell betweene 9 and 9 doth giue me B for the meane proportionall. And this measured in the scale of equall parts doth extend to 6,

which

which is the meane proportionall number betweene 4 and 9. For as 4 to 6, so 6 to 9.

In like manner if I take the line *C*, resembling 9 in a scale of equall parts, and to it open the *Sector* in the termes of 9 and 9, in the lines of *Superficies*, his parallell betweene 4 and 4 doth giue me the same line *B*, which will proue to be 6, as before, if it be measured in the same scale whence *C* was taken.

For, the figures 1, 2, 3, 4, &c. heere set downe upon the line, do sometime signifie themselues alone: sometime, 10, 20, 30, 40 &c. sometime 100, 200, 300, 400 &c. and so forward as the matter shall require. The first figure of euery number is alway that which is here set down: the rest must be supplied according to the nature of the question.

If you suppose pricks under the number given (as in *arithmeticall* extraction) and the last prick to the left hand shall fall under the last *fig.* (which will be as oft as there be odd figures) the unite will be best placed at 1, in the middle of the line, so the root, & the square will both fall forward, toward the end of the line. But, if the last pricke shall fal under the last figure but one (which will be as oft as there be euen Figures) then, the unite may be placed at 1 in the beginning of the line, and the square in the second length: or the unite may be placed at 10, in the end of the line, so the root and the square will both fall backward, toward the middle of the line.

8 *To find the square roote of a number.*

9 *The roote being giuen to find the square number of that roote.*

IN the extraction of a square roote it is usuall to set pricks under the first figure, the third, the fifth, the seventh, and so forward, beginning from the right hand toward the left, and as many pricks as fall to be under the square number given, so many figures shall be in the roote: so that if the number given be lesse then 100, the roote shall be onely of one figure; if lesse then 10000, it shall be but two figures; if lesse then 1000000, it shall be three figures, &c.

Thereupon the lines of *Superficies* are divided first into an hundred parts, and if the number given be greater then 100, the first division (which before did signifie only one) must signifie 100, and the whole line shall be 10000 parts: if yet the number given be greater then 10000, the first division must now signifie 10000, and the whole line be esteemed at 1000000 parts: and if this be too little to expresse the number given, as oft as we have recourse to the beginning, the whole line shall increase it selfe an hundred times.

By these meanes if the last pricke to the left hand shall fall under the last figure, which will be as oft as there be odde figures, the number given shall fall out betweene the center of the *Sector* and the tenth division: but if the last prick shall fall under the last figure but one, which will be as oft as there be even figures, then the number given shall fall out betweene the tenth division and the end of the *Sector*.

This being considered, when a number is given and the square roote is required, take a paire of compasses and setting one foote in the center, extend the other to the terme of the number given in one of the lines of *Superficies*; for this distance applied to one of the Lines of *Lines*, shall shew what the Square root is, without opening the *Sector*.

Thus 36 doth give a root of 6 and 360, a root of (almost) 19: and 3600, a root of 60: and 36000, a root of 189 &c.

In like manner, the neerest root of 725 is here found to be (about) 27: the neerest root of 7250, about 85: the neerest of 72500, about 269: and the neerest root of 725000, about 851: And so in the rest.

On the contrary, a number giuen may be squared, if first we extend the compasses to the number given in the lines of *Lines*, and then apply the distance to the *Lines* of *Superficies*, as may appeare by the former examples.

## 10 Three numbers being given to find the fourth in a duplicated proportion.

IT is plaine by the 19 and 20 *Prop.* 6 *Lib.* of *Euclid.* that like *Superficies* do hold in a duplicated proportion of their homologall sides, whereupon a question being moved concerning *Superficies* and their sides. It is usuall in Arithmeticke that the proportion be first duplicated before the question be resolved, which is not necessarie in the use of the *Sector*, onely the numbers which doe signifie *Superficies* must be reckoned in the lines of *Superficies*, and they which signifie the sides of *Superficies*, in the lines of *Lines*, after this manner.

If a question be made concerning a *Superficies*, the two numbers of the first denomination must be reckoned in the lines of *Lines*, and the *Sector* opened in the termes of the first number to the quantitie of a line out of the scale of *Superficies* resembling the second number; so his parallels taken betweene the termes of the third number, being measured in the same scale of *Superficies*, shall give the Superficiall number which was required.

As if a Square, whose side is fortie perches in length, shall containe ten acres in the *Superficies*, and it be required to know how many acres the Square should containe, whose side is sixtie perches.

Here If I tooke 10 out of the line of *Superficies*, and put it over in 40 in the lines of *Lines*, his parallel betweene 60 and

60 measured in the line of *Superficies*, would be 22 $\frac{1}{2}$; and such is the number of acrees required. For Squares doe hold in a duplicated proportion of their sides; wherefore when the proportion of their sides is as 4 to 6, and 4 multiplied into 4 become 16, and 6 multiplied into 6 become 36, the proportion of their squares shall be as 16 to 36; and such is the proportion of 10 to 22 $\frac{1}{2}$.

If a field measured with a statute perch of 16$\frac{1}{2}$ foote, shall containe 288 acres, and it be required to know how many acres it would containe if it were measured with a wood-land perch of 18 foote.

Here because the proportion is reciprocall, if I tooke 288 out of the line of *Superficies*, and put it ouer in 18, in the lines of *Lines*, his parallell betweene 16$\frac{1}{2}$ and 16$\frac{1}{2}$ measured in the line of *Superficies*, would be 242; and such is the number of acres required.

For seeing the proportion of the sides is as 16$\frac{1}{2}$ to 18, or in lesser numbers as 11 to 12, and that 11 multiplied into 11 become 121, and 12 into 12 become 144, the proportion of these *Superficies* shall be as 121 to 144, and so haue 288 to 242, in *reciprocall* proportion.

On the contrary, if a question be proposed concerning the side of a *Superficies*, the two numbers of the first denomination must be reckoned in the lines of *Superficies*, and the *Sector* opened in the termes of the first number, to the quantitie of a line, out of the line of *Lines* or some Scale of equall parts, resembling the second number; so his parallell taken betweene the termes of the third number being measured in the same scale with the second number, shall giue the fourth number required.

As if a field contained 288 acres when it was measured with a statute perch of 16$\frac{1}{2}$, and being measured with another perch, was found to containe 242 acres, it were required to know what was the length of the perch with which it was so measured.

Here because the proportion is reciprocall, if I tooke 16$\frac{1}{2}$ out of the line of *Lines*, and put it ouer in 242 in the lines of of *Superficies*, his parallell betweene 288 and 288, being measured in the line of *Lines*, would be 18, & such is the length of the perch in feete whereby the field was last measured.

For seeing the proportion of the acres is as 288 unto 240, or in the least numbers as 144 to 121, and that the roote of 144 is 12, and the root of 121 is 11, the proportion of roots and consequently of the perches shall be as 12 to 11, and so are 16½ to 18, in *reciprocall* proportion.

If 360 men were to be set in forme of a long square, whose sides shall haue the proportion of 5 to 8; and it were required to know the number of men to be placed in front and file: if the sides were only 5 and 8, there should be but 40 men; but there are 360: therefore, working as before, I finde that.

As 40 to the square of 5,
so 360 to the square of 15.

As 40 to the square of 8,
so 360 to the square of 24,

and so 15 and 24 are the sides required.

If 1000 men were lodged in a square ground, whose side were 60 paces, and it were required to know the side of the square wherein 5000 might be so lodged, here working as before, I should finde that:

As 1000 are to the square of 60:
so 5000 to the square of 134,

And such very neare is the number of paces required.

## CHAP. IV.

### The use of the lines of Solids.

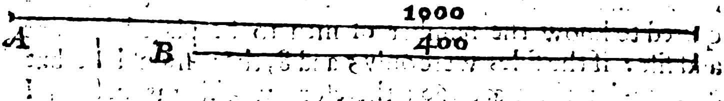
#### To finde a proportion betweene two or more like Solids.

IN the Sphere, in regular, parallell, and other like bodies, whose sides next the equall angles are proportionall, the

worke

worke is in a manner the same, with that in the first *Prop.* of *Superficies*, but that it is wrought on other lines.

Take one of the sides of the greater *Solid*, & according to it open the *Sector* in the points of a 1000 & 1000, in the lines of *Solids*, then take the like sides of the lesser *Solids* severally, and carry them parallell to the former, till they stay in like points; so the number of points wherein they stay, shall shew their proportion to 1000.




Let *A* and *B*, be the like sides of like Solids, either the diameters, or semidiameters of two spheres, or the sides of two cubes, or other like. First I take the side *A*, and to it open the *Sector* in the points of 1000, then keeping the *Sector* at this angle, I enter the lesser side *B*, parallell to the former, and finde it to crosse the line of *Solids* in the points of 400, and such is the proportion betweene the Solids required, which in lesser number is as 5 to 2.

This proposition might have been wrought by 60, or any other number that admits severall divisions.

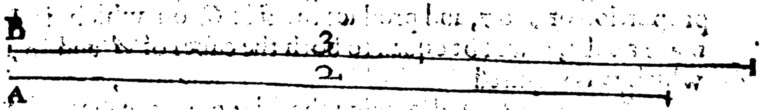
It may also be wrought without opening the *Sector*, for if the sides of the Solids given, be applied to the lines of *Solids*, begining all wayes at the center of the *Sector*, there will be such proportion betweene them, as betweene the numbers of parts whereon they fall.

2 *To augment a Solid in a given proportion.*

3 *To diminish a Solid in a given proportion.*

Take the side of the Solid given, and to it open the *Sector*, in the points of the number given: then keeping the Sector at that angle, the parallell distance betweene the points of the number required, shall give the like side of the Solid requyred.

If it be a parallelepipedon, or some irregular Solid, the other like sides may be found out in the same manner, and with them the Solids required, may be made up with the same angles.



Let *A* be the side of a cube, to be augmented in the proportion of 2 to 3. First I take the side *A*, and put it over in the lines of *Solids* in 2 and 2, so the parallell betweene 3 and 3, doth give me the side B, on which if I make a cube, it will have such proportion to the cube of *A*, as 3 to 2.

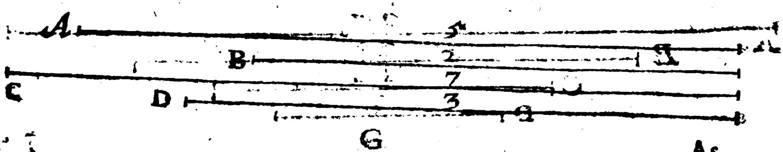
In like manner, if B were the diameter of a Sphere, to be diminished in the proportion of 3 to 2, I would take out B, and put it over in the lines of *Solids*, in 3 and 3, so the parallell betweene 2 and 2, would give me *A*: to which diameter if I should make a Sphere, it would be lesse then the Sphere, whose diameter is B, in such proportion as 2 is lesse then 3.

Here also for variety of worke, may the like caution be observed to that which we gave in the third *Prop.* of *Lines*.

*4. To adde one like Solid to another.*

*5. To subtract one like Solid from another.*

First the proportion betweene the sides of the like Solids given, is to be found by the first *Prop.* of *Solids*, then adde or subtract those proportions, and accordingly augment or diminish by the former *Prop.*

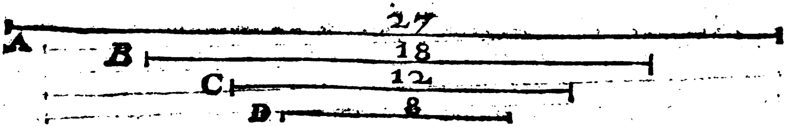


As if *A* and *B* where the sides of two cubes, and it were required to make a third cube equall to them both: first the proportion betweene the sides *A* and *B*, would be found to be as 100 to 40, or in lesser termes as 5 to 2. Then because 5 and 2 being added do make 7, I augment the side *A* in the proportion of 5 to 7, and produce the side *C*, on which if I make a cube, it will be equall to both the cubes of *A* and *B*, which was required.

In like maner *A* and *B* being the sides of two cubes, if it were required to subtract the cube of B out of the cube of A, and to make a cube equall to the remainder. Here the proportion being as 5 to 2, because 2 taken out of 5; the remainder is 3, I should diminish the side A in the proportion of 5 to 2, and so I should have the side D, on which if I make a cube, it will be equall to the remainder when the cube of B is taken out of the cube of A, that is the two cubes made upon B and D, shall be equall to the first cube made upon the side A.

### 6 *To find two meane proportionall lines betweene two extreme lines given.*

First I find what proportion is betweene the two extreme lines given as they are lines, by the fifth *Prop:* of *Lines*, then open the *Sector* in the lines of *Solids*, to the quantitie of the former extreme, and a parallell betweene the points of the number belonging to the other extreame, shall be that meane proportionall which is next the former extreme. This done, open the *Sector* againe to this meane proportionall in the points of the former extreme, and the parallell distance betweene the points of the latter extreme, shall be the other meane proportionall required.

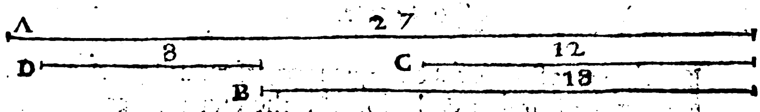


Let the two extreme lines given be A and D, the proportion betweene them, as they are lines, will be found to be as 27 to 8. Wherefore I take the line A, and put it over in the lines of *Solids* betweene 27 and 27, and keeping the *Sector* at this angle, his parallell betweene 8 and 8, doth give me *B*, the meane proportionall next unto A. Then put I over this line B, betweene the aforesaid 27 and 27, and his parallell betweene 8 and 8 doth give me the line C, the other meane proportionall which was required.

Againe, for proofe of the operation I put over this line C in the aforesaid 27 and 27, and his parallell betweene 8 and 8 doth give me the very line D: whereby it is plaine that these foure lines do hold in continuall proportion, and so B and C are found to be the meane proportionals betweene A and D the extremes given.

### 7 *To find two meane proportionall numbers betweene two extreme numbers given.*

First reckon the numbers given on both sides of the lines of *Solids*, beginning from the center, and marking the termes whereto they extend: then take a line out of the line of *Lines*, or any other scale of equall parts resembling the former of those numbers, and put it over in the lines of *Solids*, betweene the points of his like number, and a parallell betweene the points belonging to the other extreme, measured in the scale from whence the other parallell was taken, shall give that meane proportionall number which is next the former extreme. This done open the *Sector* againe to this meane proportionall in the points of the former extreme, and the parallell distance betweene the points of the latter extreme, measured in the same scale as before, shall there shew the other meane proportionall required.



Let the two extreame numbers given be 27 and 8; if I shall take the line A, resembling 27 in a scale of equall parts, and to it open the *Sector* in 27 and 27, in the line of *Solids*, his parallell betweene 8 and 8 doth give me B for his next meane proportionall, and this measured in the former scale doth extend to 18. Then put I over this line B between the aforesaid 27 and 27, and his parallell between 8 and 8 doth give me C for the other meane proportionall, and this measured in the former scale doth extend to 12. Againe, for proofe of my worke, I put over this line C betweene 27 and 27, as before, and his parallell betweene 8 and 8 doth give me D, which measured in the former scale doth extend to 8, which was the latter extreame number given; whereby it is plaine that these foure numbers do hold in continuall proportion: and therefore 18 and 12 are meane proportionalls betweene 27 and 8, which was required.

If you suppose pricks under the number given as in *arithmeticall* extraction and that last prick to the left hand shall fall under the last figure, as in 1728, the unite will be left placed at 1, in the middle of the line and the Root square and cube will all fall forward toward the end of the line.

If the last pricke shall fall under the last figure but one, as in 17280; the unite may be placed at 1, in the beginning of the line, and the cube in the second length: or the unite may be placed at 10, in the end of the line, and the cube in the first length.

But if the last prick shall fall on the last figure but two, as in 172800; then, place the unite always at 10, in the end of the line: so, the Root square and cube will all fall backward and be found in the second length.

8. *To find the cubique roote of a number.*

9 *The roote being given to finde the cube number of that roote.*

IN the extraction of a cubique root, it is usuall to set pricks under the first figure, the fourth, the seventh, and tenth, and

| | |
|---|---|
| *Inch.* | |
| *Cent* | |
| *Foot.* | |
| *Pace.* | |
| *Perch.* | |
| *Chain.* | |
| *Acre.* | 627[illegible] |
| *Mile.* | 4014489[illegible] |

Square.

and so forward, omitting two, and pricking the third from the right hane toward the left; and as many pricks as fall to be under the cubique number, so many figures shall be in the roote. So that if the number given be lesse then 1000, the roote shall be only of one figure; if lesse then 1000000, it shall be but of two figures; if above these, and lesse then 1000000000, it shall be but three figures; &c. whereupon the lines of *Solids* are divided, first into 1000, parts, and if the numbers given be greater then 1000, the first division (which before did signifie onely one) must signifie 1000, and the whole line shall be 1000000: if yet the number given be greater then 1000000, the first division must now signifie 1000000, and the whole line be esteemed at 1000000000 parts, and if these be to little to expresse the numbers given, as oft as we have recourse to the beginning, the whole line shall encreace it selfe a thousanp times.

By these meanes, if the last pricke, to the left hand, shall fall under the last figure, the number given shall be reckoned at the beginning of the lines of *Solids* from 1 to 10, and the first figure of the roote shall be alwayes either 1, or 2. If the last pricke shall fall under the last figure but one, then the number given shall be reckoned in the middle of the line of *Solids*, between 10 and 100, and the first figure of the roote shall be alwayes either 2, or 3, or 4. But if the last pricke shall fall under the last figure but two, then the number given, shall be reckoned at the end of the line of Solids, betweene 100, and 1000.

This being considered when a number is given, and the cubique roote required: Set one foote of the compasses in the center of the *Sector*, extend the other in the line of *Solids* to the points of the number given: for this distance applied to one of the lines of *Lines*, shall shew what the cubique root is, without opening the *Sector*.

So the neerest roote of 8490000, is about 204.
The neerest roote of 84900000, is about 439.
The neerest roote of 849000000, is about 947.

On the contrary, a number may be cubed, if first we extend the compasses to the number given, in the line of *Lines*, and then apply the distance to the lines of *Solids*; as may appeare by the former examples.

## 10 *Three numbers being given to finde a fourth in a triplicated proportion.*

AS like *Superficies* doe hold in a duplicated proportion, so like solids in a triplicated proportion of their homologall sides: and therefore the same worke is to be observed here on the lines of *Solids*, as before in the lines of *Superficies*; as may appeare by these two examples.

If a cube whose side is 4 inches, shall be 7 pound weight, and if it be required to know the weight of a cube whose side is 7 inches; here the proportion would be,

As 4 are to a cube of 70.
so 7 to a cube of $37\frac{1}{2}$

And if I tooke 7 out of the lines of *Solids*, and put it over in 4 and 4, in the lines of *Lines*, his parallell between 7 and 7 measured in the lines of *Solids*, would be $37\frac{1}{2}$; and such is the weight required.

If a bullet of 27 pound weight haue a diamiter of 6 inches; and it be required to know the diamiter of the like bullet, whose weight is 125 pounds; here the proportion would be,

As the cubique root of 27 is unto 6:
So the cubique root of 125 is unto 10.

And if I tooke 6 out of the line of *Lines*, and put it over in 27 and 27 of the lines of *Solids*, his parallell betweene 125 and 125 measured in the line of *Lines*, would be 10; and such is the length of the diameter required.

*The end of the first Booke.*

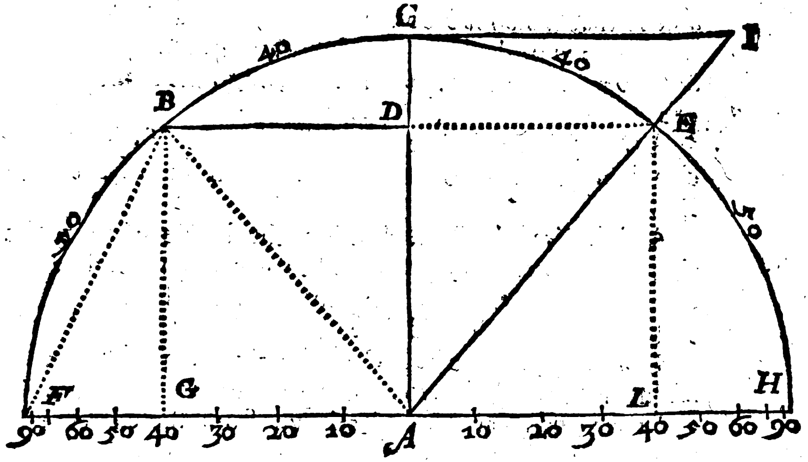
# THE SECOND BOOKE OF THE SECTOR

## Containing the vse of the Circular *Lines.*

## CPAP. I.

### *Of the nature of* Sines, Chords, Tangents *and* Secants, *fit to be knowne before hand in reference to right-line Triangles.*

IN the *Canon* of *Triangles*, a circle is commonly divided into 360 *degrees*, each *degree* into 60 *minutes*, each *minute* into 60 *seconds*.




A semicircle therefore is an arke of 180 gr.

A quadrant is an arke of 90 *gr.*

The measure of an angle is the arke of a circle, described out of the angular point, intercepted betweene the sides sufficiently produced.

So the measure of a right angle is alwayes an arke of 90 *gr.* and in this example the measure of the angle B A D is the arke B C of 40 *gr*; the measure of the angle B A G, is the arc B F of 50 *gr.*

The complement of an arke or of an angle doth commonly signifie the arke which the given arke doth want of 90 *gr:* and so the arke B F is the complement of the arke B C; & the angle B A F, whose measure is B F is the complement of the angle B A C; and on the contrary.

The complement of an arke or angle in regard of a semicircle, is that arke which the given arke wanteth to made up 180 *gr:* and so the angle E A H is the complement of the angle E A F, as the arke E H is the complement of the arke F E, in which the arke C E is the excesse aboue the quadrant.

The proportions which these arkes (being the measures of angles) have to the sides of a triangle, cannot be certaine, unlesse that which is crooked be brought to a straight line; and that may be done by the application of *Chords*, *Right Sines*, *versed Sines*, *Tangents* and *Secants*, to the semidiameter of a circle.

A *Chorde* is a right line subtending an arke: so B E is the chord of the arke B C E, and B F a chorde of the arke B F.

A *right Sine* is halfe the chorde of the double arke, viz. the right line which falleth perpendicularly from the one extreme of the given arke, vpon the diameter drawne to the other extreme of the said arke.

So if the given arke be B C, or the given angle be B A C, let the diameter be drawne through the center A unto C; and a perpendicular B D be let downe from the extreme B, upon A C; this perpendicular B D shall be the *right sine* both of the arke B C, and also of the angle B A C: and it is

also

also the halfe of the chord B E, subtending the arke B C E. which is double to the given arke B C. In like manner, the semidiameter F A, is the *right sine* of the arke F C, and of the right angle F A C; for it falleth perpendicularly upon A C, and it is the halfe of the chord F H,

This whole Sine of 90 *gr.* is hereafter called *Radius*; but the other *Sines* take their denomination from the degrees and minutes of their arks.

*Sinus versus*, the *versed sine* is a segment of the diameter, intercepted betweene the *right sine* of the same arke, and the circumference of the circle. So D C is the *versed sine* of the arke C B, and G F the *versed sine* of the arke B F, and G H the *versed sine* of the arke B H.

A *Tangent* is a right line perpendicular to the diameter, drawne by the one extreme of the given arke, and terminated by the *secant* drawne from the center through the other extreme of the said arke.

A *Secant* is a right line drawne from the center, through one extreme of the given arke, till it meete with the *tangent* raised from the diameter at the other extreme of the said arke.

So if the given arke be C E, or the given angle be C A E, let the diameter be drawne through the center A to C, and in C to A C, be raised a perpendicular C I. Then let another line be drawne from the center A through E, till it meet with the perpendicular C I in I; the line C I is a *Tangent*, and A I is the *Secant* both of the arke C E, and of the angle C A E.

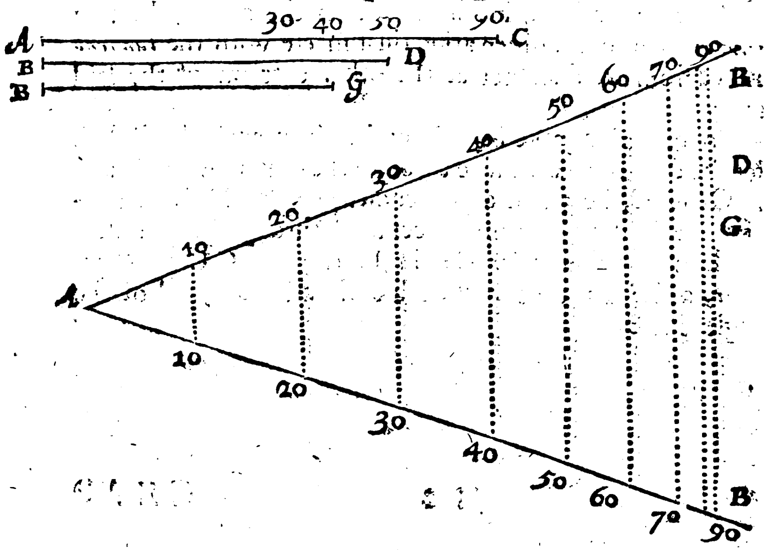
# CHAP. II.

## Of the generall use of Sines and Tangents.

### 1 The Radius being knowne to find the right sine of any arke or angle.

IF the Radius of the circle given be equall to the laterall Radius, that is, to the whole line of *Sines* on the *Sector*, there needs no farther worke, but to take the other sines also out of the side of the *Sector*. But if it be either greater or lesser, then let it be made a parallell Radius, by applying it over in the lines of *Sines*, betweene 90 and 90, so the parallell taken from the like laterall sines, shall be the *sine* required.

As if the given Radius be *A C*, and it were required to find the sine of 50 *Gr*. & his complement agreeable to that Radius.




Let *A B*, *A B* represent the lines of *sines* on the *Sector*, and let B B, the distance betweene 90 and 90, be equall to the given

given radius *A C*. Here the lines *A* 40, *A* 50, *A* 90, may be called the *laterall sines* of 40, 50, & 90; in regard of their place on the side of the *Sector*. The lines betweene 40 and 40, betweene 50 and 50, betweene 90 and 90, may be called the *parallell sines* of 40, 50, and 90; in regard they are parallell one to the other. The whole sine of 90 *Gr.* here standing for the semidiameter of the circle, may be called the Radius. And therefore if *A C* be put over in the line of *Sines* in 90 and 90 and so made a *parallell radius*, his parallell sine betweene 50 and 50, shall be B D, the sine of 50 required. And because 50 taken out of 90, the complement is 40; his *parallell sines* betweene 40 and 40, shall be B G, the sine of the complement which was required.

### 2 *The right sine of any arke being given to find the Radius.*

TVrne the sine given into a parallell sine, and his parallell *Radius* shall be the *Radius* required.

As if B D were the given sine of 50 *Gr.* and it were required to finde the Radius: let B D be made a parallell sine of 50 *Gr.* by applying it over in the lines of *Sines*, betweene 50 and 50; so his parallell Radius betweene 90 and 90 shall be A C, the Radius required.

### 3 *The Radius of a circle, or the right Sine of any arke being given, and a streight line resembling a Sine, to find the quantitie of that unknowne* Sine.

Let the Radius or right sine given be turned into his parallell; then take the right line given, and carrie it parallell to the former, till it stay in like *Sines*: so the number of degrees and minutes where it stayeth, shall give the quantitie of the Sine required.

As if B D were the given sine of 50 *Gr.* and B G the streight line given: first I make B D a parallell sine of 50 *Gr.* then keeping the *Sector* at this angle, I carie the line B G parallell, and find it to stay in no other but 40 and 40; and therefore 40 *gr*. is this quantitie required.

## 4 *The Radius or any right Sine being given, to find the versed sine of any arke*

If the arke, whose *versed sine* is required, be lesse then the quadrant, take the sine of the complement out of the radius, and the remainder shall be the *sinus versus*, the versed sine of that arke.

As If A B being the laterall *Radius*, it were required to find the versed sine of 40 *gr*; here the sine of the complement is A 50, and therefore B 50 is the *versed sine* required. Or if I reckon from B, at the end of the Sector, toward the center, the distance from 90 to 80, is the versed sine of 10 *gr*; from 90 to 70, the versed sine of 20 *gr*; from 90 to 60, is the versed sine of 30 *gr*: and so in the rest:

If A D be the given *sine* of 50 *gr*. and it be required to find the *versed sine* of 50 *gr*; here because A D is unequall to the laterall sine of 50 *gr*; I make it a parallell. And first I find the radius A C, then the sine of the complement A 40, which being taken out of A C, leaveth C 40 for the versed sine of 50 *gr*. which was required.

But if the arke, whose versed sine is required, be greater then the quadrant, his versed sine also is greater then the *Radius*, by the right sine of his excesse above 90 *gr*.

As if A C being the Radius given, it were required to find the versed sine of 130 *gr*: here the excesse above 90 *gr*. is 40 *gr*: and therefore the versed sine required is equall to the Radius A C and A 40, both being set together.

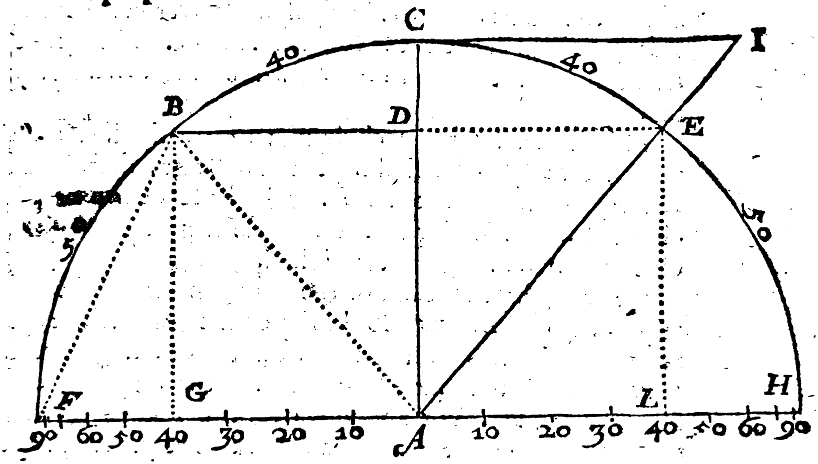
## 5 *The diameter or* Radius *being given, to finde the Chords of every arke.*

The sines may be fitted many wayes to serue for chords.

1 A *sine* being the halfe of the *chord* of the double arke, if the *sine* be doubled, it giveth the *chord* of the double arke,

a *Sine* of 10 *gr.* doubled giveth a *Chord* of 20 *gr*, and a *Sine* of 25 *gr.* being doubled giveth a *Chord* of 30 *gr.* and so in the rest. As here B D, the sine of B C, an arke of 40 *gr.* being doubled giveth B E the chord of B C E, which is an arke of 80 *gr.* Wherefore if the Radius of the circle given be equall to the laterall Radius, let the *Sector* be opened neare unto his length, so that both the lines of *Sines* may make but one direct line: so the distance on the sines betweene 10 and 10, shall be a chord of 20, the distance betweene 20 and 20, shall be a chord of 40; and the distance betweene 30 and 30, shall shall be a chord of 60; and so in the rest.

2 Because a sine is the halfe of the chord of the double arke, the proportion holdeth.




As the diamiter F H unto the Radius A H, so the chord B E unto the sine D E, or the chord G L unto the sine A L, and then if the Radius A H, be put for the diameter, which is a chord of 180 gr, the sine D E or A L, shall serue for a chord of 80 gr, and the semiradius which is the sine of 30 gr, shall serue for a chord of 60 gr, and go for the semidiameter of a circle, and so in the rest. So that by these meanes we shall not need to double the lines of *Sines* as before, but onely to double the numbers. And to this purpose I have subdivided each

each degree of the sines into two, that so they might shew how far the halfe degrees do reach in the sines, and yet stand for whole degrees when they are used as chords.

Wherefore if the Radius of the circle given be equall to the laterall semiradius (the sine of 30 *Gr.* and chord of 60 *Gr.*) there needs no farther work then to take the sine of 10 *Gr* for a chord of 20 *Gr.* and a sine of 15 *Gr.* for a chord of 30 *Gr.* &c.

But if the Radius of the circle given be either greater or lesser then the laterall semiradius, take the diameter of it, and make it a parallell chord of 180 *Gr.* by applying it over the lines of *Sines* between 90 and 90 or take the Radius or Semidiameter which is equall to the chord of 60 *Gr.* and make it a parallell Radius of 60 *Gr.* by applying it over in the sines of 30 and 30, and keepe the Sector at this angle. The parallells taken from the laterall *chords* shall be the *chords* required.

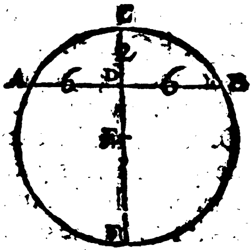
As if the diameter of a circle given were the line *A B*, and it were required to find the chord of 80 gr: first, I make *A B* a parallell chord of 180 *Gr.* or the halfe of it a parallell chord of 60 *Gr*; so his parallell *L G* doth give me *F G* the chord of 80 *Gr.* which was required.

3 Seeing that as the sine of the complement of the halfe arke is unto the *Radius*, so the sine of the same whole arke is unto the chord of it: if we seeke but for one single chord, we may find it without either doubling the sines, or doubling the number. For applying over the Radius given in the sine of the complement of halfe the arke required, his parallell sine shall be the chord required.

As if the semidiameter of the circle given were *A C*, and it were required to find the chord of 40 *Gr:* the halfe of 40 *Gr.* is 20 *Gr.* the complement of 20 *Gr.* is 70 *Gr.* Wherefore I make *A C* a parallell sine of 70 *Gr.* and his parallell sine G L doth give me F G the chord of 40 Gr. agreeable to the semidiameter A C.

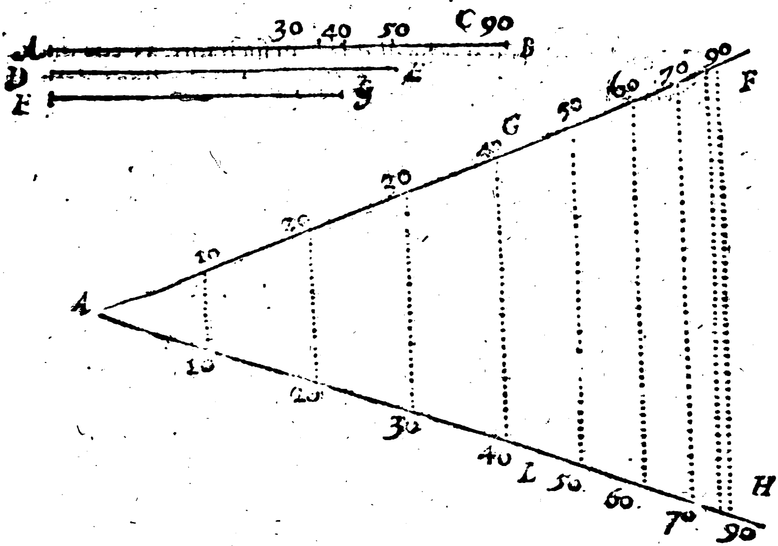
*Having*

*Having two right lines resembling the chord and versed Sine, to find the* Diameter and Radius.




Let the two right lines given be A B, resembling the chord, *C D*, the versed sine of a circle, whose arch A C B is unknowne: and let it be required to find the diameter *C F*.

Having 2 lines given, the first C D, the second A D the halfe of A B, we may find a third in continuall proportion (by the *6 or 9 Prop.* of the lines) and that shall be the line D F (18) the summe whereof and of C D gives the diameter C F (20) and the halfe thereof is the Radius (B C).



## 6 The chord of any arke being given to finde the diameter and Radius.

TVrne the chord given unto a parallell chord, and his parallell semiradius shall be the semidiameter, and the parallell radius shall be the diameter.

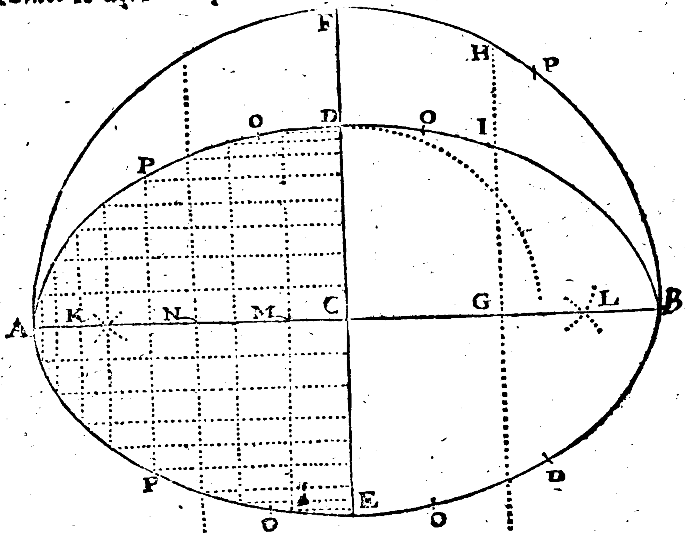
As if F G be the chord of 80 *gr.* I put this over in G and L, the sine of 40, and chord of 80 *gr.* and the parallell chord of 180 *gr:* giveth me A B the diameter required.

Or if I turne the chord given into a parallell sine of the same quantitie, his parallell sine of the complement of halfe the arke, doth give me the semidiameter.

As if F G be the given chord of 40 *gr*, I put it over in G and L, the sines of 40 *gr*, then because the halfe of 40 *gr.* is 20 *gr.* and the complement of 20 gr. is 70 gr. I take out the parallell sine of 70 gr. and it giveth me A B for the semidiameter, agreable to that chord of 40 gr.

## Having the Diameter of an Ellipsis, to describe the same upon a plaine.

IF each semidiameter be divided, in such sort, as the line of *Sines* is divided upon the *Sector*, and right lines drawne



through each division perpendicular to those semidiameters like unto sines; The points, where the sines drawne through the one semidiameter do meete the sines of the complement drawne through the other Semidiameter, shall be the points through which the Ellipsis is to be drawne.

Let the diameters be A B, B E, one crossing the middle of the other, in the point *C*. Divide first the semidiameters *C A*, *C B*; then, then the semidiameters C D, C E like unto the lines of *Sines* upon the *Sector*, by the 8 Proposition of *Lines*: So, the Ellipsis shall be drawne through the points at the meeting of the Sines of 10 and 80, of 20 and 70, of 30 and 60 &c.

Or (without the helpe of the line of *Sines*) we may draw the circle A F B upon the center C and semidiameter A C. For so; crossing the diametor A B with severall perpendicular lines continued unto the circumference of the circle, if we divide these perpendiculars on either side of the diameter, in such sort as the greater semidiamete C F is divided, by the lesser, in the point D; and draw a line winding through all those points, the line so drawne shall be the Ellipsis.

Or (without the helpe of the *Sector*) we may with the Radius A C, upon the centers D and E, describe two occult arches meeting in the points K and L. Then taking betweene C and K, any number of points *M N*, we may from the centers K and L, with the semidiameter M B describe foure occult arches; and with the Radius A M, and the same centers K and L, crosse them againe with other 4 arches in the points at *O*. In like manner, from the same centers *K* and *L*, with the Radius *N B*, we may describe other 4 occult arches; and, with the Radius A *N*, and the former centers crosse them againe, with 4 arches in the points at *P*, and so draw the Ellipsis through the points *O P*. &c.

This is (in effect) as wee should tye a thred about *A* and *L*, and then draw it easily from the point

*A*, round about the two former centers *K* and *L*, untill it were brought to the point *A* againe; which is also an easy way to describe an *Ellipsis*.

The distance of these former points from either Semidiameter may be set downe in numbers. For, supposing the lesser Semidiameter *C D*, to be 10; the greater (*C B*) to be 16, (or otherwise divided into any number of knowne points,) If we have the proportion betweene *C G* and *C B*, we may find the length of the perpendicular *G I*,

If the proportion be as 1 to 2, the perpendicular will be 8.66.

If the proportion be as 2 to 3, the perpendicular will be about 7.45.

| | |
|---|---|
| As the greater semidiameter | *C B* |
| to the part given | *C G* |
| So 100000, the Radius | *C B* |
| to the sine of | *C G* |
| whose complement is | *G H* |
| As the Radius | *C F* |
| to the sine of the complement | G *H* |
| So the lesser semidiameter | *C D* |
| to the perpendicular | *G I* |

The same may also be found without knowing the sines. For the perpendicular G *H*, is a meane proportionall betweene *A* G and G *B*: which being knowne

As *C F* unto *E D*, so is G *H* unto G *I*.

7 *To open the Sector to the quantitie of any angle given.*

8 *The Sector being opened, to find the quantitie of the angle.*

IT is one thing to open the edges of the Sector to an angle, and another thing to open the lines on the Sector to the same angle. For the lines of *lines* on the one side, & the lines of *sines* on the other side, do make an angle of 2 *gr*. when the

Sector

Sector is close shut, and the edges doe make no angle at all. So likewise the lines of *Superficies* and the lines of *Solids* doe make an angle of 10 *gr*, which are to be allowed to the edges.

The lines of *lines* may be opened to a right angle, if the whole line of 100 parts be applied over in 80 and 60.

The line of *sines* may be opened to a right angle, if the large secant of 45 *gr*. be applied over in the sines of 90 *gr*. or if the sine of 90 *gr*. be applied over in the sines of 45 *gr*. or if the sine of 45 *gr*. be applied over in the sines of 30 *gr*.

If it be required to open those lines to any other angle, take out the chord thereof, and apply it over in the *semiradius*, and those lines shall be opened to that angle.

As if it were required to open the Sector in the lines of *sines* to an angle of 40 *gr*. take out the chord of 40 *gr*, and to it open the Sector in the chord of 60 *gr*. so shall the lines of *sines* be opened to the angle required. Or if the same chord of 40 *Gr*. be applied over betweene 50, and 50, in the lines of *lines*, they shall also be opened to the same angle. If it be applied over in 25 of the lines of *Superficies*, or 125 in the lines of *Solids*, they also shall be opened to the same angle: because the chord of 60 *Gr*. or sine of 30 *Gr*. and 50 in the lines of *lines*, and 25 in the lines of *Superficies*, and 125 in the *Solids*, are all of the same length with the semiradius.

Or if the *Semiradius* be applied over betweene the sine of 30 *Gr*. and the sine of the complement of the angle required, it will open the lines of *Sines* to that angle.

As if the semiradius be applied over in the sines of 30 *Gr*. and the sine of 50 *Gr*. it shall open the lines of *Sines* to an angle of 40 *Gr*.

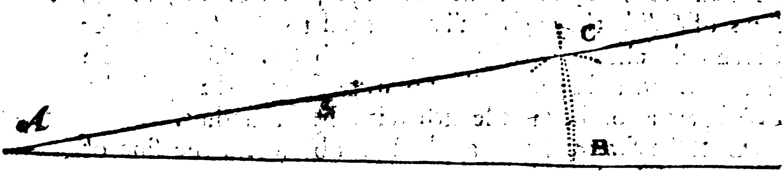
On the contrary, if the *Sector* be opened to an angle, and it be required to know the quantitie thereof, open the compasses to the semiradius, and setting one foote in the sine of 30 *Gr*. turne the other toward the other line of *sines*, and it shall fall there in the complement of the angle; if it fall on 50 *Gr*. the angle is 40 *Gr*, if on 60 *Gr*. the angle is 30 *Gr*. &c.

Or take over the parallell chord of 60 *Gr*. and measure it in the laterall chord, and it shall there shew the quantitie of the angle. As if the *Sector* being opened to an angle, I should take over the parallell of 30 *Gr.* of the sines, and 60 *Gr*; of the chords, and measure it in the laterall chords, find it to be 40 *Gr.* the angle comprehended betweene the lines of *Sines* is 40 *Gr.* but the angle betweene the edges of the *Sector* is 2 *Gr.* lesse, and therefore but 38 *Gr.*

### 9 *To finde the quantitie of any angle given.*

IF out of the angular point, to the quantitie of the *Semiradius*, be described an occult arke that may cut both sides of the angle, the chord of this arke measured in the laterall chord, shall give the quantitie of the angle.

Let the angle given be *B A C*: first I take the *Semiradius* with the compasses, and setting one foote in *A*, I cut the sides of the angle in *B* and *C*, then I take the chord *B C*, and measure it in the laterall chord, and I find it to be 11 *Gr.* and 15 *M.* and such is the quantitie of the angle given.




Or if the arke be described out of the angular point at any other distance, let the semidiameter be turned into a parallall chord of 60 *Gr.* then take the chord of this arke, and carrie it parallell till it crosse in like chords: so the place where it stayeth shall give the quantitie of the angle.

As in the former example, if I make the semidiameter *A B* a parallell chord of 60 *Gr.* and then keeping the *Sector* at that angle, carrie the chord *B C* parallell, till it stay in like chords; I shall finde it to stay in no other but 11 *Gr.* 15 *M.* and such is the angle *B A C.*

### 10 *Vpon a right line and a point given in it, to make an angle equall to any angle given.*

FIrst out of the point given describe an arke, cutting the same line: then by the 5. *Prop.* afore, find the chord of the angle given agreeable to the semidiameter, and inscribe it into this arke: so a right line drawne through the point given, and the end of this chord, shall be the side that makes vp the angle.

Let the right line given be *AB*, and the point given in it be *A*, and let the angle given be 11 *gr.* 15 *m.* Here I open the compasses to any semidiameter *AB*, (but as oft as I may conveniently to the laterall semiradius) and setting one foote in *A*, I describe an occult arke *BC*; then I seeke out the chord of 11 *gr.* 15 *m.* and taking it with the compasses, I set one foote in *B*, the other crosseth the arke in *C*, by which I draw the line *AC*, and it makes up the angle required

### 11 *To divide the circumference of a circle into any parts required.*

IF 360 the measure of the whole circumference be divided by the number of parts required, the quotient giveth the chord, which being found will divide the circumference.

So a chord of 120 *gr.* will divide the circumference into 3 equall parts; a chord of 90 *gr.* into 4 parts; a chord of 72 *gr* into 5 parts; a chord of 60 *gr.* into 6 parts; a chord of 51 *gr.* 26 into 7 parts; a chord of 45 *gr.* into 8 parts; a chord of 40 *gr.* into 9 parts; a chord of 36 *gr.* into 10 parts; a chord of 32 *gr.* 44 *m.* into 11 parts; a chord of 30 *gr.* into 12 parts

In like maner if it be required to divide the circumference of the circle whose semidiameter is *AB*, into 32: first I take the semidiamerer *AB* and, make it a parallell chord of 60 *gr.* then because 360 *gr.* beirg divided by 32 the quotient will be 11 *gr.* 15 *m.* I find the parallell chord of 11 *gr.* 15 *m.* and this will divide the circumference into 32.

But

But here the parts being many, it were better to divide it firſt into fewer, and after to come over it againe. As firſt to divide the circumference into 4, and then each 4 parts into 8, or otherwiſe, as the parts may be divided.

### 12 *To divide a right line by extreme and meane proportion.*

THe line to be divided by extreme and meane proportion, hath the ſame proportion to his greater ſegment, as in figures inſcribed in the ſame circle, the ſide of an *hexagon* a figure of ſix angles, hath to a ſide of a *decagon* a figure of ten angles: but the ſide of a *hexagon* is a chord of 60 *gr.* and the ſide of a *decagon* is a chord of 36 *gr.*

Let *AB* be the line to be divided: if I make *AB* a parallell chord of 60 *gr.* and to this ſemidiameter find *AC* a chord of 36 *gr.* this *AC* ſhall be the greater ſegment, dividing the whole line in *C*, by extreme and meane proportion. So that,

As *AB* the whole line is unto *AC* the greater ſegment:
ſo *AC* the greater ſegment unto CB the leſſer ſegment.

Or let *AC* be the greater ſegment given: if I make this a parallell chord of 36 *gr.* the correſpondent ſemidiameter ſhall be the whole line AB, and the difference CB the leſſer ſegment.


Or let *CB* be the leſſer ſegment given: if I make this a parallell chord of 36 *gr.* the correſpondent ſemidiameter ſhall be the greater ſegment *AC* which added to CB, given the whole line AB.

To avoid doubling of lines or numbers, you may put over the whole line in the *Sines* of 72 *gr.* and the parallell ſine of 36 *gr.* ſhall be the greater ſegment.

Or if you put over the whole line in the ſines of 54 *gr.* the parallell ſine of 30 gr. ſhall be the greater ſegment, and the parallell ſine of 18 gr. ſhall be the leſſer ſegment.

CHAP.

## CHAP. III,

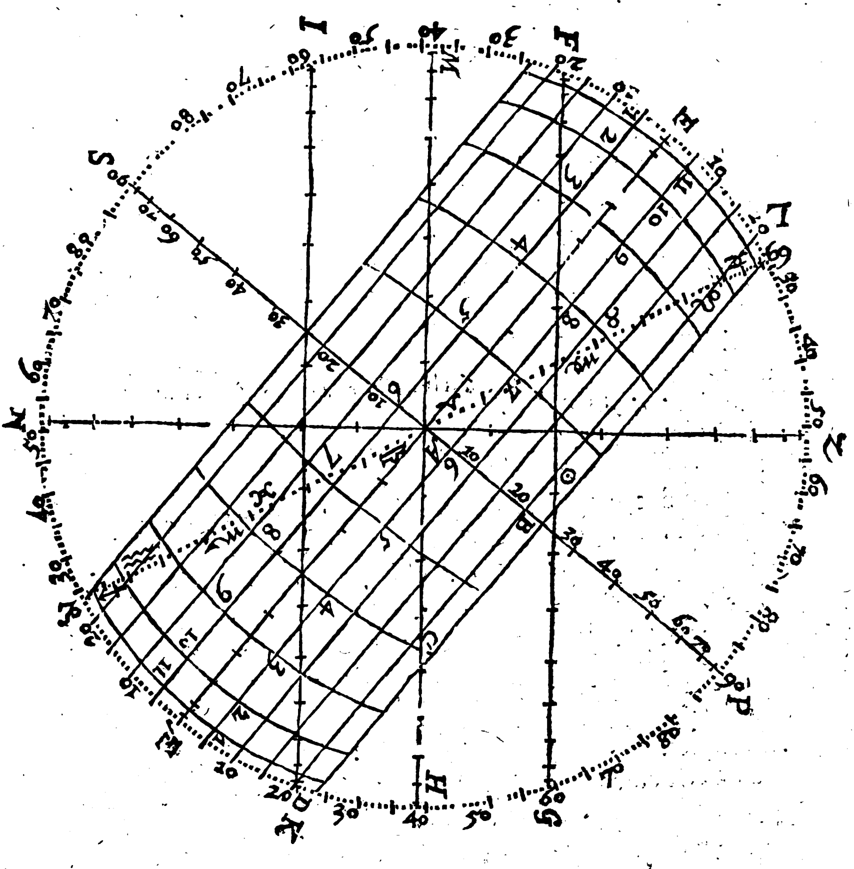
### *Of the proiection of the Sphere in Plano.*

1 THe Sphere may be proiected in *Plano* in streight lines, as in the *Analemma*, if the Semidiamiter of the circle given be divided in such sort as the line of *Sines* on the Sector.

As if the Radius of the cirle given were *A E*, the circle thereon described may represent the plane of the generall meridian, which divided into foure equal parts in *E*, *P*, *Æ*, *S*, and crossed at right angles with *E Æ* and *P S*, the diamiter *E Æ*, shall represent the æquator, and *P S* the circle ot the houre of 6. And it is also the Axis of the world, wherein *P* stands for the North pole, and *S* for the South pole. Then may each quarter of the meridian be divided into 90 *degrees* from the æquator towards the poles. In which if we number 23 *degr.* 30 *min.* the greatest declination of the Sunne from *E* to ♋ North-wards, from *Æ* to ♑ Southwards, the line drawne from ♋ to ♑ shall be the ecliptique, and the lines drawne parallell to the equator through ♋ and ♑ shall be the tropiques.

Having these common sections with the plane of the meridian, if we shall divide each Semidiameter of the Ecliptique into 90 *degr.* in such sort as the *Sines* are divided on the *Sector*. The first 30 *degr.* from *A* towards ♋, shall stand for the sine of ♈. The 30 *degr.* next following for ♉. The rest for ♊. ♋. ♌ &c. in their order. So that by these meanes we have the place of the *Sun* for all times of the yeare.

If againe we divide *A P A S*, in the like sort, and set to the numbers 10. 20. 30. &c. unto 90 *degres*, the lines drawne through each of these degrees parallell to the equa-



tor, shall shew the declination of the Sunne, and represent the paralells of latitude.

If farther we divide *A E*, *A Æ*, and each of his paralells equally in the like sort, and then carefully draw a line through each 15 *degrees*, so as it makes no angles; the lines so drawne shall be *elipsicall*, and represent the houre-circles.

cles. The meridian *P E S*, the houre of 12 at noone; that next unto it drawne through 75 *degrees* from the Center the houres of 11 and 1, that which is drawne through 60 *degrees* from the center the houres of 10 and 2. &c.

To these wee may adde the monthes of the yeare, and the dayes of each moneth, placing *Ianuarie* about *F*, *March* about *E*, *Iune* about *I*, *Iulie* about *K*, *September*, about *E Æ*, *December*, about the *Tropique* of ♑: and so the rest according to their Declination from the Æquator.

Then having respect unto the latitude, we may number it from *E* Northward unto *Z*, and there place the Zenith: by which and the center the line drawne *Z A N* shall represent the verticall Circle, passing through the Zenith and Nadir East and West, and the line *M A H* crossing it at right angles, shall represent the horizon.

These two being divided in the same sort as the ecliptique and the æquator, the line drawne through each degree of the Semidiameter *A Z*, parallell to the horizon, shall be the Circles of altitude, and the divisions in the horizon and his parallells shall give the azimuth.

Lastly, if through 18 *gr.* in *A N*, be drawne a right line *I K* parallel to the horizon, it shall shew the time when the day breaketh, and the end of the twilight.

For example of this proiection, let the place of the Sun be the last degree of ♉, the parallell passing through this place is *L D*, and therefore the meridian altitude *M L*, and the depression below the horizon at midnight *H D*: the semidiurnall arke *L C*, the seminoctnruall arke C D, the declination *A B*, the ascentionall difference *B C*, the amplitude of ascention *A C*. The difference betweene the end of twilight and the day breake is very small; for it seemes the paralrell of the *Sun* doth hardly crosse the line of twilight.

If the altitude of the Sunne begiven, let a line bee drawne from it parallell to the horizon; so it shall crosse the parallell of the *Sunne*, and there shew both the azimuth and the houre of the houre of the day. As if the place of the *Sunne* being given as before, the Altitude in the morning were found to be 20 *degr.* the line *F G*, drawne parallell to the horizon through 20 *degrees* in *A Z*, would crosse the parallell of the Sun in ☉. Wherefore *F* ☉ sheweh the azimuth, and *L* ☉. the quantitie of houres from the meridian. It seemes to be about halfe on houre past 6 in the morning, and yet more then halfe a point short of the East.

The distance of two places may be also shewed by this proiection, their latitudes being knowne, and their difference of longitude.

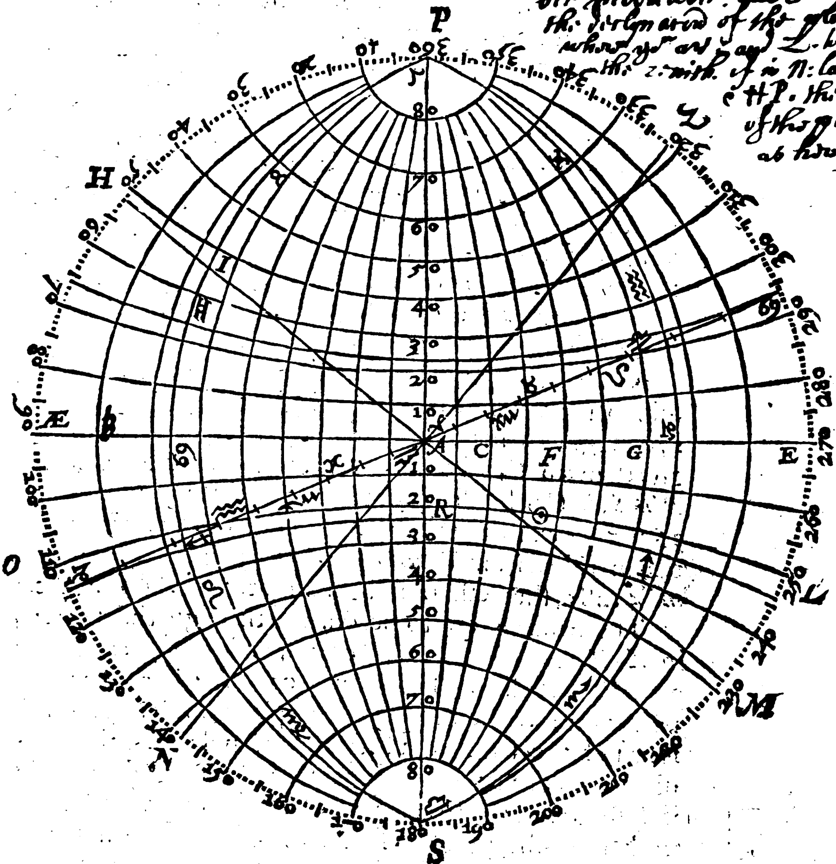
For suppose a place in the East of *Arabia*, having 20 *degr.* of North latitude, whose difference of longitude from London, is found to be an Eclipse to be 5 *houres* ½. Let Z be the Zenith of London, the parallell of latitude for that other place must be *L D*, in which the difference of longitude si L ☉. Wherefore ☉ representing the site of that place, I drawe through ☉ a parallell to the horizon *M H*, crossing the verticall A Z neare about 70 *degres* from the zenith, which multiplied by 20, sheweth the distance of London, and that place to be 1400 leagues. Or multiplyed by 60, to be 4200 miles.

2 The Sphere may be proiected in *plano* by circular lines, as in the generall Astrolabe of *Gemma Frisius*, by the help of the tangent on the side of the *Sector*.

For let the circle given represent the plane of the generall meridian as before; let it be divided into foure arts, and crossed at right angles with *E Æ* the equator, and *P S* the circle of the houre of 6, wherein *P* stands for the North pole, and *S* for the South pole. Let each quarter of the meridian be divided into 90. *degres* and so the whole into 360, beginning from *P*,

and

and setting to the numbers of 10, 20, 30. &c. 90 at *Æ*, 180 at *S*, 270 at *E*, 360 at *P*. The semidiamiters




*AP*, *AÆ*, may be divided according to the tangents of halfe their Arkes, that is a tangent of 45 *degrees*, which is alwayes 100000 equall to the Radius, shall give

 the

the semidiamiter of 90 *degrees* a tangent of 40 *degrees* 83910, shall give 80 *degrees*, in the semidiamiter: a tangent of 35 *degrees* 70021 shall give 70. &c. So that the semidiameters may bee divided in such sort as the tangent on the side of the Sector, the difference being onely in their denomination.

Having divided the circumference and the semidiameters, we may easily draw the meridians and the parallels by the help of the Sector.

The meridians are to be drawne through both the poles *P* and *S*, and the *degrees* before graduated in the æquator. The distance of the center of each meridian from *A* the center of the plane, is equall to the tangent of the same meridian, reckoned from the generall meridian *P Æ S E*; and the semidiameter equall to the secant of the same *degree*.

As for example, if I should drawe the meridian *P B S*, which is the tenth from *P Æ S*, the tangent of 10 *gr.* 17633, giveth me *A C*, and the secant of 10 *gr.* 101543, giveth me *S C*, wherefore *C* is the center of the meridian *P B S*, & *C S* his semidiameter: so *A F* a tangent of 20 *gr.* 36397 sheweth *F* to be the center of *P D S*, the twentith meridian from *P Æ S* & *A G* a tangent of 23 *gr.* 30 *m.* 43481, sheweth *G* to be the center of *P* 69 *S*. &c.

The parallels are to be drawne through the degrees, in *A P*, *A S*, and their correspondent *degrees* in the generall meridian. The distance of the center of each parallell from *A* the center of the plane, is equall to the secant of the same parallell from the pole, and the semidiameter equall to the tangent of the same *degree*. As if I should draw the parallell of 80 *degrees* which is the tenth from the pole *S*, first I open the compasses unto *AC* the tangent of 10 *degrees* 17633, and this giveth me the semidiameter of this parallell, whose center is a little from *S*, in in such distance as 101543 the secants *S C* is longer then 100000, the Radius *S A*.

The meridians and parallels being drawne, if we number

ber the 23 *degr.* 30 *m.* from *E* to ♋ Northwards, from *Æ* to ♑ Southward, the line drawne from ♋ to ♑ shall be the ecliptique: which being divided in such sort as the semidiameter *A P*, the first 30 *degr.* from *A* to ♋ shall stand for the sine of ♈, the 30 *degr.* next following for ♉; the rest for ♊ ♋ ♌. &c. in their order.

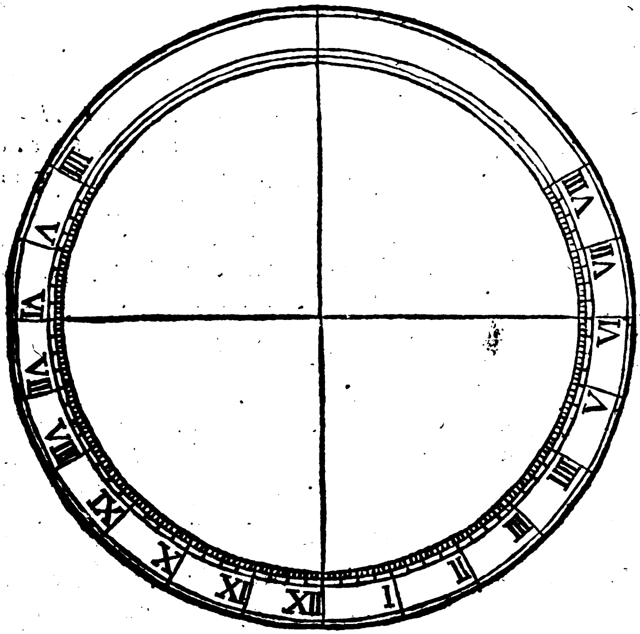
If farther we have respect unto the latitude, we may number it from *E* Northward unto *Z*, and there place the zenith, by which and the center, the line drawne *Z A N* shall represent the verticall circle, and the line *M A H* crossing it at right angles, shall represent the horizon; and these divided in the same sort as *A P*, the circles drawne through each degree of the semidiameter *A Z*, parallell to the horizon, shall be the circles of altitude: and the circles drawne through the horizon and his poles, shall giue the Azimuths.

For example of this proiection, let the place of the Sun be in the beginning of ♒, the parallell passing through this place is ♒ ☉ *L*, and therefore the meridian altitude *M L*, and the depression below the horizon at midnight *H O*, the semidiurnall arke *L* ☉, the seminocturnall arke *O* ☉, the declination *A R*, the ascensionall difference *R* ☉ the amplitude of ascention *A* ☉.

Or if *A* be put to represent the pole of the world, then shall *P Æ S E* stand for the æquator, and P ♋ S ♑ for the ecliptique, and the rest which before stood for meridians, may now serue for particular horizons, according to their severall elevations. Then suppose the place of the Sunne given to be 24 *degrees* of ♉, his longitude shall be *P I*, his right ascention *P H*, his declination *H I*. And if the place given be 19 *degr.* of ♌, his longitude shall be *P K*, his right ascention *P N*, his declination *N K*. Againe, the declination brought to the horizon of the place, shall there shew the ascentionall difference, amplitude of ascention, & the like conclusions of the globe. But I intend not here to shew the vse of the Astrolabe, but the vse of the *Sector* in proiection.

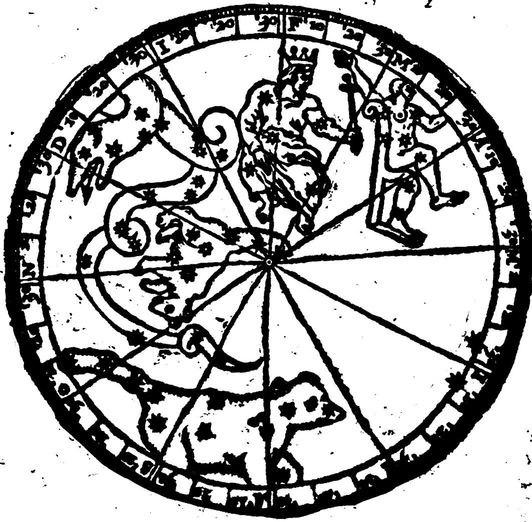
And

And after this manner may a nocturnall be proiected to shew the houre of the night, whereof I will set downe a type for the vse of Sea-men.

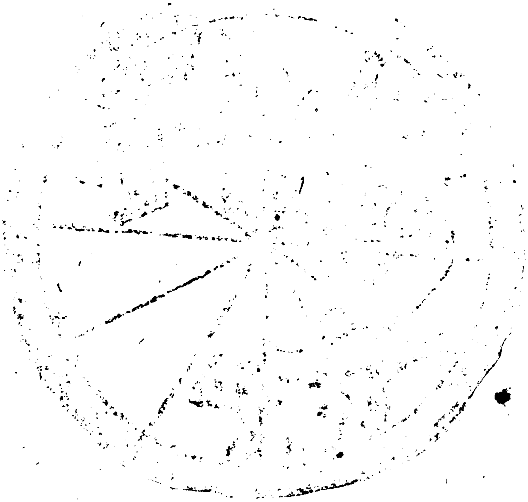



It consists as you see of two parts, the one is a plane, divided equally according to the 24 houres of the day, and each houre into quarters or minutes, as the plane will beare: the line from the center to XII, stands for the meridian, and XII, stands for the houre of 12 at midnight. The other part is a rundle for such starres as are neare the North pole, together with the 12 moneths, and the dayes of each moneth fitted to the right ascention of the starres. Those that haue occasion to see the South

The Nocturnall



Pag. 72. of the Sectors.



South pole, may do the like for the Southerne constellations, and put them in a rundle on the back of this plane, and so it may serve for all the world.

The vse of this nocturnall is easie and ready. For looke vp to the pole, and see what starres are neare the meridian, then place the rundle to the like situation, so the day of the moneth will shew the houre of the night.

3 The Sphære may be proiected in *plano* by circular lines, as in the particular Astrolabe of *Iohn Stophlerin*, by help of the tangent, as before.

For let the circle given represent the tropique of ♑, let it be divided into foure parts, and crossed at right angles with *A C* the equinoctiall coloure, and *M B* the solstitiall coloure, and generall meridian, the center *P* representing the pole of the world. Let each quarter be divided into 90 *degrees*, and so the whole into 360, beginning from *A* towards *B*. The meridian *P M*, or *P B*, may be divided according to the tangent of halfe his arke. So as the aker from the North pole to the tropique ♑, being 90 *degrees* and 23 *degrees* 30 *m.* that is 113 *degrees* 30 *m.* and the halfe arke 56 *degrees* 45 *m.* the meridian shall be divided into 90 *degrees* and 23 *degrees* 30 *m.* in such sort as the tangent of 56 *degrees* 45 *m.* on the side of the *Sector* is divided into *degrees* and halfe *degrees*; of which *P Æ* the arke of the æquator 90 *degrees* from the pole, shall be given by the tangent of 45 *degrees*. And *P 69* the arke of the Summer tropique 66 *degrees* 30 *m.* from the pole, shall be given by the tangent of 33 *degrees* 15 *m.* And the circles drawne vpon the center *P* through *Æ.* and ♋, shall be the æquator, and the Summer tropique.

Having the æquator and both the tropiques, the ecliptique ♈ ♋ ♎ ♑ shall be drawne from the one tropique to the other, through the intersection of the æquator and the Equinoctiall colure. And it may be divided first into the twelue signes after this manner: *P E* the arke of the pole of the ecliptique 23 *degrees* 30 *m.*

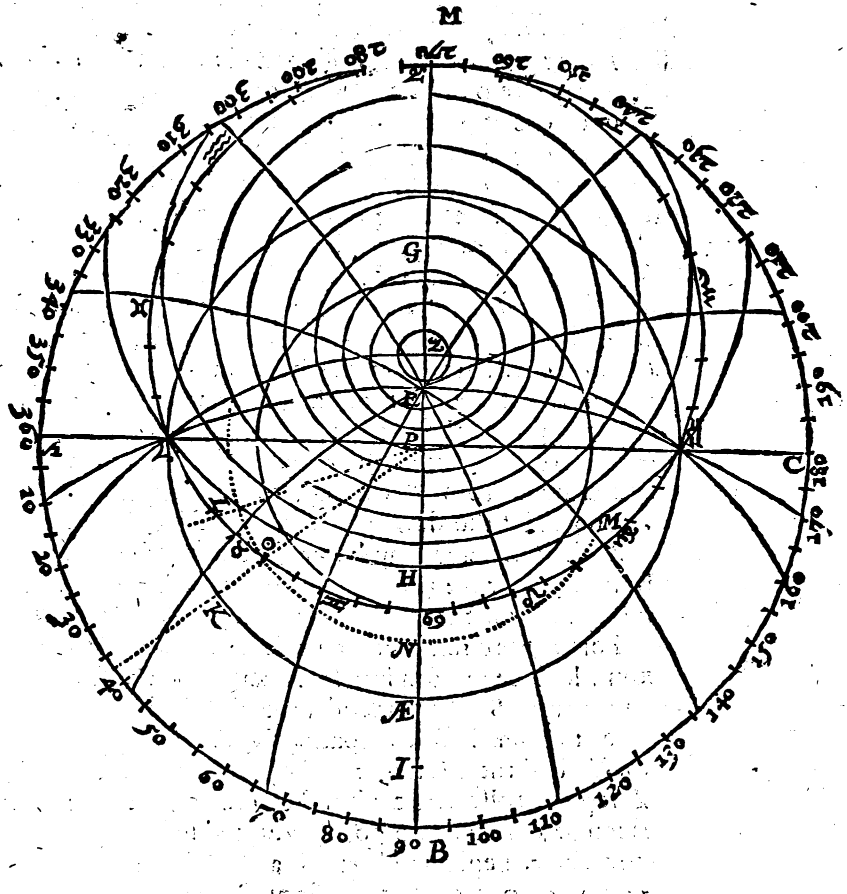
from the pole of the world, shall be given by the tangent of 11 *degrees* 45. *m.* The center of the circle of longitude passing through this pole *E* ♈ and ♎, shall be found at *D* (somewhat belowe B) by the tangent of 66 *degrees* 30 *m.* Then through *D* draw an occult line parallell to *A C.* and divide it on each side from *D*, in such sort as the tangent is divided on the side of the Sector, allowing 45 *degrees* to be equall to *D E*, So the thirtith *degree* from *D* toward the right hand, shall be the center of the circle of longitude passing through *E* ♉ and ♍. The sixtith *degree*, the center of ♊ *E* ♐. The thirtith *degree* from *D* towards the left hand, the center of ♓ *E* ♍. The sixtith, the center of ♒ *E* ♌. And the other intermediate *degrees* shall be the centers to divide each signe into 30 *gr.*

If farther we have respect unto the latitude, we may (the meridian being before divided) number it from P North-ward unto *H*, and there place the North intersection of the meridian and horizon: then the complement of the latitude being numbred from *P* Southward unto Z, shall there give the zenith; and 90 *degr.* from Z Southward unto *F*, shall there give the South intersection of the meridian and horizon. The middle betweene *F* and *H* shall be *G* the center of the horizon ♈ *H* ♎ F, passing through the beginning of ♈ and ♎. unlesse there be some former errour.

All parallels to the horizon may be found in like sort by their intersections with the meridian, and the middle betweene those intersections is alwayes the center.

The Azimuths may be drawne as the circles of longitude were before. For the circle of the first verticall ♈ Z ♎ will be found at *I* (somewhat neere unto B) by the tangent of the latitude. And if through *I* we draw an occult line parallell to *A* C, and divide it on each side from *I*, in such sort as the tangent is divided

on




on the side of the *Sector*, allowing 45 *degrees* to be equall to *L Z*, these divisions shall be the centers, and the distance from these divisions unto *Z*, shall be the semidiameters whereon to describe the rest of the Azimuths.

For example of this proiection, let ☉ the place of the Sunne given be 10 *degr.* of ♉: a right line drawne from *P* through this place unto the æquator, shall there shew his right ascention ♈ *K*, and his declination *K* ☉. Then may we on the center *P* and semidiamiter ☉ *P*, draw an occult parallell of declination, crossing the horizon in *L* and *M*, the meridian in *G* and *N*. So the right lines *P L* and *P M* produced, shall shew the time of the Sunnes rising and setting, ♈ *Q* the difference of ascention, ♎ *R* the difference of descention, ♈ *L* the amplitude of his rising, and ♎ *M* the amplitude of his setting. *L* N *M* sheweth the length of the night. Z *G* sheweth his distance from the zenith at noone, *H N* his depression below the horizon at midnight. And then having the altitude of the Sunne at any time of the day, the intersection of the parallell of altitude with the parallell of declination, sheweth the Azimuth, and a right line drawne from *P* through this intersection, giveth the houre of the day.

4 The Sphære may be proiected in *plano* by circular lines, after the maner of the old concave hemisphære, by the help of the tangent on the side of the *Sector*.

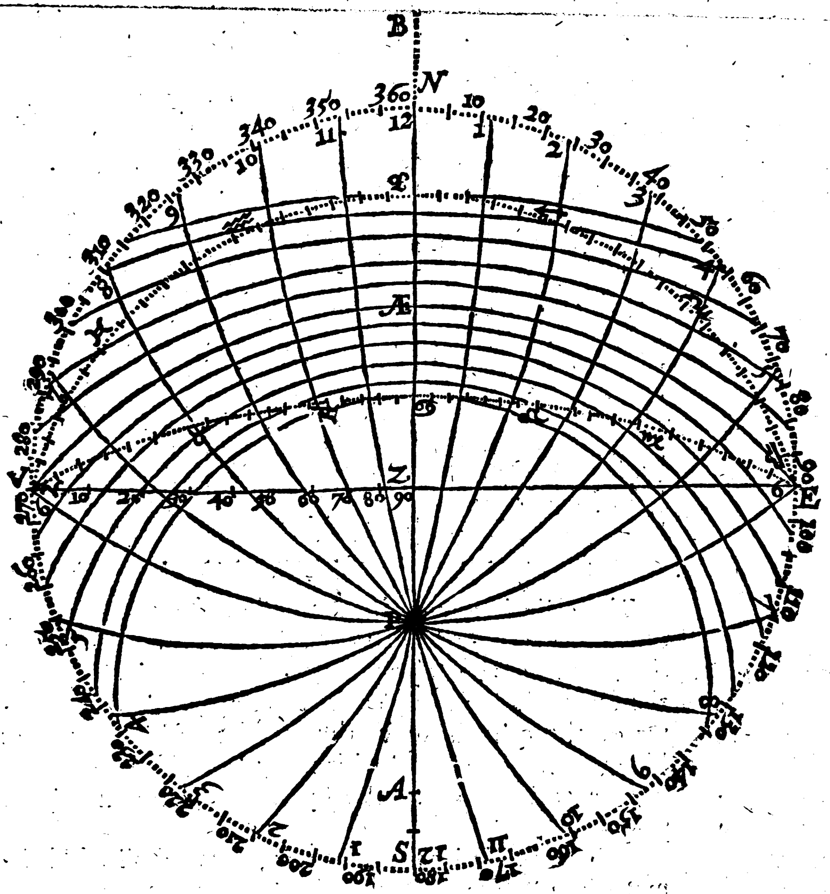
For let the circle given represent the plane of the horizon, let it be divided into foure parts, and crossed at right angles with S *N* the meridian, and *E V* the verticall; so as S may stand for the South, *N* for the North, *E* for the East, *V* the West part of the horizon, and the center Z represent also the zenith. Let each quarter of the horizon be divided into 90 *degrees*, and so the whole into 360 *degre.* beginning from N, and setting to the numbers of 10.20.30. &c. 90 at *E*, 180 at *S*, 270 at *V*, 360 at *N*.

The semidiamitor Z *N*, Z *S*, may be divided according to the tangent of halfe their arkes: so as the arke from the zenith to the horizon being 90 *gr.* and the halfe arke 45 *gr.* the semidiamiters are to be divided in such sort as the tangent of 45 *gr.* as was shewed before in the second proiection. And if from Z we draw circles through each

of

of these divisions, they shall be parallels of altitude.

Then having respect unto the altitude, we may (the meridian being before divided) number it from Z to Æ, and there place the intersection of the meridian and æquator. The complement of the latitude from Z vnto *P*,




shall there give the pole of the world, and 90 further from *P* shall there give the other intersection of the meridian and æquator.

The middle betweene these intersections shall be *A* the center of the æquator, passing through *E* and *V*, unlesse there be some former errour. The intersections of the tropiques depend on the æquator. From Æ 23 *degrees* 30 *m*. farther shall be ♑, the intersection of the meridian and the Southerne tropique. From Æ 23 *degrees* 30 *m*. nearer shall be ♋, the intersection of the meridian and the Northerne tropique. The intersections of the other intermediate paralle's, shall be given in like sort, by their *degrees* of distance from the æquator, and the middle betweene those intersections is alwayes the center.

The houre circles may be here drawne as the Azimuths in the third proiection. For the center of *E* P *V*, the houre of 6 will be found at *B* (somewhat neare unto *N*) by the tangent of the latitude. And if through B we draw an occult line parallell unto *E V*, and divide it on each side from B, in such sort as the tangent is divided on the side of the *Sector*, allowing 45 *degrees* to be equall to *B P*, and 15 *degrees* for every houre: those divisions shall be the centers, and the distance from the divisions unto *P*, shall be the semidiameters, wheron to describe the rest of the houre circles.

The ecliptique may be drawne as the æquator. For the center of that halfe which hath Southerne declination, shall be given by the tangent of the altitude, which the Sunne hath in his entrance into ♑. And the center of the other halfe, by the tangent of his altitude, at his entrance into ♋. And it may be divided, as in the former proiection, or else by tables calculated to that purpose.

To these circles thus drawne, if we shall addd the moneths of the yeare, and the dayes of each moneth, as we may well doe, at the horizon, on either side betweene

betweene the tropiques; this proiection shall be fitted for the most vsefull conclusions of the Globe.

For the day of the moneth being given, the parallell that shooteth on it, doth shew what declination the Sunne hath at that time of the yeare. And where this parallell crosseth the ecliptique, there is the place of the Sunne. Or the place of the Sunne being first given, the parallel which crosseth it, shall at the horizon shew the day of the moneth. Either of these then being given, or onely the parallell of declination, we may follow it first unto the horizon, there the distance of the end of the parallell from E or *V*, sheweth the amplitude; the same among the houre circles sheweth the time, when the Sunne riseth or setteth. Then having the altitude of the Sunne at any time of the day, the intersection of the parallell of declination with the parallell of altitude, sheweth the houre of the day; and a right line drawne from *Z*, through this intersection to the horizon, giveth the Azimuth.

Thus in either of these proiections, that which is otherwise most troublesome, is easily done by the help of the tangent line: and what I have said of this line, the same may be wrought by scale and numbers out of the table of tangents.

## CHAP. IV.

## *Of the resolution of right-line Triangles.*

In

IN all Triangles there being ſixe parts, viz. three angles and three ſides, any three of them being given, the reſt may be found by the *Sector*.

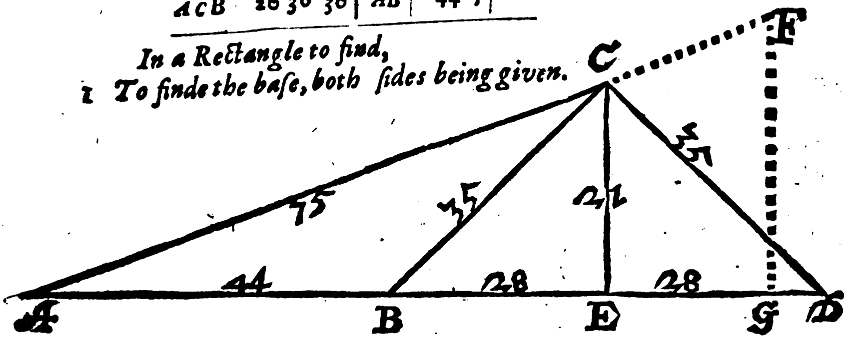
As may appeare by the *Prop* following, where in for our practiſe we may vſe theſe triangles C E A, C E B, C E D, are rectangle in E, and A G F rectangle in G. the reſt conſiſt of oblique angles.

| *Ang.* | *Gr.* | *M.* | *S.* | *Lin.* | *Parts.* |
|---|---|---|---|---|---|
| F | 90 | 0 | 0 | *AC* | 75 |
| G | 90 | 0 | 0 | *AF* | 100 |
| *A* | 16 | 15 | 36 | *FG* | 28 |
| *D* | 36 | 52 | 12 | *CE* | 21 |
| *B* | 36 | 52 | 12 | *CD* | 35 |
| *B* | 143 | 7 | 48 | *CB* | 35 |
| *AFG* | 73 | 44 | 12 | *AG* | 96 |
| *ACE* | 73 | 44 | 12 | *AE* | 72 |
| *ACB* | 20 | 36 | 36 | *AB* | 44 |

| *Ang.* | *Gr.* | *M.* | *S.* | *Lin.* | *Parts.* |
|---|---|---|---|---|---|
| *BCE* | 53 | 7 | 48 | *BD* | 28 |
| *ECD* | 53 | 7 | 48 | *AD* | 28 |
| *BCD* | 106 | 15 | 36 | *BE* | 56 |
| *ACD* | 126 | 52 | 12 | *ED* | 100 |

*In a Rectangle to find,*

1 *To finde the baſe, both ſides being given.*




Let the *Sector* be opend in the line of *lines* to a right angle, (as before was ſhewed *Cap. 2. Prop. 7.*) then take out the ſides of the triangle, and lay them, one on one *line*, the other on the other *line*, ſo as they meete in the center, & marke how farre they extend. For the *line* taken from the termes of their extenſion, ſhall be the baſe required, viz. the ſide oppoſite to the right angle.

Or adde the ſquares of the two ſides (as in *Prop. 4. Superfic.*) and the ſide of the compound ſquare ſhall be the baſe.

As if the lines *AE*, *CE*, ſhould be the ſides about the right angle, and it were required to find the baſe ſubtending the right angle.

*To*

betweene the tropiques; this proiection shall be fitt for the most vsefull conclusions of the Globe.

For the day of the moneth being given, the parallell that shooteth on it, doth shew what declination the Sunne hath at that time of the yeare. And where this parallell crosseth the ecliptique, there is the place of the Sunne. Or the place of the Sunne being first given, the parallell which crosseth it, shall at the horizon shew the day of the moneth. Either of these then being given, or onely the parallell of declination, we may follow it first unto the horizon, there the distance of the end of the parallell from E or *V*, sheweth the amplitude; the same among the houre circles sheweth the time, when the Sunne riseth or setteth. Then having the altitude of the Sunne at any time of the day, the intersection of the parallell of declination with the parallell of altitude, sheweth the houre of the day; and a right line drawne from Z, through this intersection to the horizon, giveth the Azimuth.

Thus in either of these proiections, that which is otherwise most troublesome, is easily done by the helpe of the tangent line: and what I have said of this line, the same may be wrought by scale & numbers out of the table of tangents

## CHAP. IV.

### *Of the resolution of right-line Triangles.*

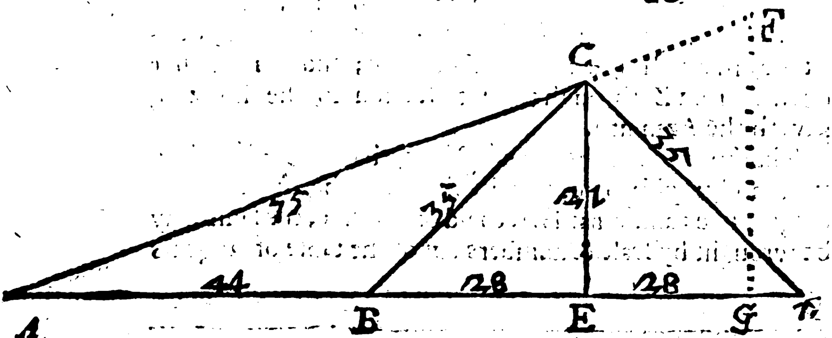
IN all Triangles there being sixe parts, viz. three angles and three sides, any three of them being given, the rest may be found by the *Sector*.

As may appeare by the *Prop.* following, wherein for our practise we may vse these triangles C E A, C E B, C E D are rectangle in E, and A G E rectangle in G the rest consist of oblique angles.

Let

| *Ang.* | Gr. | M. | S. | *Lin.* | Parts. | *Ang.* | Gr. | M. | S. | *Lin.* | Parts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *E* | 90 | 0 | 0 | *AC* | 75 | *BCE* | 53 | 7 | 48 | *BD* | 28 |
| *G* | 90 | 0 | 0 | *AF* | 100 | *ECD* | 53 | 7 | 48 | *AD* | 28 |
| *A* | 16 | 15 | 36 | *FG* | 28 | *BCD* | 106 | 15 | 36 | *BE* | 56 |
| *D* | 36 | 52 | 12 | *CE* | 21 | *ACD* | 126 | 52 | 12 | *ED* | 100 |
| *B* | 36 | 52 | 12 | *CD* | 35 | | | | | | |
| *B* | 143 | 7 | 48 | *CB* | [illegible] | | | | | | |
| *AFG* | 73 | 44 | 12 | *AO* | 96 | | | | | | |
| *ACE* | 73 | 44 | 12 | *AE* | 72 | | | | | | |
| *ACB* | 20 | 36 | 36 | *AB* | 44 | | | | | | |

### *In a Rectangle right line Triangle,*
### 1 *To finde the base, both sides being given.*




Let the *Sector* be opened in the line of *lines* to a right angle, (as before was shewed *Cap.* 2. *Prop.* 7.) then take out the sides of the triangle, and lay them, one on one *line*, the other on the other *line*, so as they meete in the center, & marke how farre they extend. For the *line* taken from the termes of their extension, shall be the base required, viz. the side opposite to the right angle.

Or adde the squares of the two sides (as in *Prop.* 4. *Superfic.*) and the side of the compound square shall be the base.

As if the lines *AE*, *CE*, should be the sides about the right angle, and it were required to find the base subtending the right angle.

First

First, I set the line of *Lines* to a right angle by applying the whole line of 10 from 6 in the one line to 8 in the other. Then if the greater of the two lines given be lesse then the line of *Lines*, I take the greater of them *AE*, and transferr it with the compasses into one of the lines of *lines*, and find, that, in my *Sector* (which is 14 inches long, and so, the line of *Lines* almost 7 inches) it reacheth from the center to 518.

Againe, I take the lesser line *CE*, and transferr it into the other line of *Lines*, and find, that it reacheth from the center unto 151. wherefore I take the distance from 151 unto 518, and such is the length of the Base *AC* required.

If either of the lines given be too large for the *Sector*, then I may measure them by feet or inches, and suppose I find the length of *AE* to be about 720, and of *CE*, 210 Then, in the line of *Lines* (being set, one perpendicular to the other, as before) I extend the Compasses from 210 unto 720; and measuring this extent in the line of *lines*, find it to be 750 parts. wherefore, I prick downe 750 parts, in the line *AC*, from the same scale by which I measured *AE*, and *CE*. So, this line *AC* shall be the Base required.

In working by the line of *Superficies*. I need no opening of the *Sector*. For, taking the line *CE* with my compasses, and measuring it in the line of *Superficies* upon my *Sector*, I find it neere 13. parts.

Then taking the line *AE*, I find it to be about 269; These two being added together make 292: and this extent is the length of the base *AC*. required.

### 2 *To find the base by having the angles and one of the sides given.*

Take the side given, and turne it into the parallell line of his opposite angle; so the parallell Radius shall be the base.

As if the line *AE* were the side of a rectangle triangle opposite to an angle of 73 *gr.* 45′, and it were required to find the Base.

First, I take the side *AE* with my compasses, and set it it over in the sines of 73 Gr. 45'. So, the parallell radius taken from between 90 and 90, will give the Base A C required.

If the side given be such as cannot well be fitted over in the sines of his opposite angle, I may measure it by feet or inches, and suppose I find the length of A E to be 720. then would I take 720 parts, out of the line of lines, and make it a parallell Sine of 73 gr. 45'. So, the parallell Radius taken from between 90 and 90, and measured in the line of *lines* will be found to be about 750 parts: wherefore, I pricke downe 750 in the line A C, by the same scale, whereby I measured A E: and this line A C shall be the Base required.

### 3 *To find a side by having the base, and the other side given.*

Let the Sector be opened in the lines of *lines* to a right angle, and the side given laid on one of those lines from the center: then take the base with a paire of compasses, and setting one foote in the terme of the given side, turne the other to the other line of the Sector, and it shall there shew the side required.

Or take the square of the side out of the square of the base (as in *Prop.* 4. *Superf.*) and the side of the remaining square shall be the side required.

Thus having A C for the Base, and C E, for the side of a rectangle triangle, the other side will be found to be A E.

Or, if A C, being measured, be 750, and C E, 210, the other side A E will be found to be 720.

### 4 *To find a side having the base, and the angles given.*

Take the base given, and make it a parallell Radius, so the

the parallell *sines* of the angles, shall bee the the opposite sides required.

Thus in the Rectangle A E C, if A C be made a parallell Radius, the parallell sine of *73 gr. 45'* will give the side *A E*; and the parallell sine of 16 *Gr.* 15' will give the other side C E.

### 5 *To find a side by having the other side and the angles given.*

Take the side given, and turne it into his parallell *sine* of his opposite angle: so the parallell *sine* of the complement shall be the side required.

Thus in the Rectangle D E C, if C E be made a parallell sine of 53 *Gr.* 8' the parallell sine of 36 *Gr.* 52'. will give the side E D: and the parallell sine of 90 *gr.* will give the Base C D.

### 6 *To find the angles by having the base and one of the sides given.*

First, take out the base given, and laying it on both sides of the Sector, so as they may meete in the center, and marke how farre it extendeth. Then take out the laterall Radius, and to it open the Sector in the termes of the base. This done, take out the side given, and place it also on the same lines of the Sector from the center. For the parallell taken in the termes of this side, shall be the sine of his opposite angle.

Or take the base given, and make it a parallell Radius; then take the side given, and carrie it parallell to the base, till it stay in like *sines*: so they shall give the quantitie of the opposite angle.

Thus in the Rectangle *A E C* having the Base A C, and the side A E, you may finde the angle CAE, to be 16 *gr.* 15'.

### 7. *To find the angles by having both the sides given*

Take out the greater side, and lay it on both sides of the Sector, so as they meete in the center, and marke how farre it extendeth. Then take the other side, and to it open the Sector in the termes of the greater side; so the parallell Radius shall be the tangent of the lesser angle. The third angle is alwayes knowne by the complement.

Thus in the Rectangle *D E C*, having the sides *C E*, and *E D*, you may find the lesser angle *E C D* to be 36 g. 52′; and therefore the other angle *E D C* to be 53. 8′.

### 8 *The Radius being given, to find the tangent, and secant of any arke.*

### 9 *The tangent of any arke being given, to find the Secant thereof, and the Radius.*

### 10 *The secant of any arke being given, to find the tangent thereof, and the Radius.*

The tangent, and the secant, together with the Radius of every arke, do make a right angle triangle; whose sides are the *Radius* and *tangent*, and the base alwayes the *secant*; and the angles alwayes knowne by reason of the given arkes. As in the Rectangle *A E C*, if on the center *A*, and semidiameter *A E*, you describe a circle, then make *A E*, to be the Radius, and *E C*, a tangent of 16. 15 and *A C* a secant of 16 *gr*. 15′.

If you describe a circle on the center *C*, and semidiameter *C E*, then is *C E* the Radius and *E* A, a tanget of 73. 45′ and, *C* A a secant of 73. 45.

Wherefore the solution is the same with those before.

### *In any right-lined triangle whatsoever,*

### 11 *To find a side by knowing the other two sides, and the angle contained by them.*

Let the *Sector* be opened in the lines of *lines* to the angle given.

given as I shewed before cop 2 *Prop.* 7. Then take out the sides of the triangle, & laying them the one on the one line, the other on the other; so as they meete in the center, marke how far they extend. For the line taken betweene the termes of their extension, shall be the third side required.

As if A C and A *D* were two sides of a right lined triangle conteining an angle of 16 *gr.* 16′ and it were required, to find the third side subtending this angle.

Eirst I set the lines to an angle of 16. 16′, by applying the sine of 8 *gr.* 8′ over in the points of 50 and 50, in the line of lines. That done, I take the longer line A D, and transfer it with my compasses, into one of the lines of *lines*, and find it to reach from the center to 720.

Againe, I take the lesser line A C, and transfer it into the other line of *lines*, where it reacheth from the center to 540. wherefore, I take the distance from 540 to 720, and such is the length of the 3 side *C D* required.

Or (if the lines be given in measure) A D 100, and A C 75: I extend the compasses from 100 to 75, and measuring this extent in the line of *lines*, find to be 35. Whereupon I take 35 parts out of the scale, by which A C, and A D were measured and prick them downe in the line C D. So, this line C D, shall be the third side required.

## 12 *To find a side by having the other two sides, and one of the adiacent angles, so it be knowne which of the other angles is acute or oblique*

Let the *Sector* be opened in the line of *lines* to the angle given, and the adiacent side laid on one of those lines from the center; then take the other side with a paire of compasses, and setting one foote in the terme of the former given side, turne the other to the other line of the *Sector* which here representeth the side required, and it shall crosse it in two places.

places; but with which of them is the terme of the side required, must be judged by the angle.

As if in the triangle following, the side *A C* being given, and the side *C D* and the angle *C A D* 16 *gr.* 16 *m.* it were required to find the side *A D*.

First I open the Sector in the line of *lines* to an angle of 16 *gr.* 16 *m.* and laying the adiacent side from the center *A*, find where it extendeth in *C*. Then I take the other side *C D* with the compasses, and setting one foote in C, & turning the other to the other line of the *Sector* I find that it doth crosse it both in B and D.

Or, (if the lines be given in measure) *A C* 75, and *C D* 35; I may take 35 out of the line of *lines* and setting one foote in 75, I shall find the other foote to crosse the other line of the *Sector*, both at 44 (answerable to *A B*) and at 109 (answerable to *A D*.)

So that it is uncertaine whither the side required be *A B* or *A D*, onely it may be judged by the angle. For if the inward angle where they crosse be obtuse, the side required is the lesser; if it be acute, it is the greater.

## 13 *To find a side by having the angles, and one of the other sides given.*

Take the side given, and turne it into the parallell sine of his opposite angle; so the parallell sines of the other angles shall be the opposite sides required.

As if in the triangle *A B C*, having the side *A B*, and knowing the angle *C A B* to be 16. *gr.* 16′, and the angle *A B C* to be 143. 8′, it were required, to find the two other sides, *A* C, and *B* C.

The three angles of a right-lined Triangle, are alwayes equall to 180 *Gr.* wherefore, I adde 16 *Gr.* 16′ unto 143. *gr.* 8′. and by the remainder to 180 *Gr.* find the third angle A C B opposite to the knowne side *A B*, to be 20 *gr.* 36′. Then, I take the side *A B*, and make it a parallell sine of 20 *gr.* 36′.

So, his parallell sine of 16. 16′ will be the side *B C*; and the Parallell sine of 143.8′ will be the side *A C*.

Or, if measuring the side *A B* I find it to be 44; I may take 44 parts, either out of the line of *lines*, or out of any other scale of equall parts, and make it a Parallell sine, of 20 *gr* 36′. So his Parallell sine of 16 *gr*. 16′ measured in the same scale, will give 35 for the length of the side *B C*; and the parallell sine of 36 *gr*. 52′ will give 75, for the length of the other side *A C*.

When the angle comes to be above 90 *gr*; the sine of 80 *gr*; doth stand for a sine of 100 *gr*: and the sine of 70 *gr*. for a sine of 110 *Gr*. and so the rest; for those, which are their complements to 180. degrees.

### 14. To find the proportion of the side by having the three angles

Take the laterall sines of the angles, and measure them in the line of lines. For the numbers belonging to those lines do give the proportion of the sides.

Thus, in the two equi-angle triangles *A E C*, A G F, if you take the laterall sine of 90 *gr*. for the right angle at E and G, and measure it in the line of *lines*, you shalll find it to be 100. Then take the laterall sine of 16 *Gr*. 16′ for the common angle at A, you shall find it to be 28. Take the laterall sine of 73 *gr*. 44′ for the third angle at C and F, you shall find it to be 96. Such therefore is the proportion of the sides.

As 100. 96. 28. So are 75. 72. 21.

### 15 To find an angle by knowing the Three sides.

Let the two containing sides be layd on the lines of the *Sector*, from the center, one on one line, and the other on the other; and let the third side, which is opposite to the angle required,

required, be fitted over in their termes: so shall the *Sector* be opened in those lines to the quantitie of the angle required.

The quantitie of this angle is found as in *Cap*: 2 *Prop*. 8.

Thus having the 3 sides of the triangle A C D, to find the angle at *A*. I take the 2 conteining sides A D, A C and transfer them with my compasses into the lines of *Lines*: where I find the one to reach from the center, to 72; the other, to 54.

Then I take C D, (the side opposite to the angle at A) and fit that over betweene 72 and 54.

Or if the 3 sides be given in measure A D, 100; A C 75: C D 35: I might take 35 for the side C D out of the line of *Lines*, and set that over from 100 to 75. This don I take the distance betweene 50 and 50 and measuring it in the line of *Sines* I find it to be about about 8 *gr*. 8': you double whereof is 16 *gr*. 16' the angle required.

## 16 *To finde an angle by having two sides and one adiacent angle.*

1 First take out the side opposite to the angle given, and laying it on both sides of the Sector, so as they meete in the center, marke how far it extendeth; then take out the laterall sine of the angle, and to it open the Sector in the termes of the first side: this done, take out the other side given, and place it also on the same lines of the Sector from the center, for the parallells taken in the termes of this side; shall be the sine of the angle opposite to the second side.

Or take out the side opposite to the angle given, and make it a parallell sine of that angle: then take the other side given and carrie it parallell to the former: till it stay in like sines: so they shall give the quantitie of the angle opposite to the second side.

Thus in the triangle A C *D*, knowing two sides A C, C*D*, with the angle G A *D* opposite to the side C D, you may find the angle A D C opposite to the other knowne side A C, to be about 36 *gr*: 52'.

### 17 *To find an angle by having two sides, and the angle contained by them.*

First find the third side by the 11. *Prop.* and then the angles may be found by the 15. or 16. *Prop.*

For observation of angles, the *Sector* may have sights set on the moveable foote; so that by looking through them, the edges of the Sector may be applied to the sides of the angle.

For measuring of the sides of lesser triangles, any scale may suffice, either of feete, or inches, or lesser parts. But for greater triangles, especially for plotting of grounds, I hold it fit, to use a chaine of foure perches in length, each perch divided into 25, and the whole chaine an hundred links, wherein, if the whole chaine be (according to 16$\frac{1}{2}$ foot in a perch) 66 foote (that is, 792 inches) each severall link will be 7 inches and $\frac{92}{100}$.

If (according to 18. in the perch) the whole chaine be 72 feet in length (that is, 864 inches) then, each severall link will be 8 inches and $\frac{64}{100}$.

For so the length being multiplied into the bredth, the five last figures give the content in roods and perches by this Table; the other figures toward the left hand, doe shew the number of acres directly.

As in a long sqnare, where the length is 24 chaines $\frac{1}{4}$ the bredth 13. chaines $\frac{1}{2}$, the usuall way is, to resolve the chaines into perches: So the length is 97 perches and the bredth 54 perches. These multiplied one into the other make 5238 square perches and those (divided by 160) give 32. Acres, 2 roods, and 38 perches for the content required.

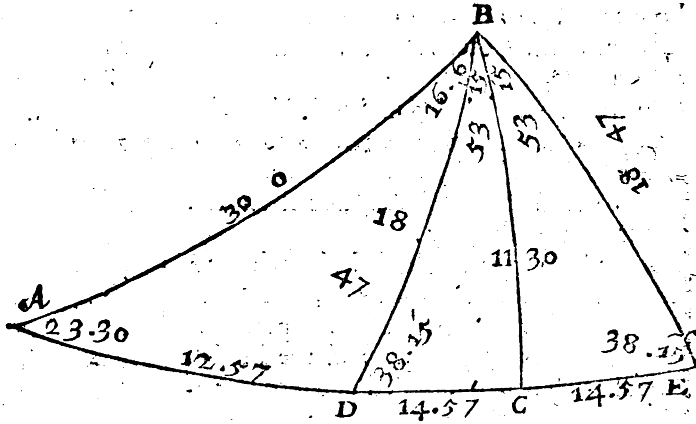
| *Links* | *R* | *P* |
|---|---|---|
| 100000 | 4 | 0 |
| 90000 | 3 | 24 |
| 80000 | 3 | 8 |
| 70000 | 2 | 32 |
| 60000 | 2 | 16 |
| 50000 | 2 | 0 |
| 40000 | 1 | 24 |
| 30000 | 1 | 8 |
| 20000 | | 32 |
| 10000 | | 16 |
| 9375 | | 15 |
| 8750 | | 14 |
| 8125 | | 13 |
| 7500 | | 12 |
| 6875 | | 11 |
| 6250 | | 10 |
| 5625 | | 9 |
| 5000 | | 8 |
| 4375 | | 7 |
| 3750 | | 6 |
| 3125 | | 5 |
| 2500 | | 4 |
| 1875 | | 3 |
| 1250 | | 2 |
| 625 | | 1 |

But, reckoning by chaines and linkes, the length is 24 *ch.* 25 *lin.* the bredth 13 *ch.* 50 *links.* These multiplied one into the other make 32,73750 square linkes. Then, cutting of the 5 last figures, I find 32. *Acres* 73750 *lin.* such as an 100000 do make an acre. Of which 70000 are equall to two roods 32 perches: and the rest 3750 equall to 6 perches more (as appeareth by this table.) So, the whole content is 32 acres, 2 roods, 38 perches, as before.

# CHAP. V.

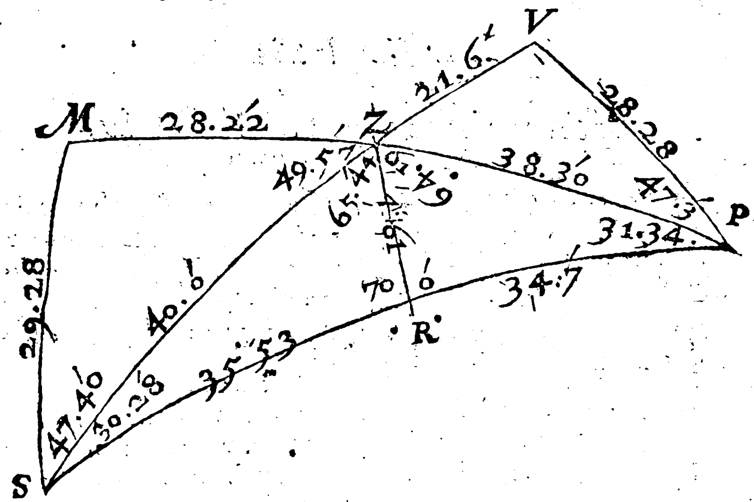
## *Of the resolution of sphæricall Triangles.*

For our practise in sphæricall triangle, let *A* be the equinoctiall point, *A B* an arke of the ecliptique representing the longitude of the Sunne in the beginning of ♉, *B C* an arke of the declination from the Sunne to the equator, and *A C* an arke of the equator representing the right ascension.




Let B D be an arke of the horizon representing the amplitude

plitude of the Sunnes rising from the East, and *B E* an arke of the horizon for his setting from the West: so DC shall be the difference of ascension, and *C E* the difference of descension; A D the oblique ascension, and *A E* the oblique descension of the same place of the Sunne in our latitude at *Oxford* of 51 *gr.* 45 *m.* whose complement 38 *gr.* 15 *m.* is the angle at *E* and D. The triangles *A C B*, D *C B*, *E C B*, are rectangle in *C*: the other *A D B*, *A E B*, consist every way of oblique angles.




Or to fit an example nearer to the latitude of *London*. Let Z *P S* represent the zenith pole and Sun, Z *P* being 38 *Gr.* 30 *m.* the complement of the latitude, *P S* 70 *Gr.* the complement of the declination, and Z *S* 40 *Gr.* the complement of the Suns altitude. The angle at Z shall shew the azimuth, and the angle at *P*, the houre of the day from the meridian. Then if from Z to *P* S we let downe a perpendicular Z *R*, we shall reduce the oblique triangle into two rectangle triangles Z *R P*, Z *R* S. Or if from *S* to Z *P* we let downe a perpendicular *S M*, we shall reduce the same Z *P* S into two other triangles, *S M Z*, *S M P*, rectangle at *M*: whatsoever is said of of any of these triangles, the same holdeth for all other triangles in the like cases.

For the resolution of each of these, there be severall wayes. I onely chuse those which are fittest for the *Sector*, wherein if that be remembred which before is shewed in the generall use of the *Sector* concerning laterall and parallell entrance, it may suffice onely to set downe the proposition of the three parts given to the fourth required, and so I shew first by the *sines* alone.

## *In a rectangle triangle.*

### 1 *To finde a side by knowing the base, and the angle opposite to the required side.*

As the Radius
is to the sine of the base:
So the sine of the opposite angle
to the sine of the side required.

As in the rectangle *ACB*, having the base *AB*, the place of the Sunne 30 *gr.* from the Equinoctiall point, and the angle *BAC* of 23 *gr.* 30 *m.* the greatest declination, if it were required to find the side *BC* the declination of the Sunne.

Take either the laterall sine of 23 *gr.* 30 *m.* and make it a parallell Radius; so the parallell sine of 30 *gr.* taken and measured in the side of the *Sector*, shall give the side required 11 *gr.* 30 *m.* Or take the sine of 30 *gr.* and make it a parallell Radius; so the parallell sine of 23 *gr.* 30 *m.* taken and measured in the laterall sines, shall be 11 *gr.* 30 *m.* as before.

So in the triangle *ZPS* having *ZP* 38 *gr.* 30 *m.* and the angle *P* 31 *gr* 34 *m* given, we shall find the perpendicular *ZR* to be 19 *gr.* 1 *m*; or having *PS* 70 *gr.* and the said angle P 31 *gr.* 34 *m.* given, we may finde the perpendicular *SM* to be 29 *gr.* 28 *m.*

### 2 *To finde a side by knowing the base and the other side.*

As the sine of the complement of the side given

Is to the Radius:
So the sine of the complement of the base
to the sine of the complement of the side required.

So in the rectangle A C B, having AB 30 *gr.* and B C 11 *gr.* 30 *m.* given, the side A C will be found 27 *gr.* 54 *m.*

Or in the rectangle Z *R* P having Z P 38 *gr.* 30 *m.* and Z *R* 49 *gr.* 1 *m.* given, the side *R P* will be found 34 *gr.* 7 *m.*

### 3 *To find a side by knowing the two oblique angles.*

As the sine of either angle
to the sine of the complement of the other angle:
So is the Radius
to the sine of the complement of the side opposite to the second angle.

So in the rectangle *A C* B, having *C A* B for the first angle 23 *gr*, 30 *m.* and *ABC* for the second 69 *gr.* 22 *m.* the side *A C* will be found 27 *gr.* 54 *m.* Or making *A B C* the first angle, and *C A B* the second, the side B *C* will be found 11 *gr.* 30 *m.*

### 4 *To finde the base by knowing both the sides.*

As the Radius
to the sine of the complement of the one side:
So the sine of the complement of the other side,
to the sine of the complement of the base required.

So in the rectangle *A C B* having A *C* 27 *gr.* 54 *m.* & B C 11 *gr.* 30 *m.* the base *A B* will be found 30 *gr.*

### 5 *To finde the base by knowing the one side, and the angle opposite to that side.*

As the sine of the angle given,
to the sine of the side given:
So is the Radius

to the sine of the base required.

So in the rectangle B C D, knowing the latitude and the declination, we may find the amplitude; as having B C the side of the declination 11 *gr.* 30 *m.* and B D C the angle of the complement of the latitude 38 *gr.* 15 *m.* the base B D which is the amplitude, will be found to be 18 *gr.* 47 *m.*

*6 To find an angle by the other oblique angle, and the side opposite to the inquired angle.*

As the Radius
to the sine of the complement of the side:
So the sine of the angle given,
to the sine of the complement of the angle required.

So in the rectangle A C B, having the angle B A C 23 *gr.* 30 *m.* and the side A C 27 *gr.* 54 *m.* the angle A B C will be found 69 *gr.* 21 *m.*

*7 To finde an angle by the other oblique angle, and the side opposite to the angle given.*

As the sine of the complement of the side
to the sine of the complement of the angle given:
So is the Radius
to the sine of the angle required.

So in the rectangle, A C B, having B A C 23 *gr.* 30 *m.* and B C 11 *gr.* 30 *m.* the angle A B C will be found 69 *gr.* 21 *m.*

*8 To finde an angle by the base, and the side opposite to the inquired angle.*

As the sine of the base
is to the Radius:
So the sine of the side
to the sine of the angle required.

So in the rectangle B C D, having B D 18 *gr.* 47 *m.* and B C 11 *gr.* 30 *m.* the angle B D C will be found 38 *gr.* 15 *m.*

These

These eight Propositions have been wrought by the *sines* alone; those which follow require joynt helpe of the *tangent*.

And forasmuch as the *tangent* could not well be extended beyond 63 *gr*. 30 *m*. I shall set downe two wayes for the resolution of each Proposition; if the one will not hold, the other may.

## 9 *To find a side by having the other side, and the angle opposite to the inquired side.*

1 As the Radius
 to the sine of the side given:
So the tangent of the angle,
 to tangent of the side required.

2 As the sine of the side given,
 is to the Radius:
So the tangent of the complement of the angle,
 to the tangent of the complement of the side required.

So in the rectangle A C B, having the side A C 27 *Gr*. 54 *m*, and the angle B A C 23 *Gr*. 30 *m*. the side B C will be found to be 11 *gr*, 30 *m*.

## 10 *To find a side by having the other side, and the angle next to the inquired side.*

1 As the tangent of the angle,
 to the tangent of the side given:
So is the Radius
 to the sine of the side required.

2 As the tangent of the complement of the side,
 to the tangent of the complement of the angle;
So is the Radius
 to the sine of the side required.

This and the like, where the tangent standeth in the first place, are best wrought by parallell entrance. And so in the rectangle B C D, having B C the side of declination 11 *gr.* 30 *m.* and B D C the angle of the complement of the latitude 38 *Gr.* 15 *m.* the side D C, which is the ascensionall difference, will be found 14 *Gr.* 57 *m.*

By the ascensionall difference is given the time of the Sunnes rising and setting, and length of the day; allowing an houre for each 15 *gr.* and 4 minutes of times for each severall degree. As in the example the difference betweene the Sunnes ascension in a right sphere, which is alwayes at 6 of the clocke, and his ascension in our latitude being 14 *gr*, 57 *m.* it sheweth that the Sunne riseth very neare an houre before 6, because of the Northerne declination; or after 6, if the Sunne be declining to the Southward.

### 11 *To find a side by knowing the base, and the angle adiacent next to the inquired side.*

1 As the Radius
to the sine of the complement of the angle:
So is the tangent of the base,
to the tangent of the side required.

2 As the sine of the complement of the angle
is to the Radius:
So the tangent of the complement of the base,
to the tangent of the complement of the side required.

So in the rectangle A C B, knowing the place of the Sun from the next equinoctiall point, and the angle of his greatest declination, we may find his right ascension: viz. the base A B 30 *gr.* and the angle B A C 23 *gr.* 30 *m.* being given, the right ascension A C will be found 27 *gr.* 54 *m.*

### 12 *To find the base by knowing the oblique angles.*

As the tangent of the one angle;

to the tangent of the complement of the other angle:
So is the Radius
to the sine of the complement of the base.

So in the rectangle A C B, having B A C 23 *gr.* 30 *m.* and A B C 69 *gr.* 21 *m.* the base A B will be found 30 *gr.*

13 *To finde the base, by knowing one of the sides, and the angle adiacent next that side.*

1 As the Radius
is to the sine of the complement of the angle:
So the tangent of the complement of the side,
to the tangent of the complement of the base.

2 As the sine of the complement of the angle
is to the Radius
So the tangent of the side given,
to the tangent of the base required.

So in the rectangle *A C B*, having *A C* 27 *gr.* 54 *m.* and *B A C* 23 *gr.* 30 *m.* the base A B will be found 30 *gr.* 0 *m.*

14 *To find an angle, by knowing both the sides.*

1 As the Radius
is to the sine of the side next the inquired angle:
So the tangent of the complement of the opposite side,
to the tangent of the complement of the angle required.

2 As the sine of the side next the inquired angle,
is to the Radius:
So the tangent of the opposite side,
to the tangent of the angle required.

So in the rectangle A C B, having A C 27 *gr.* 54 *m.* and B C 11 *gr.* 30 *m.* the angle at *A* will be found 23 *gr.* 30 *m.* and the angle at B 69 *gr.* 21 *m.*

### 15 *To finde an angle, by knowing the base, and the side next adiacent to the inquired angle*

1 As the tangent of the complement of the side,
to the tangent of the complement of the base:
So is the Radius
to the sine of the complement of the angle required.

2 As the tangent of the base,
to the tangent of the side:
So is the Radius,
to the sine of the complement of the angle required.

So in the rectangle BCD, having the base BD 18 *gr.* 47 *m.* and the side BC 11 *gr.* 30 *m.* the angle DBC between them will be found 53 *gr.* 15 *m.*

### 16 *To find an angle, by knowing the other oblique angle, and the base.*

1 As the Radius,
to the sine of the complement of the base:
So the tangent of the angle given,
to the tangent of the complement of the angle required.

2 As the sine of the complement of the base,
is to the Radius:
So the tangent of the complement of the angle given,
to the tangent of the angle required.

So in the rectangle ACB, having the angle at *A* 23 *gr.* 30 *m.* and the base AB 30 *gr.* the angle ABC will be found 69 *gr.* 22 *m.*

These fixteen cases are all that can fall out in a rectangle triangle: those which follow do hold

In

## *In any sphæricall triangle whatsoever*

### 17 *To find a side opposite to an angle given, by knowing one side, and two angles, whereof one is opposite to the given side, the other to the side required.*

As the sine of the angle opposite to the side given,
is to the sine of that side given:
So the sine of the angle opposite to the side required,
to the sine of the side required.

So in the triangle A B E, having the place of the Sunne, the latitude, and the greatest declination, we may finde the amplitude. As having A B 30 *gr.* B A E 23 *gr.* 30 *m.* and AEB 38 *gr.* 15 *m.* the side B E which is the amplitude, will be found 18 *gr.* 47 *m.*

### 18 *To finde an angle opposite to a side given, by having one angle and two sides, the one opposite to the given angle, the other to the angle required.*

As the sine of the side opposite to the angle given,
is to the sine of that angle given:
So the sine of the side opposite to the angle required,
to the sine of the angle required.

So in the triangle Z *P S*, having the azimuth, and altitude, and declination, we may find the houre of the day. As having *P* Z *S* 130 *gr.* 3 *m.* *P S* 70 *gr.* and Z *S* 40 *gr.* the angle *Z P S*, which sheweth the houre from the meridian shall be found 31 *gr.* 34 *m.*

### 19 *To find an angle by knowing the three sides.*

This proposition is most usefull, but most difficult of all others: as in Arithmetique, so by the *Sector*, yet may it be performed severall wayes.

1 According to *Regiomontanus* and others.

As the sine of the lesser side next the angle required,
to the difference of the versed sines of the base and difference of the sides:
So is the Radius
to a fourth proportionall.
Then as the sine of the greater side next the angle required is to that fourth proportionall;
So is the Radius
to the versed sine of the angle required.

So in the triangle *Z P S*, having the side *P S*, the coplement of the declination 70 *gr.* 0 *m.* the side *Z P* the complement of the latitude 38 *gr.* 30 *m.* and the base *Z S* the complement of the altitude 40 *gr.* the angle of the houre of the day *Z P S* will be found 31 *gr.* 34 *m.* which is 2 *h.* 6 *m.* from the meridian.
For the base being 40 *gr.* 0 *m.* and the difference of the sides 38 *gr.* 30 *m.* and 70 *gr.* 0 *m.* being 31 *gr.* 30 *m.* the difference of their versed sines will be the same with the distance between the right sine of 50 *gr.* and 58 *gr.* 30 *m.* This difference I take out, and make it a parallell sine of the lesser side 38 *gr.* 30 *m.* so the parallell Radius will be the fourth proportionall. Then coming to the second operation, I make this fourth proportionall a parallell sine of the greater side of 70 *gr.* 0 *m.* and take out his parallell Radius. For this measured from 90 *gr.* toward the center, will be the versed sine of 31 *gr.* 34 *m.*

In the like sort in the same triangle *Z P S*, having the same complements giuen, the angle *P Z S* which is the azimuth from the North part of the meridian, will be found 130 *gr.* 3 *m.* For here the base opposite to the angle required being 70 *gr.* and the difference of the sides 38 *gr.* 30 *m.* and 40 *gr.* being 1 *gr.* 30 *m.* the difference of their versed sines will be the same with the distance betweene the right sines of 20 *gr.* and 88 *gr.* 30 *m.* This difference I take, and make it a parallell sine of the lesser side 38 *gr* 30 *m.* so the parallell Radius will be the fourth proportionall. Then coming to the second operation, I make this fourth proportionall a parallell sine of the

the greater side 40 *gr.* and take out his parallell Radius. For this measured from 90 *gr.* beyond the center in the lines of *sines* stretched forth at their full length, will be the versed sine of 130 *gr.* 3 *m.*

2. I may finde an angle by knowing three sides, by that which I have elsewhere demonstrated upon *Barth: Pitiscus*, and that at one operation in this manner.

As the sine of the greater side
  is to the secant of the complement of the other side:
 So the difference of sines of the complement of the base, and the arke compounded of the lesser side with complement of the greater,
  to the versed sine of the angle required.

So in the same triangle *Z P S*, having the same complements given, the angle at *P*, which sheweth the houre from the meridian, will be found as before 31 *gr.* 34 *m.*

For the sides being 38 *gr.* 30 *m.* and 70 *gr.* 0 *m.* I take the secant of the complement of 38 *gr.* 30 *m.* and make it a parallell sine of 70 *gr*; then keeping the Sector at this angle, I consider that the complement of 70 *gr.* being 20 *gr.* added unto 38 *gr* 30 *m.* the compounded side (which is here the meridian altitude) will be 58 *gr* 30 *m*; and that the base being 40 *gr*, the difference of sines of the compounded side and the complement of the base will be (as before) the distance betweene the sines of 50 *gr.* and 58 *gr.* 30 *m.* Wherefore I take out this difference, and lay it on both the lines of *sines* from the center: so the parallell taken in the termes of this difference, and measured from 90 *gr.* toward the center, doth give the versed sine of 31 *gr.* 34 *m.*

This example, of finding the houre of the day might otherwise have been proposed in these termes.

As the sine of the complement of the declination,
  is to the secant of the Latitude:
 So the difference between the sine of the altitude proposed, and the sine of the meridian Altitude.

 to

to the versed sine of the houre from the Meridian.

Then the Latitude being 51 g. 30′, the declination 20 gr. northward, and the Altitude 50 gr. the worke would be the same as before.

The other angles *P Z S*, *P S Z*, may be found in the same sort; but having the sides and one angle, it will be sooner done by that which we shewed before in the 18 *Prop*.

## 20 *To find a side by knowing the three angles.*

If for the greater angle we take his complement to 180 gr the angles shall be turned into sides, and the sides into angles, & the operation shall be the same, as in the former *Prop*.

As in the triangle Z P S, having the angle Z P S 31 *Gr.* 34′. Z S P 30 *gr.* 28′ and P Z *S* 130 *gr.* 3′, I would take the greater angle, of 130 *gr.* 3′. out of 180 *gr*, and there remaine 49 *gr.* 57′. Then as if I had a Triangle of 3 knowne sides, one of 31 *gr.* 34′, another of 30 *gr* 20′ and a third of 49 *gr.* 57′, I would seeke the angle opposite to one of these sides, by the last Prop. So the angle which is thus found, would be the side which is here required.

## 21 *To find a side, by having the other two sides, and the angle comprehended.*

This proposition being the converse of the nineteenth, may be wrought accordingly; but the best way both for it and those which follow, is to resolve them into two rectangles, by letting downe a perpendicular, as was shewed in the first *Prop*.

So in the triangle Z P S, having Z P the complement of the latitude, and P S the complement of the declination, with *Z* P S the angle of the houre from the meridian, we may find Z S the complement of the altitude of the *Sunne*.

For having let downe the perpendicular Z *R* by the first *Prop*

*Prop.* we have two triangles, *Z R* P, *Z R S*, both rectangle at *R*. Then may we finde the side P *R*, either by the second, or tenth, or eleventh *Prop.* which taken out of P *S*, leaveth the side *R S*: with this *R S* and *Z R* we may find the base *Z* S by the fourth *Prop.*

Or having let downe the perpendicular *SM*, we have two rectangle triangles S *M Z*, *S M P*. Then may we find *M P*, from which if we take *Z P*, there remaineth *M Z*: but with *MZ* and *S M*, we may find the base *Z S*.

### 22 *To find a side, by having the other two sides, and one of the angles next the inquired side.*

So in the triangle *Z P S* having *Z P* the complement of the latitude, and *P S* the complement of the declination, with *P Z* S the angle of the azimuth, we may finde *Z S* the complement of the altitude of the *Sunne*.

For having *Z P*, and the angle at *Z*, we may to *S Z* produced, let downe a perpendicular *P V*. Then we have two rectangle triangles, P V *Z*, P V S, wherein if we find the sides V *Z*, V *S*, and take the one out of the other, there will remain the side required *Z S*.

### 23 *To finde the side, by having one side, and the two angles next the inquired side.*

So in the triangle A B D, having A B the place of the sun, and *B A D* the angle of the greatest declination, and *A D B* the angle of the equator with the horizon, we may find *A D* the oblique ascention.

For having let downe *B C* the perpendicnlar of declination, we have two rectangles triangles, *A C B*, *D C B*. Then may we find *A C* the right ascention, and D C the ascentionall difference; and comparing the one with the other, there remaineth *A D*,

## 24 *To find a side, by having two angles, and the side enclosed by them.*

So in the triangle Z *P S*, having the angles at Z and P, with the side intercepted Z P, we may find the side P S. For having let downe the perpendicular P V, we have two rectangles P V Z, P V S. Then may we find the angle V P Z, either by the seventh, or fifteenth or sixteenth *prop.* which added to Z P S, maketh the angle V P S, with this V P S. and P V, we may find the base P S, according to the 13 *Prop.*

## 25 *To find an angle by having the other two angles and the side inclosed by them.*

So in the triangle Z P *S*, having the angles at Z and P, with the side intercepted Z P, we may finde the other angle *Z S* P. For having let downe the perpendicular Z R, we have two rectangles Z R P, Z R *S*. Then may we finde the angle P Z R by the sixteenth *Prop.* and that compared with P Z *S*, leaveth the angle R Z *S*: with this R Z S and Z R we may find the angle required Z S R, according to the sixth *Proposition.*

## 26 *To finde an angle, by having the other two angles, and one of the sides next the inquired angle.*

So in the triangle A B D, having the angles at *A* and *D*, with the side A B, we may find the angle A B D. For having let downe the perpendicular B C, we have two rectangles, A C B, D C B. Then may we find the angles A B C, D B C, and take D B C out of A B C; for so there remaineth the angle required A B D.

## 27 *To find an angle, by knowing two sides, and the angle contained by them.*

So

So in the triangle *Z* P S, having the sides *Z* P, P S, with the angle comprehended *Z* P S, we may find the angle P *Z* S. For having let downe the perpendicular S M, we have two rectangles *S M Z*, S *M* P. Then may we find the side M P, and taking *Z* P out of *M* P, there remaineth *M Z*: with this *MZ* and the perpendicular *M*S, we may find the angle *M Z* S, by the fourteenth Prop. This angle M *Z* S, taken out 180 *gr.* there remaineth P *Z* S.

28 *To finde an angle by knowing the two sides next it and one of the other angles.*

So in the triangle *Z* P S, having the sides *Z* P and P S, with the angle P *Z* S, we may find the angle *Z* P S. For having let downe the perpendicular P *V*, we have two rectangles P V *Z*, P V S. Then may we find the angles *V* P Z, *V* P S, and taking *V* P Z out of *V* P S, there remaineth Z P S which was required.

These 28 cases are all that can fall out in any sphæricall triangle: if any do not presently understand them, let them once more reade over the use of the globes, and they shall soone become easie unto them.

## CHAP. VI.

### *Of the use of the Meridian line in Navigation.*

THe *Meridian* line is here set on the side of the Sector streched forth at full length, on the same plane with the line of *lines* and *Solids*, and is diuided unequally toward 87 *gr.*

(whereof 70 *gr.* are about one halfe) in such sort as the Meridian in the Chart of *Mercators* proiection. The vse of it may be:

### 1 *To divide a sea Chart according to proiection.*

If a degree of the æquator on the sea-chart be equall to the hundred part of the line of *lines* in the *Sector*, the degrees of the *Meridian* vpon the *Sector*, shall give the like degrees vpon the sea-chart: if otherwise they be unequall, then may the meridian's of the sea-chart be divided in such sort as the line of *Meridians* is divided on the *Sector*, by that which we shewed before in the 8 *prop.* of the line of lines.

But to avoid error, I have here set downe a Table, whereby the Meridian line may be divided out of the degrees of the æquator, supposing each degree in the Æquator, to be subdivided into a thousand parts. By which Table, and the vsuall Table of *Sines*, *Tangents* and *Secants*, the proportions following may be also resolved arithmetically. For the manner of division, let the æquator be drawne, and divided, and crossed with parallell meridians, as in the common sea-chart: then looke into the Table, and let the distance betweene the Æquator and 40 *gr.* in the meridian, from the æquator, be equall to 43 *gr.* 711 *parts* of the Æquator; let 50 *gr.* in the meridian from the æquator, be equall to 57 *gr.* 909 *parts* of the equator; and so in the rest.

The making of this Table is, by addition of *Secants.* For the *Parallells* of *latitudes* being lesse then Æquator or Meridian, in such proportion, as the Radius is to the *Secant* of the *Parallell.* For example, the Parallell of 60 *degrees* of *Latitude* is lesse then the Æquator (and consequently, each degree of this *Parallell* of 60 degrees lesse then a degree of the æquator, or Meridian) in such proportion as 100000 the *Radius* hath unto 200000 the *Secant* of 60 *degrees.*

| M | Gr | Par | M | Gr | par | M | Gr | Par | M | Gr | Par | M | Gr | Par |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 3 | 3 | 001 | 6 | 6 | 011 | 9 | 9 | 037 | 12 | 12 | 088 |
| | | 100 | | 3 | 101 | | 6 | 111 | | 9 | 138 | | 12 | 190 |
| | | 200 | | 3 | 201 | | 6 | 212 | | 9 | 239 | | 12 | 293 |
| | | 300 | | 3 | 301 | | 6 | 312 | | 9 | 341 | | 12 | 395 |
| | | 400 | | 3 | 402 | | 6 | 413 | | 9 | 442 | | 12 | 497 |
| | | 500 | | 3 | 502 | | 6 | 514 | | 9 | 543 | | 12 | 600 |
| | | 600 | | 3 | 602 | | 6 | 614 | | 9 | 645 | | 12 | 702 |
| | | 700 | | 3 | 702 | | 6 | 715 | | 9 | 746 | | 12 | 805 |
| | | 800 | | 3 | 803 | | 6 | 816 | | 9 | 848 | | 12 | 907 |
| | | 900 | | 3 | 903 | | 6 | 916 | | 9 | 949 | | 13 | 010 |
| 1 | 1 | 000 | 4 | 4 | 003 | 7 | 7 | 017 | 10 | 10 | 051 | 13 | 13 | 112 |
| | 1 | 100 | | 4 | 103 | | 7 | 118 | | 10 | 152 | | 13 | 215 |
| | 1 | 200 | | 4 | 204 | | 7 | 219 | | 10 | 254 | | 13 | 318 |
| | 1 | 300 | | 4 | 304 | | 7 | 319 | | 10 | 355 | | 13 | 421 |
| | 1 | 400 | | 4 | 404 | | 7 | 420 | | 10 | 457 | | 13 | 523 |
| | 1 | 500 | | 4 | 504 | | 7 | 521 | | 10 | 559 | | 13 | 626 |
| | 1 | 600 | | 4 | 605 | | 7 | 622 | | 10 | 661 | | 13 | 729 |
| | 1 | 700 | | 4 | 705 | | 7 | 723 | | 10 | 762 | | 13 | 832 |
| | 1 | 800 | | 4 | 805 | | 7 | 824 | | 10 | 864 | | 13 | 935 |
| | 1 | 900 | | 4 | 906 | | 7 | 925 | | 10 | 966 | | 14 | 038 |
| 2 | 2 | 000 | 5 | 5 | 006 | 8 | 8 | 026 | 11 | 11 | 068 | 14 | 14 | 141 |
| | 2 | 100 | | 5 | 106 | | 8 | 127 | | 11 | 170 | | 14 | 244 |
| | 2 | 200 | | 5 | 207 | | 8 | 228 | | 11 | 272 | | 14 | 347 |
| | 2 | 300 | | 5 | 307 | | 8 | 329 | | 11 | 374 | | 14 | 450 |
| | 2 | 400 | | 5 | 408 | | 8 | 430 | | 11 | 476 | | 14 | 553 |
| | 2 | 500 | | 5 | 508 | | 8 | 531 | | 11 | 578 | | 14 | 656 |
| | 2 | 601 | | 5 | 609 | | 8 | 632 | | 11 | 680 | | 14 | 760 |
| | 2 | 701 | | 5 | 709 | | 8 | 733 | | 11 | 782 | | 14 | 863 |
| | 2 | 801 | | 5 | 810 | | 8 | 834 | | 11 | 884 | | 14 | 967 |
| | 2 | 901 | | 5 | 910 | | 8 | 936 | | 11 | 986 | | 15 | 070 |
| 3 | 3 | 001 | 6 | 6 | 011 | 9 | 9 | 037 | 12 | 12 | 088 | 15 | 15 | 174 |

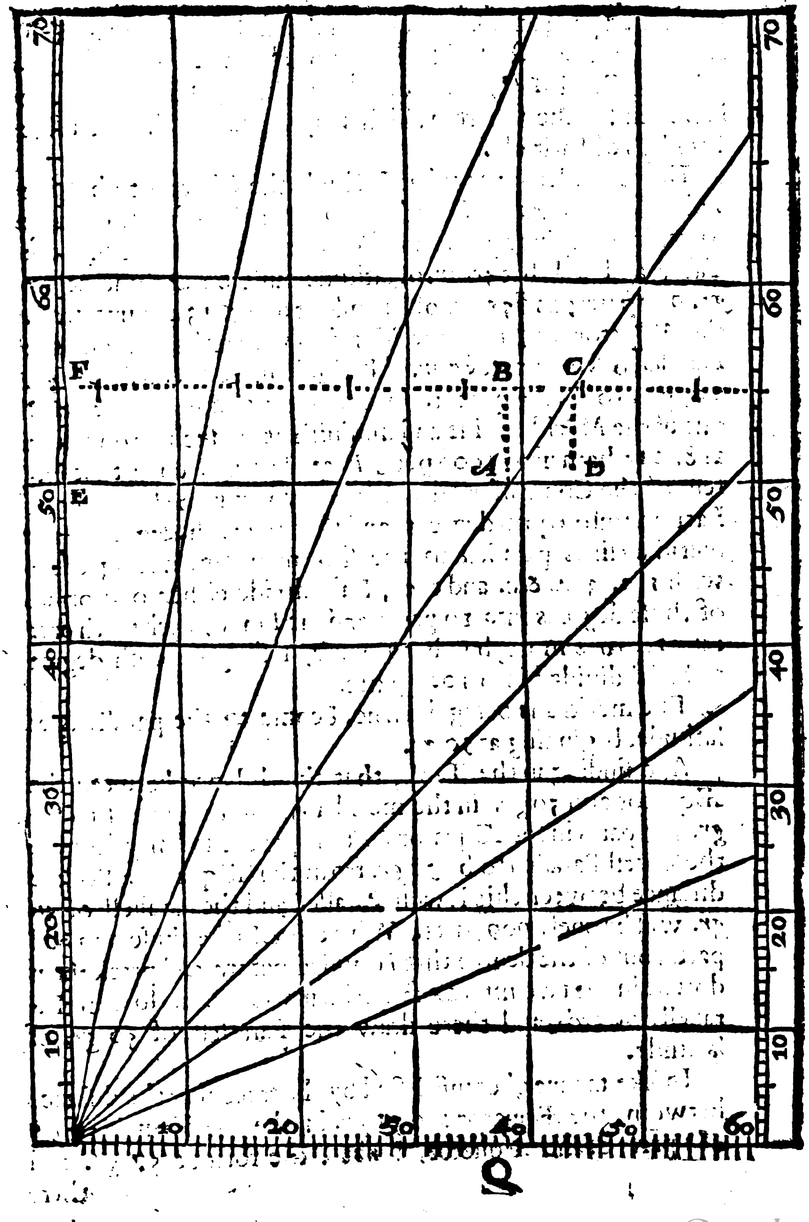
| M | G. | Par | M | Gr | Par | M | Gr | Par | M | Gr | Par | M | Gr | part |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 15 | 174 | 18 | 18 | 303 | 21 | 21 | 486 | 24 | 24 | 734 | 27 | 28 | 058 |
| | 15 | 277 | | 18 | 408 | | 21 | 593 | | 24 | 844 | | 28 | 171 |
| | 15 | 381 | | 18 | 513 | | 21 | 701 | | 24 | 953 | | 28 | 283 |
| | 15 | 485 | | 18 | 619 | | 21 | 808 | | 25 | 063 | | 28 | 396 |
| | 15 | 588 | | 18 | 724 | | 21 | 915 | | 25 | 173 | | 28 | 508 |
| | 15 | 692 | | 18 | 830 | | 21 | 023 | | 25 | 282 | | 28 | 621 |
| | 15 | 796 | | 18 | 935 | | 22 | 130 | | 25 | 392 | | 28 | 734 |
| | 15 | 900 | | 19 | 041 | | 22 | 238 | | 25 | 502 | | 28 | 847 |
| | 16 | 004 | | 19 | 146 | | 22 | 345 | | 25 | 613 | | 28 | 959 |
| | 16 | 107 | | 19 | 251 | | 22 | 453 | | 25 | 723 | | 29 | 072 |
| 16 | 16 | 211 | 19 | 19 | 356 | 22 | 22 | 561 | 25 | 25 | 833 | 28 | 29 | 186 |
| | 16 | 316 | | 19 | 463 | | 22 | 669 | | 25 | 943 | | 29 | 299 |
| | 16 | 420 | | 19 | 569 | | 22 | 777 | | 26 | 054 | | 29 | 413 |
| | 16 | 524 | | 19 | 675 | | 22 | 885 | | 26 | 164 | | 29 | 526 |
| | 16 | 628 | | 19 | 781 | | 22 | 993 | | 26 | 275 | | 29 | 640 |
| | 16 | 732 | | 19 | 887 | | 23 | 101 | | 26 | 386 | | 29 | 753 |
| | 16 | 836 | | 19 | 993 | | 23 | 210 | | 26 | 497 | | 29 | 867 |
| | 16 | 941 | | 20 | 100 | | 23 | 318 | | 26 | 608 | | 29 | 981 |
| | 17 | 045 | | 20 | 206 | | 23 | 427 | | 26 | 719 | | 30 | 095 |
| | 17 | 150 | | 20 | 312 | | 23 | 535 | | 26 | 830 | | 30 | 300 |
| 17 | 17 | 255 | 20 | 20 | 419 | 23 | 23 | 643 | 26 | 26 | 941 | 29 | 30 | 324 |
| | 17 | 359 | | 20 | 525 | | 23 | 752 | | 27 | 052 | | 30 | 438 |
| | 17 | 464 | | 20 | 632 | | 23 | 861 | | 27 | 164 | | 30 | 553 |
| | 17 | 568 | | 20 | 738 | | 23 | 970 | | 27 | 275 | | 30 | 667 |
| | 17 | 673 | | 20 | 845 | | 24 | 079 | | 27 | 387 | | 30 | 782 |
| | 17 | 778 | | 20 | 952 | | 24 | 188 | | 27 | 499 | | 30 | 897 |
| | 17 | 883 | | 21 | 059 | | 24 | 297 | | 27 | 610 | | 31 | 012 |
| | 17 | 988 | | 21 | 165 | | 24 | 406 | | 27 | 722 | | 31 | 127 |
| | 18 | 093 | | 21 | 272 | | 24 | 515 | | 27 | 834 | | 31 | 242 |
| | 18 | 198 | | 21 | 379 | | 24 | 624 | | 27 | 946 | | 31 | 357 |
| 18 | 18 | 303 | 21 | 21 | 486 | 24 | 24 | 734 | 27 | 28 | 058 | 30 | 31 | 473 |

| M | Gr | Par | M | Gr | Par | M | Gr | Par | M | Gr | Par | M | Gr | Par |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 31 | 473 | 33 | 34 | 992 | 36 | 38 | 633 | 39 | 42 | 415 | 42 | 46 | 362 |
| | 31 | 588 | | 35 | 111 | | 38 | 757 | | 42 | 544 | | 46 | 496 |
| | 31 | 704 | | 35 | 231 | | 38 | 880 | | 42 | 673 | | 46 | 631 |
| | 31 | 820 | | 35 | 350 | | 39 | 004 | | 42 | 802 | | 46 | 766 |
| | 31 | 936 | | 35 | 470 | | 39 | 129 | | 42 | 931 | | 46 | 902 |
| | 32 | 052 | | 35 | 591 | | 39 | 253 | | 43 | 061 | | 47 | 037 |
| | 32 | 168 | | 35 | 710 | | 39 | 377 | | 43 | 191 | | 47 | 173 |
| | 32 | 284 | | 35 | 830 | | 39 | 502 | | 43 | 320 | | 47 | 309 |
| | 32 | 409 | | 35 | 950 | | 39 | 627 | | 43 | 451 | | 47 | 445 |
| | 32 | 517 | | 36 | 071 | | 39 | 752 | | 43 | 581 | | 47 | 581 |
| 31 | 32 | 633 | 34 | 36 | 191 | 37 | 39 | 877 | 40 | 43 | 711 | 43 | 47 | 718 |
| | 32 | 750 | | 36 | 312 | | 40 | 002 | | 43 | 842 | | 47 | 855 |
| | 32 | 867 | | 36 | 433 | | 40 | 128 | | 43 | 973 | | 47 | 992 |
| | 32 | 984 | | 36 | 554 | | 40 | 253 | | 44 | 104 | | 48 | 129 |
| | 33 | 101 | | 36 | 675 | | 40 | 379 | | 44 | 235 | | 48 | 267 |
| | 33 | 218 | | 36 | 796 | | 40 | 505 | | 44 | 366 | | 48 | 404 |
| | 33 | 336 | | 36 | 917 | | 40 | 631 | | 44 | 498 | | 48 | 542 |
| | 33 | 453 | | 37 | 039 | | 40 | 757 | | 44 | 630 | | 48 | 681 |
| | 33 | 571 | | 37 | 161 | | 40 | 884 | | 44 | 762 | | 48 | 819 |
| | 33 | 688 | | 37 | 283 | | 41 | 011 | | 44 | 894 | | 48 | 958 |
| 32 | 33 | 806 | 35 | 37 | 405 | 38 | 41 | 137 | 41 | 45 | 026 | 44 | 49 | 097 |
| | 33 | 924 | | 37 | 527 | | 41 | 264 | | 45 | 159 | | 49 | 236 |
| | 34 | 042 | | 37 | 649 | | 41 | 392 | | 45 | 292 | | 49 | 375 |
| | 34 | 161 | | 37 | 771 | | 41 | 519 | | 45 | 425 | | 49 | 515 |
| | 34 | 279 | | 37 | 894 | | 41 | 646 | | 45 | 558 | | 49 | 655 |
| | 34 | 397 | | 38 | 017 | | 41 | 774 | | 45 | 691 | | 49 | 795 |
| | 34 | 516 | | 38 | 140 | | 41 | 902 | | 45 | 825 | | 49 | 935 |
| | 34 | 635 | | 38 | 263 | | 42 | 030 | | 45 | 959 | | 50 | 076 |
| | 34 | 754 | | 38 | 386 | | 42 | 158 | | 46 | 093 | | 50 | 217 |
| | 34 | 873 | | 38 | 509 | | 42 | 287 | | 46 | 227 | | 50 | 358 |
| 33 | 34 | 992 | 36 | 38 | 633 | 39 | 42 | 415 | 42 | 46 | 362 | 45 | 50 | 499 |

| M | Gr | Par | M | Gr | Par | M | Gr | Par | M | Gr | Par | M | Gr | Par |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | 50 | 499 | 48 | 54 | 860 | 51 | 59 | 481 | 54 | 64 | 412 | 57 | 69 | 711 |
| | 50 | 641 | | 55 | 010 | | 59 | 640 | | 64 | 582 | | 69 | 895 |
| | 50 | 783 | | 55 | 160 | | 59 | 800 | | 64 | 753 | | 70 | 080 |
| | 50 | 925 | | 55 | 310 | | 59 | 960 | | 64 | 924 | | 70 | 263 |
| | 51 | 068 | | 55 | 460 | | 60 | 120 | | 65 | 096 | | 70 | 449 |
| — | 51 | 210 | — | 55 | 611 | — | 60 | 280 | — | 65 | 268 | — | 70 | 635 |
| | 51 | 353 | | 55 | 762 | | 60 | 441 | | 65 | 440 | | 70 | 821 |
| | 51 | 496 | | 55 | 913 | | 60 | 601 | | 65 | 613 | | 71 | 008 |
| | 51 | 639 | | 56 | 065 | | 60 | 763 | | 65 | 786 | | 71 | 195 |
| | 51 | 783 | | 56 | 217 | | 60 | 925 | | 65 | 960 | | 71 | 383 |
| 46 | 51 | 927 | 49 | 56 | 369 | 52 | 61 | 088 | 55 | 66 | 134 | 58 | 71 | 572 |
| | 52 | 071 | | 56 | 522 | | 61 | 250 | | 66 | 308 | | 71 | 761 |
| | 52 | 215 | | 56 | 675 | | 61 | 413 | | 66 | 483 | | 71 | 950 |
| | 52 | 360 | | 56 | 828 | | 61 | 577 | | 66 | 659 | | 72 | 140 |
| | 52 | 505 | | 56 | 981 | | 61 | 740 | | 66 | 835 | | 72 | 331 |
| — | 52 | 650 | — | 57 | 135 | — | 61 | 904 | — | 67 | 011 | — | 72 | 522 |
| | 52 | 795 | | 57 | 289 | | 62 | 069 | | 67 | 188 | | 72 | 714 |
| | 52 | 941 | | 57 | 444 | | 62 | 234 | | 67 | 365 | | 72 | 906 |
| | 53 | 087 | | 57 | 598 | | 62 | 399 | | 67 | 543 | | 73 | 099 |
| | 53 | 233 | | 57 | 754 | | 62 | 564 | | 67 | 721 | | 73 | 292 |
| 47 | 53 | 380 | 50 | 57 | 909 | 53 | 62 | 730 | 56 | 67 | 900 | 59 | 73 | 486 |
| | 53 | 526 | | 58 | 065 | | 62 | 897 | | 68 | 079 | | 73 | 680 |
| | 53 | 673 | | 58 | 221 | | 63 | 063 | | 68 | 258 | | 73 | 875 |
| | 53 | 821 | | 58 | 377 | | 63 | 231 | | 68 | 438 | | 74 | 071 |
| | 53 | 968 | | 58 | 534 | | 63 | 398 | | 68 | 618 | | 74 | 267 |
| — | 54 | 116 | — | 58 | 691 | — | 63 | 566 | — | 68 | 799 | — | 74 | 464 |
| | 54 | 264 | | 58 | 848 | | 63 | 734 | | 68 | 981 | | 74 | 661 |
| | 54 | 413 | | 59 | 006 | | 63 | 903 | | 69 | 163 | | 74 | 859 |
| | 54 | 562 | | 59 | 164 | | 64 | 072 | | 69 | 345 | | 75 | 057 |
| | 54 | 711 | | 59 | 322 | | 64 | 242 | | 69 | 528 | | 75 | 256 |
| 48 | 54 | 860 | 51 | 59 | 481 | 54 | 64 | 412 | 57 | 69 | 711 | 60 | 75 | 456 |

| M | Gr | Par | M | Gr | Par | M | Gr | Par | M | Gr | Par | M | Gr | Par |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | 75 | 456 | 63 | 81 | 749 | 66 | 88 | 725 | 69 | 96 | 575 | 72 | 105 | 579 |
| | 75 | 650 | | 81 | 970 | | 88 | 971 | | 96 | 854 | | 105 | 904 |
| | 75 | 857 | | 82 | 191 | | 89 | 219 | | 97 | 135 | | 106 | 230 |
| | 76 | 059 | | 82 | 413 | | 89 | 467 | | 97 | 418 | | 105 | 558 |
| | 76 | 261 | | 82 | 635 | | 89 | 716 | | 97 | 701 | | 106 | 888 |
| | 76 | 464 | | 82 | 860 | | 89 | 967 | | 97 | 986 | | 107 | 220 |
| | 76 | 667 | | 83 | 084 | | 90 | 218 | | 98 | 272 | | 107 | 553 |
| | 76 | 871 | | 83 | 310 | | 90 | 470 | | 98 | 560 | | 107 | 888 |
| | 77 | 076 | | 83 | 536 | | 90 | 723 | | 98 | 849 | | 108 | 226 |
| | 77 | 281 | | 83 | 763 | | 90 | 978 | | 99 | 139 | | 108 | 565 |
| 61 | 77 | 487 | 64 | 83 | 990 | 67 | 91 | 232 | 70 | 99 | 431 | 73 | 108 | 906 |
| | 77 | 594 | | 84 | 219 | | 91 | 489 | | 99 | 724 | | 109 | 249 |
| | 77 | 901 | | 84 | 448 | | 91 | 746 | | 100 | 018 | | 109 | 594 |
| | 78 | 109 | | 84 | 678 | | 92 | 005 | | 100 | 314 | | 109 | 941 |
| | 78 | 317 | | 84 | 909 | | 92 | 264 | | 100 | 612 | | 110 | 290 |
| | 78 | 526 | | 85 | 141 | | 92 | 525 | | 100 | 910 | | 110 | 641 |
| | 78 | 736 | | 85 | 374 | | 92 | 787 | | 101 | 211 | | 110 | 994 |
| | 78 | 947 | | 85 | 607 | | 93 | 050 | | 101 | 513 | | 111 | 349 |
| | 79 | 158 | | 85 | 842 | | 93 | 314 | | 101 | 816 | | 111 | 707 |
| | 79 | 370 | | 86 | 077 | | 93 | 579 | | 102 | 121 | | 112 | 056 |
| 62 | 79 | 583 | 65 | 86 | 313 | 68 | 93 | 846 | 71 | 102 | 427 | 74 | 112 | 428 |
| | 79 | 796 | | 86 | 550 | | 94 | 113 | | 102 | 735 | | 112 | 792 |
| | 80 | 010 | | 86 | 788 | | 94 | 382 | | 103 | 044 | | 113 | 158 |
| | 80 | 225 | | 87 | 027 | | 94 | 652 | | 103 | 356 | | 113 | 526 |
| | 80 | 441 | | 87 | 267 | | 94 | 923 | | 103 | 668 | | 113 | 897 |
| | 80 | 657 | | 87 | 508 | | 95 | 195 | | 103 | 983 | | 114 | 270 |
| | 80 | 874 | | 87 | 749 | | 95 | 458 | | 104 | 299 | | 114 | 645 |
| | 81 | 091 | | 87 | 992 | | 95 | 743 | | 104 | 616 | | 115 | 023 |
| | 81 | 310 | | 88 | 235 | | 96 | 019 | | 104 | 936 | | 115 | 403 |
| | 81 | 529 | | 88 | 480 | | 96 | 296 | | 105 | 257 | | 115 | 786 |
| 63 | 81 | 749 | 66 | 88 | 725 | 69 | 96 | 575 | 72 | 105 | 579 | 75 | 116 | 171 |

| M | Gr. | Par | M | Gr. | Par | M | Gr. | Par | M | Gr. | Par | M | Gr. | part |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 116 | 171 | 78 | 129 | 075 | 81 | 145 | 650 | 84 | 168 | 947 | 87 | 208 | 705 |
| | 116 | 559 | | 129 | 558 | | 145 | 292 | | 169 | 912 | | 210 | 649 |
| | 116 | 949 | | 130 | 045 | | 146 | 942 | | 170 | 893 | | 212 | 668 |
| | 117 | 342 | | 130 | 536 | | 147 | 600 | | 171 | 891 | | 214 | 745 |
| | 117 | 737 | | 131 | 031 | | 148 | 265 | | 172 | 907 | | 216 | 909 |
| | 118 | 135 | | 131 | 530 | | 148 | 937 | | 173 | 941 | | 219 | 158 |
| 76 | 118 | 536 | | 132 | 034 | | 149 | 618 | | 174 | 994 | | 221 | 498 |
| | 118 | 939 | | 132 | 542 | | 150 | 307 | | 176 | 067 | | 223 | 938 |
| | 119 | 345 | | 133 | 055 | | 151 | 003 | | 177 | 160 | | 226 | 486 |
| | 119 | 755 | | 133 | 572 | | 151 | 709 | | 178 | 275 | | 229 | 153 |
| | 120 | 160 | 79 | 134 | 094 | 82 | 152 | 423 | 85 | 179 | 411 | 88 | 231 | 950 |
| | 120 | 581 | | 134 | 620 | | 153 | 147 | | 180 | 569 | | 234 | 891 |
| | 121 | 000 | | 135 | 151 | | 153 | 878 | | 181 | 752 | | 237 | 991 |
| | 121 | 420 | | 135 | 687 | | 154 | 620 | | 182 | 950 | | 241 | 268 |
| | 121 | 843 | | 136 | 228 | | 155 | 372 | | 184 | 194 | | 244 | 744 |
| 77 | 122 | 270 | | 136 | 775 | | 156 | 132 | | 185 | 454 | | 248 | 445 |
| | 122 | 700 | | 137 | 326 | | 156 | 903 | | 186 | 743 | | 252 | 402 |
| | 123 | 133 | | 137 | 883 | | 157 | 685 | | 188 | 062 | | 256 | 652 |
| | 123 | 570 | | 138 | 445 | | 158 | 478 | | 189 | 411 | | 261 | 243 |
| | 124 | 009 | | 139 | 012 | | 159 | 281 | | 190 | 793 | | 266 | 235 |
| | 124 | 452 | 80 | 139 | 585 | 83 | 160 | 096 | 86 | 192 | 210 | 89 | 271 | 705 |
| | 124 | 898 | | 140 | 164 | | 160 | 922 | | 193 | 661 | | 277 | 753 |
| | 125 | 348 | | 140 | 748 | | 161 | 761 | | 195 | 151 | | 284 | 517 |
| | 125 | 801 | | 141 | 339 | | 162 | 612 | | 196 | 680 | | 292 | 191 |
| | 126 | 258 | | 141 | 936 | | 163 | 475 | | 198 | 251 | | 301 | 058 |
| | 126 | 718 | | 142 | 138 | | 164 | 352 | | 199 | 867 | | 311 | 563 |
| | 127 | 182 | | 143 | 147 | | 165 | 242 | | 201 | 529 | | 324 | 455 |
| | 127 | 649 | | 143 | 763 | | 166 | 146 | | 203 | 240 | | 341 | 166 |
| | 128 | 121 | | 144 | 385 | | 167 | 065 | | 205 | 005 | | 365 | 039 |
| | 128 | 596 | | 145 | 014 | | 167 | 999 | | 206 | 825 | | 408 | 011 |
| 8 | 129 | 075 | 81 | 145 | 650 | 94 | 168 | 947 | 87 | 208 | 705 | 90 | Infinite | |


70
60
F
B
C
A
D
50
E
40
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70
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Q

If it be a particular Chart, I would first draw the line *A B* serving for the first Meridian and crosse it with 2 perpendiculars *B C* and *A D*, the one at the upper end, the other at the lower end of the Chart, which may serve for the extreme Parallells of Latitude.

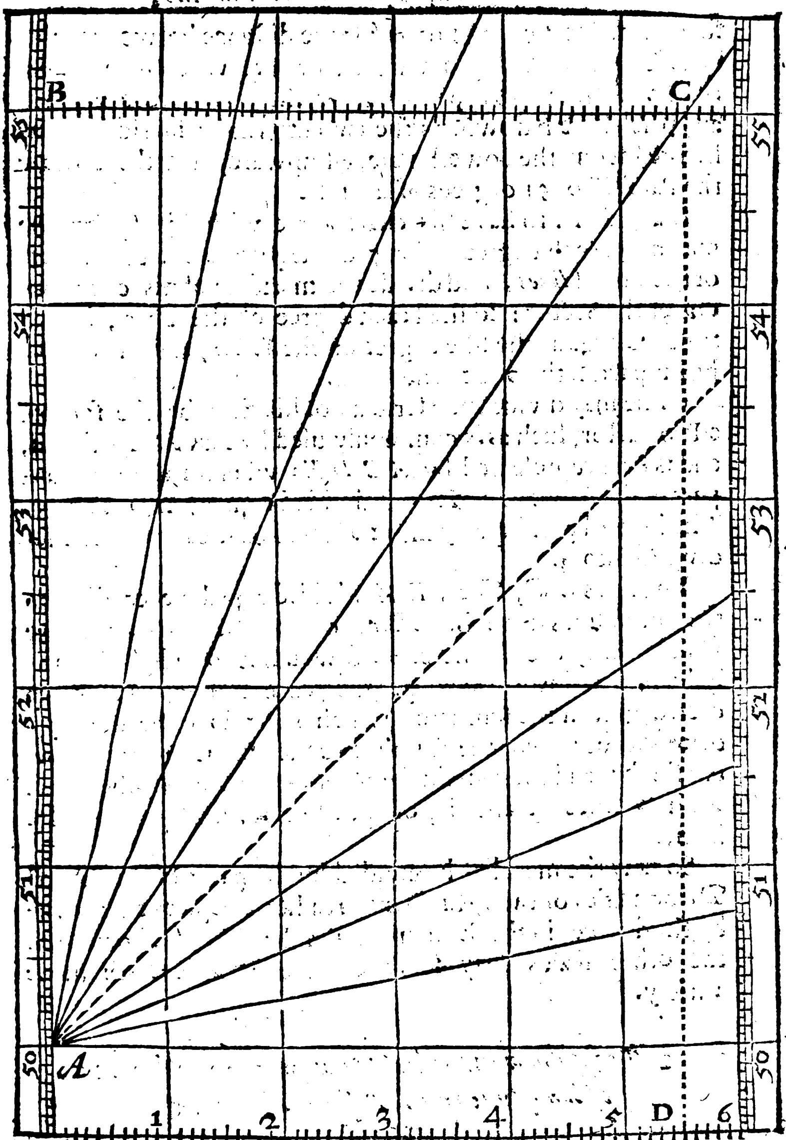
Then considering at what Latitude the Chart is to begin and end, and that this Chart entended for the latitude of these parts, is to begin at 50 *gr.* and so end at 55 *gr.* I looke into the Table, and find that 50 *gr.* of latitude must be drawne at 57 *gr.* 909 parts; and 55 *gr.* of latitude at 66 *gr.* 134 parts from the Æquator; and that the Meridian distance betweene the Parallell of 50 *gr.* and 55 *gr.* of Latitude must be equall to 8 *gr.* 225 parts of the Æquator. Whereupon I take the line *A B* out of the Meridian line and diminish it in such proportion as 8. 225 hath unto 1900 per 3 *Prop. Lin.* and with that extent of the Compasses I divide the two extreme Parallells of Latitude into equall degrees, and through each degree draw meridian lines parallell to the first meridian, noting them with 1, 2, 3. 4. &c. and then, I subdivide either one or all of those degrees into 10 parts, and (if I may) each tenth part into 10 parts more, but howsoever, I suppose each degree to be subdivided into 1000 parts.

The meridians being drawne, I come to the parallells of latitude, beginning at 50 *gr.*

And finding in the Table, that the distance between the Æquator and 50 *gr.* in the meridian should be equall to 57 *gr.* 909 parts in the Æquator and his parallells I may suppose the lowest Parallell to be 57 *gr.* from the Æquator: So the distance between this lowest Parallell and the Parallell of 50 *gr.* will be onely 909 parts. Wherefore I take these 909 odd parts, out of the degree that I divided before, and prick them downe in the two uttermost meridians from the lowest Parallell upwards, and there draw the Parallell of 50 *gr.* of latitude.

In like manner, because I find by the table that the distance betweene the Æquator and 51 *gr.* in the meridian is 59 *gr.* 481 parts of the Æquator, I abate the former 57 *gr.* and

there


B
C
55
54
53
52
51
50
A
1
2
3
4
5
D
6
55
54
53
52
51
50

there remaine 2 gr. 481 parts for the distance betweene the lowest Parallell, and this Parallell of 51: wherefore I take these 2 degrees 481 parts out of the line before divided and pricke them downe in the two uttermost Meridians (as before) from the lowest Parallell upward, and there draw the Parallell of 51 degrees of latitude.

If any desire to have his chart agree with his *Sector*, he may make each degree of longitude æquall to the tenth part of the line of *lines*, and divide the meridian of his chart out out of the Sector: so shall each degree of the chart, be ten times as large as the like degree on the *Sector*, and the worke be easie from the one to the other.

Or he may divide the Meridian of his chart by the side of a Protractor, such as is commonly used by surveiors of land, and is here represented by *ACDE*: wherein the outward part of the semicircle *ABC* is divided æqually into 180 *gr*. The inward part æqually into 16 Rumbs, and each Rumb subdivided into 4.

The lines *CD*, *DE*, *EA* divided æqually according to the line of lines upon the *Sector*, or the Parallells upon the Chart. Onely the Diameter *AC* would be divided unequally by letting downe occult perpendicular lines upon it, from each degree in the semicircle which being done the intermediate part betweene the Rumbs and the Diameter may be all cut forth: and the backside of the long square may be filled with 6 lines of chords, or scales of severall parts in the inch,

So may the meridian be divided by the parts of the side *ED*, the angles of each Rumb may readily be pricked downe by the degrees in the Semicircle, and the line of chords and the other scales may serve to doe the like with more variety.

## 2 *To find how many leagues answer to one degree of longitude in every severall latitude.*

In sailing by the compasse, the course holds sometime upon a great circle, sometime upon a parallel to the æquator; but most commonly upon crooked lines winding towards one of the poles, which lines are well knowne by the name of *Rumbs*.

If the course hold upon a great circle, it is either North or South, under some meridian, or East or West, under the æquator. And in these cases, every degree requires an allowance of twentie leagues, every twentie leagues will make a degree difference in the sailing: so that here needs no further precept then the rule of proportion in the Chapter of *lines*.

But if the course hold East or West, or any of the parallels to the æquator;

As the Radius
is to twenty leagues, the measure of one degree at the æquator:
So the sine of the complement of the latitude
to the measure of leagues answering to one degree in that latitude.

Wherefore I take 20 leagues out of the line of *lines*, and make it a parallell Radius, by fitting it over in the sines of 90 and 90: so his parallell sine taken out of the complement of the latitude, and measured in the line of *lines*, shall shew the number of leagues required,

Thus in the latitude of 18 *gr.* 12 *m.* we shall find 19 leagues answering to one degree of longitude, and 18 leagues in the latitude of 25 *gr.* 15 *m*, as in this Table.

This may be done more readily without opening the Sector, by doubling the sine of the complement of the latitude, as may appeare in the same example.

It may also be done by the line of meridianes, either upon the Sector, or upon the chart. For if we open a paire of compasses to the quantitie of one degree of longitude in the æquator, or one of his Parallells and measure it in the meridian line setting one foote as much above the latitude given, as the other falleth beneath it, so that the latitude may be in the middle betweene the feete of the compasses, the number of leagues intercepted shall be that which was required.

But if the course hold upon any of the *rumbs*, betweene a parallell of the æquator and the meridian we are to consider (besides the quarter of the world to which we tend, which must be alwayes knowne.)

1 The difference of longitude at least in generall,
2 The difference of latitude, and that in paticular,
3 The *rumb* whereon the course holds.
4 The distance upon the *rumb*, which is the distance, which we are here to consider, and is alwaves somewhat greater then the like distance upon a greater circle. And for these first I shew in generall this third *Prop.*

| Gr. | ' | Lg. |
|---|---|---|
| 0 | 0 | 20 |
| 18 | 12 | 19 |
| 25 | 15 | 18 |
| 31 | 48 | 17 |
| 36 | 52 | 16 |
| 41 | 25 | 15 |
| 45 | 34 | 14 |
| 49 | 28 | 13 |
| 53 | 8 | 12 |
| 56 | 38 | 11 |
| 60 | 0 | 10 |
| 63 | 15 | 9 |
| 66 | 25 | 8 |
| 69 | 30 | 7 |
| 72 | 32 | 6 |
| 75 | 31 | 5 |
| 78 | 28 | 4 |
| 81 | 23 | 3 |
| 84 | 15 | 2 |
| 87 | 8 | 1 |

### 3 *To find how many leagues do answer to one degree of latitude in every severall Rumb.*

The Seamans compasse is commonly divided into 32 points, the halfe into 16, the quarter into 8, which have their names of *N*, *N b E*, *N N E*, &c. according to those parts of the world to which they point. Answerable to these points are the *Rumbes* upon their chart; each quarter divided into 8; each *Rumb* 11 *gr.* 15′ distant one from the other: The first *Rumbe* being that which is 11 *gr.* 15′. distant from the Meridian; The second 22 *gr.* 30′ the third 33 *gr.* 45′ and so the rest. And (if they have need of smaller partrs) they subdivide each *Rumb* into quarters allowing 2 *gr.* 48′. to the first quarter

quarter 5 *gr.* 37′ to the halfe *Rumb* &c. as in the Table following.

As the sine of the complement of the *rumb* frō the meridian.

is to 20 leagues the measure of one degree at the meridian:

So the Radius

to the leagues answering to one degree upon the Rumb.

As if in sailing *n e b n*, from 50 *gr.* of North latitude, it were required how many leagues the ship should run, before it could come to 51 *gr.* of latitude, Because this is the third *Rumb* and the inclination thereof 33 *gr.* 45′ I would take 20 leagues &c.

Wherefore I take 20 leagues out of the line of *lines*, and make it a parallell sine of 56 *gr.* 15′ the complement of the Rumb from the meridian; so his parallel Radius taken and measured in the line of *lines*, shall shew me 24, for the number of leagues required.

And thus in the first Rumb from the meridian, we shall find 20 *lgs* 39 *parts* answering to one degree of latitude and 21 *lgs* 65 *parts* in the second Rumb, &c. as in this Table, where we subdivide each league into a hundred parts, and shew besides what inclination the rumb hath to the meridian.

This may be done more readily without opening the *Sector*, by doubling the secant of the Rumbe, as may appeare in the same example.

It may also be done upon the chart, if first we draw the Rumb, then we take the

| Rumbs. | Inclinatiō to the Meridiā | | Number of leags. | |
|---|---|---|---|---|
| | Gr. | M. | Lgs | Par |
| | 2 | 49 | 20 | 02 |
| | 5 | 37 | 20 | 10 |
| | 8 | 26 | 20 | 22 |
| 1 | 11 | 15 | 20 | 39 |
| | 14 | 4 | 20 | 62 |
| | 16 | 52 | 20 | 90 |
| | 19 | 41 | 21 | 24 |
| 2 | 22 | 30 | 21 | 65 |
| | 25 | 19 | 22 | 12 |
| | 28 | 7 | 22 | 68 |
| | 30 | 56 | 23 | 32 |
| 3 | 33 | 45 | 24 | 05 |
| | 36 | 34 | 24 | 90 |
| | 39 | 22 | 25 | 87 |
| | 42 | 11 | 26 | 99 |
| 4 | 45 | 0 | 28 | [illegible]8 |
| | 47 | 49 | 29 | 78 |
| | 50 | 37 | 31 | 52 |
| | 53 | 26 | 33 | 57 |
| 5 | 56 | 15 | 36 | 00 |
| | 52 | 4 | 38 | 90 |
| | 61 | 52 | 42 | 43 |
| | 64 | 41 | 36 | 78 |
| 6 | 67 | 30 | 52 | 26 |
| | 70 | 19 | 59 | 37 |
| | 73 | 7 | 68 | 90 |
| | 75 | 56 | 82 | 31 |
| 7 | 78 | 45 | 102 | 52 |
| | 81 | 34 | 136 | 30 |
| | 84 | 22 | 205 | 24 |
| | 87 | 11 | 407 | 60 |
| 8 | 90 | 0 | Infinita. | |

the distance upon the Rumb betweene two parallells, & measure it in the meridian line, as farre above the greater latitude as beneath the lesser. For so the number of leagues intercepted, shall be that which was required.

For example: in the second chart Pag 97 I first draw the 8 Rumbs, from the intersection of the meridian with the Parallell of 50 *gr.* of latitude, either by the which I have shewed before in the generall use of sines *Cap.* 11 *Prop.* 10 or by help of the protraction last mentioned. For, laying the center of the Protractor to the point of intersection, (which is to be the center of the Rumbs) and turning the diameter of the protractor, untill it be parallell to the Meridians of the chart (which is then done, when the Meridians and Parallells in the chart fall under like divisions in the Protractor) I may make one pricke at 11 *gr*, 15′ another, at 22 *gr.* 30′ in outward part of the semicircle, and so the rest.

Or, having neither *Sector* nor Protractor I would have a line of chords set on the side of the Ruler which I am to use from which I may take 60 *gr* and with that extent setting one foote of the Compasses in the former point of intersection, draw an occult arke of a circle, and therein pricke downe the former arkes from the Meridian as in *cap.* 11 *Prop.* 10. So, these arkes being pricked downe, by either of these wayes, the right lines drawne through the center and those prickes, shall be the Rumbs required.

The Rumbes being drawne. I take the distance betweene the Parallells of 50 and 51 *gr* upon *AC*, the third Rumb: and mersuring it in the Meridian line I find the compasses to reach from about $\frac{1}{10}$ of a degree below the parallell of 50; but $\frac{1}{10}$ above the parallell of 51 *gr.* intercepting 1 *gr.* $\frac{2}{10}$ or 24 leagues such as 20 make a degree.

Againe, I take the distance upon the same Rumbe betweene the Parallell of 54 and 55 *gr.* which I find to be somewhat longer then the former distance betweene the Parallells of 50 and 51; but measuring it in the Meridian line according to the latitude of the Parallells I find but 1 *gr.* $\frac{2}{10}$ (or 24 leagues) as before for ahe number of leagues answering to one degree of

Letietud

Latitude upon this third Rumb.

And by the same reason, I may finde the number of leagues answering to a degree of Latitude upon the rest of the Rumbs agreeable to the Table.

This considered in generall, I shew more particularly in twelue *Prop.* following, how of these foure any two being given the other two may be found, both by *Mercators* chart, and by this *Sector*.

## 1 *By one latitude Rumb and distance, to find the difference of latitudes.*

As the Radius
to the sine of the complement of the Rumb from the me-
So the distance upon the Rumb, (ridian;
to the difference of latitudes.

Let the place given be *A* in the latitude of 50 *gr.* *C* in a greater latitude, but unknowne, the distance upon the Rumb being 6 *gr.* betweene them, and the Rumb the third from the meridian.

First I take 6 *gr.* from the distance upon the Rumb, out of the line of *lines* and make it a parallell Radius, by putting it over in the sines of 90 and 90. Then keeping the *Sector* at this angle, I take out the parallell sine of 56 *gr.* 15 *m*, which is the sine of the complement of the third Rumb from the meridian, and measuring it in the line of *lines*, I find it to be 5 *gr.* and such is the difference of latitude required.

Or I may take out the sine of 56 *gr.* 15 *m.* for the complement of the third Rumb from the meridian, and make it a parallell Radius; then keeping the *Sector* at this angle, I take 6 *gr.* for the distance, either out of the line of *lines*, or any other scale of equall parts, or else out of the meridian line, and lay it on both sides of the *Sector* from the center; either on the line of *lines* or *sines*: so the parallell taken from the termes of this distance, and measured in the same scale wherein the distance was measured, shall shew the difference of latitude to be 5 *gr.* as before.

But in shorter distances, such as fall within the compasse of a daies sailing, this worke will hold much better. As may appeare by comparing the worke with the Table following: where the numbers in the front do signifie the leagues; those in the side, the Rumb; and the rest in the middle, the difference of latitude.

In the Chart let a meridian *AB* be drawne through *A*, and in *A* with *AB* make an angle of the Rumb *BAC*. Then open the compasses, according to the latitude of the places, to *EF* the quantitie of 6 *gr.* in the meridian, transferring them into the Rumb from *A* to *C*, and through *C* draw the parallell *BC*, crossing the meridian *AB* in *B*: so the degrees in the meridian from *A* to *B*, shall shew the difference of latitude to be 5 *gr.*

## 2 *By the Rumb and both latitudes to find the distance upon the Rumb.*

As the sine of the complement of the Rumb from the meridian,
is to the Radius:
So the difference of latitudes,
to the distance upon the Rumb.

As if the places given were *A* in the latitude of 50 *gr.* *C* in the latitude of 55 *gr.* and the Rumb the third from the meridian.

Here I may take 5 *gr.* for the difference of latitude out of the line of *lines*, and put it over in the sine of 56 *gr.* 15 *m.* for the complement of the third Rumb from the meridian. Then keeping the *Sector*, at this angle, I take out the parallell Radius, and measuring it in the line of *lines*, I find it to be 6 *gr.* and such is the distance upon the Rumb, which was required.

Or I may take the laterall Radius, and make it a parallell sine of 56 *gr.* 15 *m.* the complement of the Rumb from the meridian: then keeping the Sector at this angle, I take 5 *gr.* for the difference of latitude, either out of the line of *lines*, or

| Lg Rum | 100 G | M | 80 G | M | 60 G | M | 40 G | M | 20 M | 19 M | 18 M | 17 M | 16 M | 15 M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 0 | 4 | 0 | 3 | 0 | 2 | 0 | 60 | 57 | 54 | 51 | 48 | 45 |
| | 4 | 59 | 3 | 59 | 2 | 59 | 1 | 59 | 60 | 57 | 54 | 51 | 48 | 45 |
| | 4 | 58 | 3 | 58 | 2 | 59 | 1 | 59 | 60 | 57 | 54 | 51 | 48 | 45 |
| | 4 | 56 | 3 | 57 | 2 | 58 | 1 | 58 | 59 | 56 | 53 | 50 | 47 | 44 |
| 1 | 4 | 54 | 3 | 55 | 2 | 56 | 1 | 57 | 59 | 56 | 53 | 50 | 47 | 44 |
| | 4 | 51 | 3 | 53 | 2 | 55 | 1 | 56 | 58 | 56 | 52 | 50 | 47 | 43 |
| | 4 | 47 | 3 | 50 | 2 | 52 | 1 | 55 | 57 | 55 | 52 | 49 | 46 | 43 |
| | 4 | 42 | 3 | 46 | 2 | 49 | 1 | 53 | 56 | 54 | 51 | 48 | 45 | 42 |
| 2 | 4 | 37 | 3 | 42 | 2 | 46 | 1 | 51 | 55 | 53 | 50 | 47 | 44 | 41 |
| | 4 | 31 | 3 | 37 | 2 | 43 | 1 | 48 | 54 | 52 | 49 | 46 | 43 | 40 |
| | 4 | 25 | 3 | 32 | 2 | 39 | 1 | 46 | 53 | 50 | 48 | 45 | 42 | 39 |
| | 4 | 17 | 3 | 26 | 2 | 34 | 1 | 43 | 51 | 49 | 46 | 44 | 41 | 38 |
| 3 | 4 | 10 | 3 | 20 | 2 | 30 | 1 | 40 | 50 | 47 | 45 | 42 | 40 | 37 |
| | 4 | 1 | 3 | 13 | 2 | 25 | 1 | 36 | 48 | 46 | 43 | 41 | 39 | 36 |
| | 3 | 52 | 3 | 5 | 2 | 19 | 1 | 32 | 46 | 44 | 42 | 39 | 37 | 35 |
| | 3 | 42 | 2 | 58 | 2 | 13 | 1 | 28 | 44 | 42 | 40 | 38 | 36 | 33 |
| 4 | 3 | 32 | 2 | 50 | 2 | 7 | 1 | 25 | 42 | 40 | 38 | 36 | 34 | 32 |
| | 3 | 22 | 2 | 41 | 2 | 1 | 1 | 21 | 40 | 38 | 36 | 34 | 32 | 30 |
| | 3 | 10 | 2 | 32 | 1 | 54 | 1 | 16 | 38 | 36 | 34 | 32 | 30 | 28 |
| | 2 | 59 | 2 | 23 | 1 | 47 | 1 | 12 | 36 | 34 | 32 | 30 | 29 | 27 |
| 5 | 2 | 47 | 2 | 14 | 1 | 40 | 1 | 7 | 33 | 32 | 30 | 28 | 27 | 25 |
| | 2 | 34 | 2 | 3 | 1 | 32 | 1 | 2 | 31 | 29 | 28 | 26 | 25 | 23 |
| | 2 | 22 | 1 | 53 | 1 | 25 | 0 | 57 | 28 | 27 | 25 | 24 | 23 | 22 |
| | 2 | 8 | 1 | 43 | 1 | 17 | 0 | 52 | 26 | 24 | 23 | 22 | 21 | 19 |
| 6 | 1 | 55 | 1 | 32 | 1 | 8 | 0 | 46 | 23 | 22 | 21 | 20 | 18 | 17 |
| | 1 | 41 | 1 | 20 | 1 | 0 | 0 | 40 | 20 | 19 | 18 | 17 | 16 | 15 |
| | 1 | 27 | 1 | 9 | 0 | 52 | 0 | 35 | 17 | 16 | 16 | 15 | 14 | 13 |
| | 1 | 13 | 0 | 58 | 0 | 44 | 0 | 30 | 15 | 14 | 13 | 12 | 12 | 11 |
| 7 | 0 | 59 | 0 | 47 | 0 | 35 | 0 | 24 | 12 | 11 | 11 | 10 | 9 | 9 |
| | 0 | 44 | 0 | 36 | 0 | 26 | 0 | 18 | 9 | 8 | 8 | 7 | 7 | 7 |
| | 0 | 30 | 0 | 24 | 0 | 18 | 0 | 12 | 6 | 6 | 5 | 5 | 5 | 4 |
| | 0 | 15 | 0 | 12 | 0 | 9 | 0 | 9 | 3 | 3 | 3 | 3 | 2 | 2 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Lg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | M | M | M | M | M | M | M | M | M | M | M | M | M | Rum. |
| 40 | 39 | 36 | 33 | 30 | 27 | 24 | 21 | 18 | 15 | 12 | 9 | 6 | 3 | |
| 42 | 39 | 36 | 33 | 30 | 27 | 24 | 21 | 18 | 15 | 12 | 9 | 6 | 3 | |
| 42 | 39 | 36 | 33 | 30 | 27 | 24 | 21 | 18 | 15 | 12 | 9 | 6 | 3 | |
| 42 | 39 | 36 | 33 | 30 | 27 | 24 | 21 | 18 | 15 | 12 | 9 | 6 | 3 | |
| 41 | 38 | 35 | 32 | 29 | 26 | 24 | 21 | 18 | 15 | 12 | 9 | 6 | 3 | 1 |
| 41 | 38 | 35 | 32 | 29 | 26 | 23 | 20 | 17 | 15 | 12 | 9 | 6 | 3 | |
| 40 | 37 | 34 | 32 | 29 | 26 | 23 | 20 | 17 | 14 | 11 | 9 | 6 | 3 | |
| 40 | 37 | 34 | 31 | 28 | 25 | 23 | 20 | 17 | 14 | 11 | 8 | 6 | 3 | |
| 39 | 36 | 33 | 31 | 28 | 25 | 22 | 19 | 17 | 14 | 11 | 8 | 6 | 3 | 2 |
| 38 | 35 | 33 | 30 | 27 | 24 | 22 | 19 | 16 | 14 | 11 | 8 | 5 | 3 | |
| 37 | 34 | 32 | 29 | 25 | 24 | 21 | 19 | 16 | 13 | 11 | 8 | 5 | 3 | |
| 36 | 33 | 31 | 28 | 26 | 23 | 21 | 18 | 15 | 13 | 10 | 8 | 5 | 3 | |
| 35 | 32 | 30 | 27 | 25 | 22 | 20 | 17 | 15 | 12 | 10 | 7 | 5 | 2 | 3 |
| 34 | 30 | 29 | 26 | 24 | 22 | 19 | 17 | 14 | 12 | 10 | 7 | 5 | 2 | |
| 33 | 30 | 28 | 25 | 23 | 21 | 19 | 16 | 14 | 12 | 9 | 7 | 5 | 2 | |
| 31 | 29 | 27 | 24 | 22 | 20 | 18 | 16 | 13 | 11 | 9 | 7 | 4 | 2 | |
| 30 | 28 | 25 | 23 | 21 | 19 | 17 | 15 | 13 | 11 | 8 | 6 | 4 | 2 | 4 |
| 28 | 26 | 24 | 22 | 20 | 18 | 16 | 14 | 12 | 10 | 8 | 6 | 4 | 2 | |
| 27 | 25 | 23 | 21 | 19 | 17 | 15 | 13 | 11 | 10 | 8 | 6 | 4 | 2 | |
| 25 | 23 | 21 | 20 | 18 | 16 | 14 | 13 | 11 | 9 | 7 | 5 | 4 | 2 | |
| 23 | 22 | 20 | 18 | 17 | 15 | 13 | 12 | 10 | 8 | 7 | 5 | 3 | 2 | 5 |
| 22 | 20 | 18 | 17 | 15 | 14 | 12 | 11 | 9 | 8 | 6 | 5 | 3 | 2 | |
| 20 | 18 | 17 | 16 | 14 | 13 | 11 | 10 | 8 | 7 | 6 | 4 | 3 | 1 | |
| 18 | 17 | 15 | 14 | 13 | 12 | 10 | 9 | 8 | 6 | 5 | 4 | 3 | 1 | |
| 16 | 15 | 14 | 13 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 3 | 2 | 1 | 6 |
| 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | |
| 12 | 11 | 10 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 3 | 2 | 1 | |
| 10 | 9 | 9 | 8 | 7 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 1 | 1 | |
| 8 | 8 | 7 | 6 | 6 | 6 | 5 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 7 |
| 6 | 6 | 5 | 5 | 4 | 5 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | |
| 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | |
| 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |

or out of some other scale of equall parts, and lay it on both sides of the *Sector* from the center, either on the line of *lines* or of *sines*: so the parallell taken from the termes of this difference, and measured in the same scale with the difference, shall shew the distance upon the Rumb to be 6 *gr.* or 120 leagues.

Or keeping the *Sector* at this angle, I may take the difference betweene 50 *gr.* and 55 *gr.* out of the *Meridian* line, and measuring it in the æquator, I shall find it to be equall to 8 *gr.* 22 *p.* of the æquator. Wherefore I take the parallell between 822 and 822 out of the line of *lines*, and measuring it in the line of *lines* I shall find it to be 989; which shewes that according to this projection, the distance upon this third Rumb, answerable to the former difference of latitudes, will be equal to 9 *gr.* 89 *p.* of the equator.

Or the Sector remaining at this angle, I may take the difference betweene 50 *gr.* and 55 *gr.* out of the *Meridian* line, and lay it from the center on both sides of the *Sector*, either on the line of *lines* or of *sines*: so the parallell taken from the termes of this difference, shall be the very line of distance required, the same with *A C* or *E F* upon the chart; which may serve for the better pricking downe of the distance upon the Rumb, without taking it forth of the *Meridian* line as in the former *Prop.*

Or if the Rumb fall nearer to the æquator, that the laterall Radius cannot be fitted over in it, this proposition may be wrought by parallell entrance.

For if I first take out the sine of 56 *gr.* 15 *m.* and make it a parallell Radius, by fitting it over in the sines of 90 and 90, or in the ends of the line of *lines*, and then take 5 *gr.* for the difference of latitudes out of the line of *lines* and carrie it parallell to the former, I shall find it to crosse both lines of *lines* in the points of 6: and so it gives the same distance as before.

Or if the distance be small, it may be found by the former Table. For the Rumb being found in the side of the Table, and the difference of latitude in the same line; the top of the columne wherein the difference of latitude was found, shall giue the number of leagues in the distance required.

Or we may find this distance in the Table of Rumbs in the fift *Prop* following. For according to the example looke into the Table of the third Rumb for 5 *gr.* of latitude, and there we shall finde 6 *gr.* 10 parts under the title of distance.

So if the difference of latitude vpon the same Rumb were 50 *gr.* the distance would be 60 *gr.* 13 parts. If the difference of latitude vpon the same Rumb were onely ½ of a degree the distance would be onely 60 parts, such as 100 doe make a degree.

In the chart let a Meridian *A B* be drawne through *A*, and paralels of latitude through *A* and *C*; and then in *A* with *A B* make an angle of the Rumb *B A C*: so the distance taken from *A* to *C*, and measured in the Meridian line, according to the latitude of the places, shall be found to be 6 *gr.* or 120 leagues. And such is the distance required.

### 3 *By the distance and both latitudes to find the Rumb.*

As the distance vpon the Rumb,
to the difference of latitudes:
So is the Radius
to the sine of the complement of the Rumb from the Meridian.

As if the places given were A in the latitude of 50 *gr.* C in the latitude of 55 *gr.* the distance betweene them being 6 *gr.* vpon the Rumb. First I take 6 *gr.* for the distance vpon the Rumb, & lay it on both sides of the *Sector* from the center; then out of the same scale I take 5 *gr.* for the difference of latitude, and to it open the *Sector* in the termes of the former distance: so the parallell Radius taken and measured in the sines, doth give 56 *gr.* 15 *m.* the complement whereof 33 *gr.* 45 *m.* is the angle of the Rumbs inclination to the Meridian, which was required.

In

In the chart let a Meridian A B be drawne through A, and parallels of latitude both through A and C; then open the compasses according to the latitude of the places to *E F* the quantitie of *6 gr* in the meridian, and setting one foote in A turne the other till it crosse the parallell *B C* in *C*, and draw the right line *A C*: so the angle *B A C* shall shew the inclination of the Rumb to the meridian to be 33 *gr*. 45 *m*. as before.

These three last *Prop.* depend one on the other, and may be wrought as truely by the common sea-chart as by this of *Mercators* proiection: and therefore in working them by the *Sector*, the distance and the difference of latitudes may as well or better be taken out of the line of *lines* (which here representeth the Æquator) or any other line of equall parts, as out of the inlarged degrees in the *meridian* line. But in the propositions following, the difference of longitude must be taken out of the Æquator; the difference of latitudes and distance vpon the Rumb, must alwaves be taken out of the *meridian* line; which I therefore call the proper difference, and proper distance.

## 4 *By the longitude and latitude of two places to find the Rumb.*

As if the places given were A in the latitude of 53 *gr* C in the latitude of 55 gr. and the difference of longitude betweene them were 5 gr. 30 *m*.

In the chart let meridians and parallels be drawne through A and C, and a straight line for the Rumb from A to C; then by that we shewed C. 2. *Prop.* 9 inquire the quantitie of the angle B A C. and it shall be found to be 33 gr. 45 *m*. which is the third Rumb from the Meridian. Wherefore the proportion holds for the *Sector*,

As *A B* the proper difference of latitude,
is to *B C* the difference of longitude:
So *A B* as Radius,
to B *C* the tangent of the Rumb from the Meridian.

According to this I take the proper difference of latitude from

from 50 *gr.* to 55 *gr.* out of the line of *meridians*, and lay it on both sides of the *Sector* from the center; then I take the difference of longitude 5 *gr.* ½ out of the line of *lines*, and to it open the *Sector* in the termes of the former difference of latitudes: so the parallell *Radius* taken from betweene 90 and 90, and measured in the greater *tangent* on the side of the *Sector*, doth give 33 *gr.* 45 *m.* for the Rumb required.

But if the Rumb fall nearer to the Æquator;

As *A D* the difference of longitudes,
is to *D C* the proper difference of latitudes:
So *A D* as Radius,
to *D C* the tangent of the rumb from the æquator.

According to this I take the former difference of latitudes from 50 *gr.* to 55 *gr.* out of the line of *Meridians*, and to it open the *Sector* in the termes of the difference of longitude reckoned in the line of *lines* from the center: so the parallell Radius taken and measured in the *tangent*, doth give 56 *gr.* 15 *m.* for the Rumb from the Æquator; which is the complement to the former 33 *gr.* 45. *m.* and so both wayes it is found to be the third rumb from the Meridian.

But if this Rumb were to be found in the common sea-chart, it should seeme to be aboue 47 *gr.* which is more then the fourth Rumb from the Meridian.

### 5. *By the Rumb and both latitudes, to find the difference of longitude.*

As if the places given were *A* in the latitude of 50 *gr.* and C in the latitude of 55 *gr.* and the Rumb the third from the meridian.

In the chart, let a meridian be drawne through A, and a parallell of latitude through C, then in *A* with *A B* make the angle of the rumb from the meridian *B A C*, (as was shewed *Cap.* 2. *Prop.* 10.) So the degrees in the parallell betweene *B* and *C*, shall be found to 5 *gr.* ½, the difference of longitude

longitude which was required. Wherefore the proportion holds for the *Sector*.

As *A B* the Radius,
to *B C* the tangent of the Rumb from the meridian:
So *A B* as proper difference of the latitudes,
to B C the difference of longitude.

According to this we may take the tangent of the Rumb which is here 33 *gr*.45 *m*. from the meridian, out of the greater *tangent* on the side of the *Sector*, and putting it over betweene 90 and 90, make it a Radius: then keeping the *Sector* at this angle, take the proper difference of latitudes from 50 gr. to 55 gr. out of the line of *Meridians*, and lay it on both sides of the Sector from the center: so the parallel taken from the termes of this difference, and measured in the line of *lines* shall shew the difference of longitude to be 5 gr. ½.

Or if the Rumb fall nearer the equator.

As *D C* the tangent of the Rumb from the equator,
to *A D* the Radius:
So *D C* as proper difference of the latitudes,
to *A D* the difference of longitude.

According to this we may best work by parallel entrance, first taking 56 gr. 15 *m*. for the angle of the Rumb from the equator, out of the greater tangent, and make it a parallell Radius: then take the proper difference of latitudes out of the line of meridians, and carrie it parallell to the former: so we shall find it to crosse the line of lines in 5 gr.½. And this is the difference of longitude required, the same as before.

But if this difference were to be found by the common sea-chart, it should seeme to be onely 3 gr. 20 *m*. which is more then 2 degrees lesse then the truth. And yet this error would be greater, if either the latitude be greater, or the Rumb fall nearer the Æquator: as may appeare by comparing the common sea-chart with the Tables following.

| The first Rumbe from the Meridian. | North and by East, South and by East, | | | | | | North and by West, South and by West, | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| La | Long. | | Dist. | | La | Long. | | Dist. | | La | Long. | | Dist. | |
| Gr | Gr. | P. | Gr. | P. | Gr | Gr. | P. | Gr. | P. | Gr | Gr. | P. | Gr. | P. |
| 0 | | 0 | | 0 | 30 | 6 | 26 | 30 | 59 | 60 | 15 | 01 | 61 | 18 |
| 1 | | 20 | 1 | 02 | 31 | 6 | 49 | 31 | 61 | 61 | 15 | 4 | 62 | 20 |
| 2 | | 40 | 2 | 04 | 32 | 6 | 72 | 32 | 63 | 62 | 15 | 83 | 63 | 21 |
| 3 | | 60 | 3 | 06 | 33 | 6 | 96 | 33 | 65 | 63 | 16 | 26 | 64 | 23 |
| 4 | | 80 | 4 | 08 | 34 | 7 | 20 | 34 | 67 | 64 | 16 | 71 | 65 | 25 |
| 5 | 1 | 00 | 5 | 10 | 35 | 7 | 44 | 35 | 69 | 65 | 17 | 17 | 66 | 27 |
| 6 | 1 | 20 | 6 | 12 | 36 | 7 | 68 | 36 | 71 | 66 | 17 | 65 | 67 | 29 |
| 7 | 1 | 40 | 7 | 14 | 37 | 7 | 92 | 37 | 73 | 67 | 18 | 15 | 68 | 31 |
| 8 | 1 | 60 | 8 | 16 | 38 | 8 | 17 | 38 | 75 | 68 | 18 | 67 | 69 | 33 |
| 9 | 1 | 80 | 9 | 18 | 39 | 8 | 43 | 39 | 77 | 69 | 19 | 21 | 70 | 25 |
| 10 | 2 | 00 | 10 | 20 | 40 | 8 | 70 | 40 | 78 | 70 | 19 | 78 | 71 | 37 |
| 11 | 2 | 20 | 11 | 22 | 41 | 8 | 96 | 41 | 80 | 71 | 20 | 37 | 72 | 39 |
| 12 | 2 | 40 | 12 | 24 | 42 | 9 | 22 | 42 | 82 | 72 | 21 | 00 | 73 | 41 |
| 13 | 2 | 61 | 13 | 25 | 43 | 9 | 50 | 43 | 84 | 73 | 21 | 66 | 74 | 43 |
| 14 | 2 | 81 | 14 | 27 | 44 | 9 | 76 | 44 | 86 | 74 | 22 | 36 | 75 | 45 |
| 15 | 3 | 02 | 15 | 29 | 45 | 10 | 04 | 45 | 88 | 75 | 23 | 10 | 76 | 47 |
| 16 | 3 | 22 | 16 | 31 | 46 | 10 | 33 | 46 | 90 | 76 | 23 | 90 | 77 | 49 |
| 17 | 3 | 43 | 17 | 33 | 47 | 10 | 62 | 47 | 92 | 77 | 24 | 75 | 78 | 51 |
| 18 | 3 | 64 | 18 | 35 | 48 | 10 | 91 | 48 | 94 | 78 | 25 | 67 | 79 | 53 |
| 19 | 3 | 85 | 19 | 37 | 49 | 11 | 21 | 49 | 96 | 79 | 26 | 67 | 80 | 55 |
| 20 | 4 | 06 | 20 | 39 | 50 | 11 | 52 | 50 | 98 | 80 | 27 | 76 | 81 | 57 |
| 21 | 4 | 27 | 21 | 41 | 51 | 11 | 83 | 52 | 0 | 81 | 28 | 97 | 82 | 59 |
| 22 | 4 | 49 | 22 | 43 | 52 | 12 | 15 | 53 | 2 | 82 | 30 | 32 | 83 | 61 |
| 23 | 4 | 70 | 23 | 45 | 53 | 12 | 47 | 54 | 4 | 83 | 31 | 84 | 84 | 63 |
| 24 | 4 | 92 | 24 | 47 | 54 | 12 | 81 | 55 | 6 | 84 | 33 | 61 | 85 | 65 |
| 25 | 5 | 14 | 25 | 49 | 55 | 13 | 16 | 56 | 8 | 85 | 35 | 69 | 86 | 67 |
| 26 | 5 | 36 | 26 | 51 | 56 | 13 | 50 | 57 | 10 | 86 | 38 | 24 | 87 | 69 |
| 27 | 5 | 58 | 27 | 53 | 57 | 13 | 86 | 58 | 12 | 87 | 41 | 52 | 88 | 71 |
| 28 | 5 | 80 | 28 | 55 | 58 | 14 | 23 | 59 | 14 | 88 | 46 | 15 | 89 | 73 |
| 29 | 6 | 03 | 29 | 57 | 59 | 14 | 62 | 60 | 16 | 89 | 51 | 06 | 90 | 75 |
| 30 | 6 | 26 | 30 | 50 | 60 | 15 | 01 | 61 | 18 | 90 | | | | |

| The second Rumb from the Meridian. | | | | North North-east, South South-east, | | | | North North-West South South-west | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| La | Long. | | Dist. | | La | Long. | | Dist. | | La | Long. | | Dist. | |
| Gr | Gr. | P. | Gr. | P. | Gr | Gr. | P. | Gr. | P. | Gr | Gr. | P. | Gr. | P. |
| 0 | | 0 | | 0 | 30 | 13 | 03 | 32 | 47 | 60 | 31 | 25 | 64 | 94 |
| 1 | 0 | 42 | 1 | 08 | 31 | 13 | 51 | 33 | 50 | 61 | 32 | 09 | 66 | 03 |
| 2 | 0 | 83 | 2 | 16 | 32 | 14 | 00 | 34 | 64 | 62 | 32 | 96 | 67 | 11 |
| 3 | 1 | 24 | 3 | 25 | 33 | 14 | 49 | 35 | 72 | 63 | 33 | 86 | 68 | 19 |
| 4 | 1 | 65 | 4 | 33 | 34 | 15 | 00 | 36 | 80 | 64 | 34 | 79 | 79 | 27 |
| 5 | 2 | 07 | 5 | 41 | 35 | 15 | 50 | 37 | 88 | 65 | 35 | 75 | 70 | 35 |
| 6 | 2 | 49 | 6 | 49 | 36 | 16 | 09 | 38 | 97 | 66 | 36 | 75 | 71 | 44 |
| 7 | 2 | 91 | 7 | 57 | 37 | 16 | 5. | 40 | 05 | 67 | 37 | 80 | 72 | 52 |
| 8 | 3 | 32 | 8 | 66 | 38 | 17 | 03 | 41 | 13 | 68 | 38 | 88 | 73 | 60 |
| 9 | 3 | 74 | 9 | 74 | 39 | 17 | 56 | 42 | 21 | 09 | 40 | 00 | 74 | 68 |
| 10 | 4 | 16 | 10 | 82 | 40 | 18 | 10 | 43 | 39 | 70 | 41 | 19 | 75 | 77 |
| 11 | 4 | 59 | 11 | 90 | 41 | 18 | 65 | 44 | 38 | 71 | 42 | 43 | 76 | 85 |
| 12 | 5 | 01 | 12 | 99 | 42 | 19 | 20 | 45 | 46 | 72 | 43 | 74 | 77 | 93 |
| 13 | 5 | 43 | 14 | 07 | 43 | 19 | 76 | 46 | 54 | 73 | 45 | 11 | 79 | 01 |
| 14 | 5 | 85 | 15 | 15 | 44 | 20 | 33 | 47 | 62 | 74 | 46 | 57 | 80 | 10 |
| 15 | 6 | 28 | 16 | 23 | 45 | 20 | 91 | 48 | 71 | 75 | 48 | 12 | 81 | 18 |
| 16 | 9 | 71 | 17 | 32 | 46 | 21 | 50 | 49 | 79 | 76 | 49 | 78 | 82 | 26 |
| 17 | 7 | 14 | 18 | 40 | 47 | 22 | 11 | 50 | 85 | 77 | 51 | 55 | 83 | 34 |
| 18 | 7 | 58 | 19 | 48 | 48 | 22 | 72 | 52 | 95 | 78 | 53 | 46 | 84 | 42 |
| 19 | 8 | 01 | 20 | 50 | 49 | 23 | 35 | 53 | 03 | 79 | 55 | 54 | 85 | 51 |
| 20 | 8 | 45 | 21 | 65 | 50 | 23 | 98 | 54 | 12 | 80 | 57 | 82 | 86 | 59 |
| 21 | 8 | 90 | 22 | 73 | 51 | 24 | 63 | 55 | 20 | 81 | 60 | 33 | 87 | 67 |
| 22 | 9 | 34 | 23 | 81 | 52 | 25 | 30 | 56 | 28 | 82 | 63 | 13 | 88 | 76 |
| 23 | 9 | 79 | 24 | 89 | 53 | 25 | 98 | 57 | 37 | 83 | 66 | 32 | 89 | 84 |
| 24 | 10 | 24 | 25 | 98 | 54 | 26 | 69 | 58 | 45 | 84 | 69 | 99 | 90 | 92 |
| 25 | 10 | 70 | 27 | 06 | 55 | 27 | 39 | 59 | 53 | 85 | 74 | 32 | 92 | 00 |
| 26 | 11 | 16 | 28 | 14 | 56 | 28 | 12 | 60 | 61 | 86 | 79 | 63 | 93 | 09 |
| 27 | 11 | 62 | 29 | 22 | 57 | 28 | 87 | 61 | 7 | 87 | 86 | 46 | 94 | 17 |
| 28 | 12 | 08 | 30 | 31 | 58 | 29 | 64 | 62 | 78 | 88 | 96 | 10 | 95 | 25 |
| 29 | 12 | 55 | 31 | 39 | 59 | 30 | 44 | 63 | 86 | 89 | 112 | 57 | 96 | 33 |
| 30 | 13 | 03 | 32 | 47 | 60 | 31 | 25 | 64 | 94 | 90 | | | | |

| The third Rumbe from the Meridian | | | | North-east by North, South-east by South, | | | | | North-west by North, South-west by South. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| La. | Long. | | Dist. | | La. | Long. | | Dist. | | La. | Long. | | Dist. | |
| Gr | Gr. | P. | Gr. | P. | Gr | Gr. | P. | Gr | P. | Gr | Gr. | P. | Gr. | P. |
| 0 | | 0 | | 0 | 30 | 21 | 03 | 36 | 08 | 60 | 50 | 42 | 72 | 16 |
| 1 | 0 | 66 | 1 | 20 | 31 | 21 | 80 | 37 | 28 | 61 | 51 | 78 | 73 | 36 |
| 2 | 1 | 33 | 2 | 40 | 32 | 22 | 58 | 38 | 49 | 62 | 53 | 18 | 74 | 56 |
| 3 | 2 | 00 | 3 | 61 | 33 | 23 | 38 | 39 | 69 | 63 | 54 | 63 | 75 | 77 |
| 4 | 2 | 67 | 4 | 81 | 34 | 24 | 18 | 40 | 89 | 64 | 56 | 12 | 76 | 97 |
| 5 | 3 | 34 | 6 | 01 | 35 | 25 | 00 | 42 | 09 | 65 | 57 | 68 | 78 | 17 |
| 6 | 4 | 01 | 7 | 22 | 36 | 25 | 82 | 43 | 30 | 66 | 59 | 29 | 79 | 37 |
| 7 | 4 | 68 | 8 | 42 | 37 | 26 | 64 | 44 | 50 | 67 | 60 | 69 | 80 | 58 |
| 8 | 5 | 36 | 9 | 62 | 38 | 27 | 48 | 45 | 70 | 68 | 62 | 71 | 81 | 78 |
| 9 | 6 | 03 | 10 | 82 | 39 | 28 | 34 | 46 | 90 | 69 | 64 | 53 | 82 | 98 |
| 10 | 6 | 71 | 12 | 03 | 40 | 29 | 21 | 48 | 11 | 70 | 66 | 44 | 84 | 19 |
| 11 | 7 | 39 | 13 | 23 | 41 | 30 | 09 | 49 | 31 | 71 | 68 | 45 | 85 | 39 |
| 12 | 8 | 07 | 14 | 43 | 42 | 30 | 98 | 50 | 51 | 72 | 70 | 75 | 86 | 59 |
| 13 | 8 | 76 | 15 | 64 | 43 | 31 | 88 | 51 | 71 | 73 | 72 | 77 | 87 | 79 |
| 14 | 9 | 44 | 16 | 84 | 44 | 32 | 80 | 52 | 91 | 74 | 75 | 12 | 89 | 00 |
| 15 | 10 | 13 | 18 | 04 | 45 | 33 | 74 | 54 | 12 | 75 | 77 | 62 | 90 | 20 |
| 16 | 10 | 83 | 19 | 24 | 46 | 34 | 69 | 55 | 32 | 76 | 80 | 30 | 91 | 40 |
| 17 | 11 | 53 | 20 | 45 | 47 | 35 | 67 | 56 | 52 | 77 | 83 | 15 | 92 | 61 |
| 18 | 12 | 23 | 21 | 65 | 48 | 36 | 66 | 57 | 73 | 78 | 86 | 25 | 93 | 81 |
| 19 | 12 | 93 | 22 | 85 | 49 | 37 | 67 | 58 | 93 | 79 | 89 | 60 | 95 | 01 |
| 20 | 13 | 64 | 24 | 05 | 50 | 38 | 69 | 60 | 13 | 80 | 93 | 27 | 96 | 22 |
| 21 | 14 | 35 | 25 | 26 | 51 | 39 | 74 | 61 | 33 | 81 | 97 | 32 | 97 | 42 |
| 22 | 15 | 07 | 26 | 46 | 52 | 40 | 82 | 62 | 54 | 82 | 101 | 85 | 98 | 62 |
| 23 | 15 | 80 | 27 | 66 | 53 | 41 | 91 | 63 | 74 | 83 | 106 | 97 | 96 | 82 |
| 24 | 16 | 53 | 28 | 86 | 54 | 43 | 03 | 64 | 94 | 84 | 112 | 90 | 101 | 03 |
| 25 | 17 | 26 | 30 | 07 | 55 | 44 | 19 | 66 | 15 | 85 | 119 | 90 | 102 | 23 |
| 26 | 18 | 00 | 31 | 27 | 56 | 45 | 37 | 67 | 35 | 86 | 128 | 45 | 103 | 43 |
| 27 | 18 | 75 | 32 | 47 | 57 | 46 | 58 | 68 | 55 | 87 | 139 | 47 | 104 | 64 |
| 28 | 19 | 50 | 33 | 67 | 58 | 47 | 82 | 69 | 75 | 88 | 155 | 00 | 105 | 84 |
| 29 | 20 | 26 | 34 | 88 | 59 | 49 | 11 | 70 | 96 | 89 | 181 | 58 | 107 | 04 |
| 30 | 21 | 03 | 36 | 08 | 60 | 50 | 42 | 72 | 16 | 90 | | | | |

| The fourth Rumbe from the Meridian. | | | | | North-east, South-east, | | | | | North west, South-west. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| La. | Long. | | Dist. | | La. | Long. | | Dist. | | La. | Long. | | Dist. | |
| Gr | Gr. | P. | Gr. | P. | Gr | Gr. | P. | Gr. | P. | Gr | Gr. | P. | Gr. | P. |
| 0 | | 0 | | 0 | 30 | 31 | 47 | 42 | 43 | 60 | 75 | 45 | 84 | 85 |
| 1 | 1 | 00 | 1 | 41 | 31 | 32 | 63 | 43 | 84 | 61 | 77 | 49 | 85 | 27 |
| 2 | 2 | 00 | 2 | 83 | 22 | 33 | 81 | 45 | 25 | 62 | 79 | 58 | 87 | 68 |
| 3 | 3 | 00 | 4 | 24 | 33 | 34 | 99 | 46 | 67 | 63 | 81 | 75 | 89 | 09 |
| 4 | 4 | 00 | 5 | 66 | 34 | 36 | 19 | 48 | 07 | 64 | 83 | 99 | 90 | 51 |
| 5 | 5 | 01 | 7 | 07 | 35 | 37 | 41 | 49 | 50 | 65 | 86 | 31 | 91 | 92 |
| 6 | 6 | 01 | 8 | 49 | 36 | 38 | 63 | 50 | 91 | 66 | 88 | 73 | 93 | 34 |
| 7 | 7 | 02 | 9 | 90 | 37 | 39 | 88 | 52 | 33 | 67 | 91 | 23 | 94 | 75 |
| 8 | 8 | 03 | 11 | 31 | 38 | 41 | 14 | 53 | 74 | 68 | 93 | 85 | 96 | 17 |
| 9 | 9 | 04 | 12 | 73 | 39 | 42 | 42 | 55 | 15 | 69 | 95 | 58 | 97 | 58 |
| 10 | 10 | 05 | 14 | 14 | 40 | 43 | 71 | 56 | 57 | 70 | 99 | 43 | 98 | 99 |
| 11 | 11 | 07 | 15 | 55 | 41 | 45 | 03 | 57 | 98 | 71 | 102 | 43 | 100 | 41 |
| 12 | 12 | 09 | 16 | 97 | 42 | 46 | 36 | 59 | 40 | 72 | 105 | 58 | 101 | 82 |
| 13 | 13 | 11 | 18 | 38 | 43 | 47 | 72 | 60 | 81 | 73 | 108 | 91 | 103 | 24 |
| 14 | 14 | 14 | 19 | 80 | 44 | 49 | 10 | 62 | 22 | 74 | 112 | 43 | 104 | 65 |
| 15 | 15 | 17 | 21 | 21 | 45 | 50 | 50 | 63 | 64 | 75 | 116 | 17 | 106 | 06 |
| 16 | 16 | 21 | 22 | 63 | 46 | 51 | 93 | 65 | 05 | 76 | 120 | 17 | 107 | 48 |
| 17 | 17 | 25 | 24 | 04 | 47 | 53 | 38 | 66 | 46 | 77 | 124 | 45 | 108 | 89 |
| 18 | 18 | 30 | 25 | 45 | 48 | 54 | 86 | 67 | 88 | 78 | 129 | 08 | 110 | 31 |
| 19 | 19 | 36 | 26 | 87 | 49 | 56 | 37 | 69 | 29 | 79 | 134 | 10 | 111 | 72 |
| 20 | 20 | 42 | 28 | 28 | 50 | 57 | 91 | 70 | 71 | 80 | 139 | 59 | 113 | 14 |
| 21 | 21 | 49 | 29 | 70 | 51 | 59 | 48 | 72 | 12 | 81 | 145 | 65 | 114 | 55 |
| 22 | 22 | 56 | 31 | 11 | 52 | 61 | 09 | 73 | 54 | 82 | 152 | 42 | 115 | 96 |
| 23 | 23 | 64 | 32 | 53 | 53 | 62 | 73 | 74 | 95 | 83 | 160 | 10 | 117 | 38 |
| 24 | 24 | 73 | 33 | 94 | 54 | 64 | 41 | 76 | 37 | 84 | 168 | 95 | 118 | 79 |
| 25 | 25 | 28 | 35 | 35 | 55 | 66 | 13 | 77 | 78 | 85 | 179 | 41 | 120 | 21 |
| 26 | 26 | 94 | 36 | 77 | 56 | 67 | 90 | 79 | 20 | 86 | 192 | 21 | 121 | 62 |
| 27 | 28 | 06 | 38 | 18 | 57 | 69 | 74 | 80 | 61 | 87 | 208 | 71 | 123 | 04 |
| 28 | 29 | 18 | 39 | 60 | 58 | 71 | 57 | 82 | 02 | 88 | 231 | 95 | 124 | 45 |
| 29 | 30 | 32 | 41 | 01 | 59 | 73 | 49 | 83 | 44 | 89 | 271 | 71 | 125 | 86 |
| 30 | 31 | 47 | 42 | 43 | 60 | 75 | 45 | 84 | 85 | 90 | | | | |

| The fift Rumbe from the Meridian. | North-east and by East, North-west and by West, South-east and by East, South-west and by West | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| La | Long. | | Dist. | | La | Long. | | Dist. | | La | Long. | | Dist. | |
| Gr | Gr. | P. | Gr. | P | Gr | Gr. | P | Gr. | P | Gr | Gr, | P, | Gr. | P |
| 0 | | 0 | | 0 | 30 | 47 | 10 | 54 | 00 | 60 | 112 | 93 | 108 | 00 |
| 1 | 1 | 49 | 1 | 80 | 31 | 48 | 84 | 55 | 80 | 61 | 115 | 97 | 109 | 80 |
| 2 | 2 | 99 | 3 | 60 | 32 | 50 | 60 | 57 | 60 | 62 | 119 | 10 | 111 | 60 |
| 3 | 4 | 49 | 5 | 40 | 33 | 52 | 37 | 59 | 40 | 63 | 122 | 34 | 113 | 40 |
| 4 | 6 | 00 | 7 | 20 | 34 | 54 | 16 | 61 | 20 | 64 | 125 | 70 | 115 | 20 |
| 5 | 7 | 50 | 9 | 00 | 35 | 55 | 98 | 63 | 00 | 65 | 129 | 18 | 117 | 00 |
| 6 | 9 | 00 | 10 | 80 | 36 | 57 | 82 | 64 | 80 | 66 | 132 | 78 | 118 | 80 |
| 7 | 10 | 50 | 12 | 60 | 37 | 59 | 68 | 66 | 60 | 67 | 139 | 54 | 120 | 60 |
| 8 | 12 | 01 | 14 | 40 | 38 | 61 | 57 | 68 | 40 | 68 | 140 | 45 | 122 | 40 |
| 9 | 13 | 52 | 16 | 20 | 39 | 63 | 48 | 70 | 20 | 69 | 144 | 53 | 124 | 20 |
| 10 | 15 | 04 | 18 | 00 | 40 | 65 | 42 | 72 | 00 | 70 | 148 | 81 | 126 | 00 |
| 11 | 16 | 56 | 19 | 80 | 41 | 67 | 39 | 73 | 80 | 71 | 153 | 30 | 127 | 80 |
| 12 | 18 | 09 | 21 | 60 | 42 | 69 | 39 | 75 | 60 | 72 | 158 | 00 | 129 | 60 |
| 13 | 19 | 62 | 23 | 40 | 43 | 71 | 42 | 77 | 40 | 73 | 163 | 00 | 131 | 40 |
| 14 | 21 | 16 | 25 | 20 | 44 | 73 | 48 | 79 | 20 | 74 | 168 | 26 | 133 | 20 |
| 15 | 22 | 70 | 27 | 00 | 45 | 75 | 58 | 81 | 00 | 75 | 173 | 80 | 135 | 00 |
| 16 | 24 | 62 | 28 | 80 | 46 | 77 | 72 | 82 | 80 | 76 | 179 | 84 | 136 | 80 |
| 17 | 25 | 82 | 30 | 60 | 47 | 79 | 89 | 84 | 60 | 77 | 186 | 26 | 138 | 60 |
| 18 | 27 | 39 | 32 | 40 | 48 | 82 | 10 | 86 | 40 | 78 | 193 | 17 | 140 | 40 |
| 19 | 28 | 97 | 34 | 20 | 49 | 84 | 36 | 88 | 20 | 79 | 200 | 69 | 142 | 20 |
| 20 | 30 | 55 | 36 | 00 | 50 | 86 | 67 | 90 | 00 | 80 | 208 | 91 | 144 | 00 |
| 21 | 32 | 15 | 37 | 80 | 51 | 89 | 03 | 91 | 80 | 81 | 217 | 98 | 145 | 80 |
| 22 | 33 | 76 | 39 | 60 | 52 | 91 | 43 | 93 | 60 | 82 | 228 | 13 | 147 | 60 |
| 23 | 35 | 38 | 41 | 40 | 53 | 93 | 88 | 95 | 40 | 83 | 239 | 61 | 149 | 40 |
| 24 | 37 | 01 | 43 | 20 | 54 | 96 | 40 | 97 | 20 | 84 | 252 | 85 | 151 | 20 |
| 25 | 38 | 66 | 45 | 00 | 55 | 98 | 98 | 99 | 00 | 85 | 268 | 51 | 153 | 00 |
| 26 | 40 | 32 | 46 | 80 | 56 | 101 | 62 | 100 | 80 | 86 | 287 | 67 | 154 | 80 |
| 27 | 41 | 00 | 48 | 60 | 57 | 104 | 33 | 102 | 60 | 87 | 312 | 36 | 156 | 60 |
| 28 | 43 | 67 | 50 | 40 | 58 | 107 | 12 | 104 | 40 | 88 | 345 | 15 | 158 | 40 |
| 29 | 45 | 38 | 52 | 20 | 59 | 109 | 98 | 106 | 20 | 89 | 406 | 72 | 160 | 20 |
| 30 | 47 | 10 | 54 | 00 | 60 | 112 | 93 | 108 | 00 | 90 | | | | |

*The sixt Rumbe from the Meridian* } *East North-east, West North-west.* *East South-east, West South-west.*

| La | Long. | Dist. | La | Long. | Dist. | La | Long. | Dist. |
|---|---|---|---|---|---|---|---|---|
| Gr | Gr. P. | Gr. P. | Gr | Gr. P. | Gr P. | Gr | Gr. P. | Gr. P. |
| 0 | 0 | 0 | 30 | 75 98 | 87 39 | 60 | 18218 | 15678 |
| 1 | 2 41 | 2 61 | 31 | 78 78 | 81 00 | 61 | 18707 | 15540 |
| 2 | 4 83 | 5 23 | 32 | 81 61 | 83 62 | 62 | 19213 | 16201 |
| 3 | 7 25 | 7 84 | 33 | 84 48 | 86 23 | 63 | 19736 | 16462 |
| 4 | 9 66 | 10 45 | 34 | 87 37 | 88 84 | 64 | 20277 | 167 24 |
| 5 | 12 08 | 13 06 | 35 | 90 30 | 91 46 | 65 | 20838 | 169 85 |
| 6 | 14 51 | 15 68 | 36 | 93 27 | 94 07 | 66 | 21420 | 172 46 |
| 7 | 16 94 | 18 29 | 37 | 96 27 | 96 68 | 67 | 22025 | 175 08 |
| 8 | 19 37 | 20 90 | 38 | 99 31 | 99 30 | 68 | 22657 | 177 69 |
| 9 | 21 81 | 23 52 | 39 | 10240 | 10191 | 69 | 23315 | 180 30 |
| 10 | 24 25 | 26 13 | 40 | 10553 | 10452 | 70 | 24006 | 182 92 |
| 11 | 26 71 | 28 74 | 41 | 10871 | 10714 | 71 | 24737 | 185 53 |
| 12 | 19 17 | 31 36 | 42 | 11193 | 10975 | 72 | 25490 | 188 14 |
| 13 | 31 65 | 33 97 | 43 | 11520 | 11236 | 73 | 26292 | 190 75 |
| 14 | 34 14 | 36 58 | 44 | 11853 | 11497 | 74 | 27143 | 193 37 |
| 15 | 36 63 | 39 20 | 45 | 12192 | 117 9 | 75 | 28046 | 195 98 |
| 16 | 39 13 | 41 81 | 46 | 12535 | 12020 | 76 | 29011 | 198 59 |
| 17 | 41 65 | 44 42 | 47 | 12887 | 12281 | 77 | 30046 | 201 21 |
| 18 | 44 18 | 47 03 | 48 | 13244 | 12543 | 78 | 31102 | 203 82 |
| 19 | 46 73 | 49 65 | 49 | 13609 | 12804 | 79 | 32373 | 206 43 |
| 20 | 49 29 | 52 26 | 50 | 13981 | 13065 | 80 | 33700 | 209 05 |
| 21 | 51 87 | 54 87 | 51 | 14350 | 13327 | 81 | 35164 | 211 66 |
| 22 | 54 47 | 57 49 | 52 | 14747 | 13588 | 82 | 36800 | 214 27 |
| 23 | 57 08 | 60 10 | 53 | 15144 | 13849 | 83 | 38651 | 216 89 |
| 24 | 59 71 | 62 71 | 54 | 15550 | 14110 | 84 | 40789 | 219 50 |
| 25 | 62 36 | 65 33 | 55 | 15966 | 14372 | 85 | 43313 | 222 11 |
| 26 | 65 04 | 67 94 | 56 | 16393 | 14633 | 86 | 46405 | 224 73 |
| 27 | 67 74 | 70 55 | 57 | 16831 | 14895 | 87 | 50388 | 227 34 |
| 28 | 70 46 | 83 17 | 58 | 17280 | 15156 | 88 | 56000 | 229 95 |
| 29 | 73 20 | 75 78 | 59 | 17742 | 15417 | 89 | 65608 | 232 56 |
| 30 | 75 98 | 78 39 | 60 | 18218 | 15678 | 90 | | |

| The seventh Rumbe from the Meridian. | | | East and by North, West and by North, | | | East and by South, West and by South. | | |
|---|---|---|---|---|---|---|---|---|
| La. | Long. | Dist. | La. | Long. | Dist. | La. | Long. | Dist. |
| G. | Gr. P. | Gr. P. | Gr. | Gr. P. | Gr. P. | Gr. | Gr. P. | Gr. P. |
| 0 | 0 | 0 | 30 | 15823 | 15377 | 60 | 37935 | 30755 |
| 1 | 502 | 512 | 31 | 16406 | 15890 | 61 | 38956 | 31267 |
| 2 | 1005 | 1025 | 32 | 16996 | 16402 | 62 | 40010 | 31780 |
| 3 | 1508 | 1538 | 33 | 17592 | 16915 | 63 | 41098 | 32293 |
| 4 | 2012 | 2050 | 34 | 18195 | 17428 | 64 | 42226 | 32805 |
| 5 | 2516 | 2563 | 35 | 18804 | 17940 | 65 | 43394 | 33318 |
| 6 | 3021 | 3075 | 36 | 19422 | 18453 | 66 | 44603 | 33830 |
| 7 | 3527 | 3588 | 37 | 20048 | 18965 | 67 | 45866 | 34343 |
| 8 | 4034 | 4100 | 38 | 20682 | 19478 | 68 | 47180 | 34855 |
| 9 | 4542 | 4613 | 39 | 21324 | 19990 | 69 | 48552 | 35368 |
| 10 | 5052 | 5126 | 40 | 21976 | 20503 | 70 | 49989 | 35881 |
| 11 | 5563 | 5638 | 41 | 22637 | 21016 | 71 | 51494 | 36393 |
| 12 | 6077 | 6151 | 42 | 23308 | 21528 | 72 | 53079 | 36906 |
| 13 | 6592 | 6663 | 43 | 23990 | 22041 | 73 | 54752 | 37418 |
| 14 | 7109 | 7176 | 44 | 24684 | 22553 | 74 | 56522 | 37931 |
| 15 | 7628 | 7688 | 45 | 25389 | 23066 | 75 | 58403 | 38443 |
| 16 | 8150 | 8201 | 46 | 26105 | 23579 | 76 | 60413 | 38956 |
| 17 | 8675 | 8714 | 47 | 26836 | 24091 | 77 | 62567 | 39469 |
| 18 | 9202 | 9226 | 48 | 27580 | 24604 | 78 | 64891 | 39981 |
| 19 | 9731 | 9739 | 49 | 28340 | 25116 | 79 | 67415 | 40494 |
| 20 | 10264 | 10251 | 50 | 29113 | 25629 | 80 | 70175 | 41006 |
| 21 | 10801 | 10764 | 51 | 29903 | 26141 | 81 | 73225 | 41519 |
| 22 | 11342 | 11277 | 52 | 30711 | 26654 | 82 | 76630 | 42032 |
| 23 | 11887 | 11789 | 53 | 30537 | 27169 | 83 | 80486 | 42544 |
| 24 | 12435 | 12302 | 54 | 32382 | 27679 | 84 | 84938 | 43057 |
| 25 | 12987 | 12814 | 55 | 33248 | 28192 | 85 | 90198 | 43569 |
| 26 | 13544 | 13327 | 56 | 34136 | 28704 | 86 | 96631 | 44082 |
| 27 | 14105 | 13840 | 57 | 35047 | 29217 | 87 | 104926 | 44594 |
| 28 | 14671 | 14352 | 58 | 35981 | 29730 | 88 | 116611 | 45107 |
| 29 | 15244 | 14865 | 59 | 36945 | 30242 | 89 | 136623 | 45620 |
| 30 | 15823 | 15377 | 60 | 37935 | 30755 | 99 | | |

The right Rumbe of East and West, with the Longitude answering to one degr. of distance, and the distance belonging to one degree of Longitude.

| Lat. | Long. | Dist. | Lat. | Long. | Dist. | Lat. | Long. | Dist. |
|---|---|---|---|---|---|---|---|---|
| Gr | Gr. P. | Parts. | Gr | Gr. P. | Parts. | Gr | Gr. P. | Parts. |
| 0 | 0 | 10000 | 30 | 1 25 | 86 60 | 60 | 2 00 | 50 00 |
| 1 | 1 00 | 99 98 | 31 | 1 17 | 85 71 | 61 | 2 06 | 48 48 |
| 2 | 1 00 | 99 94 | 32 | 1 18 | 84 80 | 62 | 2 13 | 46 94 |
| 3 | 1 00 | 99 86 | 33 | 1 19 | 83 86 | 63 | 2 20 | 45 40 |
| 4 | 1 00 | 99 75 | 34 | 1 21 | 82 90 | 64 | 2 28 | 43 83 |
| 5 | 1 00 | 99 62 | 35 | 1 22 | 81 91 | 65 | 2 37 | 42 26 |
| 6 | 1 01 | 99 45 | 36 | 1 24 | 80 90 | 66 | 2 46 | 40 67 |
| 7 | 1 01 | 99 25 | 37 | 1 25 | 79 86 | 67 | 2 56 | 39 07 |
| 8 | 1 01 | 99 02 | 38 | 1 27 | 78 80 | 68 | 2 67 | 37 46 |
| 9 | 1 01 | 98 76 | 39 | 1 29 | 77 71 | 69 | 2 79 | 35 83 |
| 10 | 1 02 | 98 48 | 40 | 1 31 | 76 60 | 70 | 2 92 | 34 20 |
| 11 | 1 02 | 98 16 | 41 | 1 33 | 75 47 | 71 | 3 07 | 32 55 |
| 12 | 1 02 | 97 81 | 42 | 1 35 | 74 31 | 72 | 3 24 | 30 90 |
| 13 | 1 03 | 97 43 | 43 | 1 37 | 73 13 | 73 | 3 42 | 29 23 |
| 14 | 1 03 | 97 03 | 44 | 1 39 | 71 93 | 74 | 3 63 | 27 56 |
| 15 | 1 03 | 96 59 | 45 | 1 41 | 70 71 | 75 | 3 86 | 25 88 |
| 16 | 1 04 | 96 12 | 46 | 1 44 | 69 46 | 76 | 4 13 | 24 19 |
| 17 | 1 04 | 95 63 | 47 | 1 47 | 68 20 | 77 | 4 44 | 22 49 |
| 18 | 1 05 | 95 10 | 48 | 1 49 | 66 91 | 78 | 4 81 | 20 79 |
| 19 | 1 06 | 94 55 | 49 | 1 52 | 65 60 | 79 | 5 24 | 19 08 |
| 20 | 1 06 | 93 97 | 50 | 1 55 | 64 28 | 80 | 5 76 | 17 36 |
| 21 | 1 07 | 93 35 | 51 | 1 59 | 62 93 | 81 | 6 39 | 15 64 |
| 22 | 1 08 | 92 72 | 52 | 1 62 | 61 56 | 82 | 7 18 | 13 91 |
| 23 | 1 09 | 92 05 | 53 | 1 66 | 60 18 | 83 | 8 20 | 12 18 |
| 24 | 1 09 | 91 35 | 54 | 1 70 | 58 77 | 84 | 9 57 | 10 45 |
| 25 | 1 10 | 90 63 | 55 | 1 74 | 57 35 | 85 | 11 47 | 8 71 |
| 26 | 1 11 | 89 88 | 56 | 1 79 | 55 92 | 86 | 14 33 | 6 97 |
| 27 | 1 12 | 89 10 | 57 | 1 84 | 54 46 | 87 | 19 11 | 5 23 |
| 28 | 1 13 | 88 29 | 58 | 1 89 | 52 99 | 88 | 28 65 | 3 49 |
| 29 | 1 14 | 87 46 | 59 | 1 94 | 51 50 | 89 | 57 30 | 1 74 |
| 30 | 1 15 | 86 60 | 60 | 2 00 | 50 00 | 90 | | 0 |

These tables are calculated for each of the Rumbs. The first seven have three columnes, and of them the first containeth the degrees of Latitude from the Æquinoctiall to the Pole: the second doth give the difference of Longitude, and the third the distance, both of them belonging to that Rumb and latitude.

As in the Table of the third Rumb, at the *latitude* of 50 *Gr.* I find under the title of *Longitude* 38 *gr.* 69 *parts*, and under the title of *distance* 60 *gr.* 13 *parts.* This shewes that if the course held constantly on the third Rumb from the Æquinoctiall to the Latitude of 50 *gr.* the difference of Longitude would be 38 *gr.* 69 *parts* of 100 and the distance upon the Rumbe 60 gr. 13 parts. For here I reckon the distance by degrees, rather then by leagues or miles, and subdivide each degree into 100 parts, rather then into 60 minutes, for the more ease in calculation, and withall to make the calculation to agree the better, both with this, and my *Crosse staffe* and other instrumentr.

The use of these Tables, for the finding of the difference of Longitude, is this. Turne to the table of the Rumb, and there see what longitude belongeth to either latitude, then take the one longitude out of the other, the remainder will be the difference of longitude required.

As in the former example, where the places given were *A* in the latitude of 50 Gr. *C* in the latitude of 55 Gr. and the Rumb the third from the meridian: I looke into the table of the third Rumb and there find,

| | |
|---|---|
| Latitude 50 gr. | Longitude 38 gr. 69 parts. |
| Latitude 55 *gr.* | Longitude 44 *gr.* 19. |
| Therefore the diff. of longitude 5 *gr.* | 50 |

There is another use of these tables, for the describing of the Rumbs both on the *Globe*, and all sorts of *Charts*: For having drawne the circles of longitude and latitude, and finding by the tables, the difference of longitude belonging to each Rumb and latitude: If we make a pricke in the chart, at every

every degree of latitude, according to that difference of longitude, and draw lines through those prickes, so as they make no angles, the lines so drawne shall be the Rumbs required.

The use of the eight Rumb is something different from the rest. For there being here no change of latitude, I have set to each latitude, the difference of longitud, belonging to one degree of distance, and the distance belonging to one degree of longitude.

As if two places shall be 20 leagues, or one degree distant one from the other, in the latitude of 50 *gr.* the difference of longitude betweene them will be 1 *gr.* 55 *parts.* But if they differ one degree in longitude, the distance betweene them will be onely 64 parts, which fall short of 13 leagues, or at the most 64 *gr.* 28 parts, such as 10000 do make a degree.

## 6 *By the difference of longitude, Rumb, and one latitude, to find the other latitude.*

As if the places given were *A*, in the latitude of 50 *gr.* C in a greater lattiude but unknowne, the difference of longitude 5 *gr.* $\frac{1}{2}$, and the Rumb the third from the Meridian.

In the chart let A *B*, *D C*, meridians, be drawne through A and *C*, according to the difference of longitnde, one 5 *gr* $\frac{1}{2}$ from the other; and a parallell of latitude through *A*, crossind the meridian C D in D: then in A, with A B, make an angle of the Rumbe B A C: so the degrees in the meridian betweene D and *C*, shall be found to be 5 *gr.* the proper difference of latitude which was required. Wherefore the proportion holds for the *Sector*,

As A D the Radius
  to D C the tangent of the Rumb from the æquator
So A D as difference of longitude,
  to D C the proper difference of latitude

According to this, I take 56 *gr*, 15 *m.* for the angle of the Rumb from the æquator, out of the greater *Tangents*, and make it a parallell Radius. Then I Reckon 5 gr.½ in the line of *lines* from the center, for the difference of longitud. So the parallell taken from the termes of this difference, and measured in the line of *meridians*, shall reach from 50 gr. the latitude given, to 55 gr. which is the latitude required.

Or if the Rumb fall nearer to the meridian.

As *BC* the tangent of the Rumb from the meridian,
is to *AB* the Radius:
So *BC* as difference of longitude,
to *AD* the proper difference of latitude.

According to this we may best work by parallel entrance; first take 35 gr.45 *m.* for the angle of the Rumb from the meridian, out of the greater *Tangent*, and make it a parallell Radius; then take 5 gr.½ for the difference of longitude out of the line of *lines*, and carry it parallell to the former, till the feete of the compasses stay in like points: so the line between the center and the place of this stay, being taken and measured in the line of *meridians* from 50 gr. forward, shall shew the latitude required to be 55 gr. as in the former way.

The like may be found by the tables of Rumbs. For in the table of the third Rumb, at the latitude of 50 gr. I finde the longitude of 38 gr. 69 *p*; to this if I adde 5 *gr*. 50 *p*. for the difference of longitude given, the compound longitude will be 44 gr. 19 *p*. and this answers to the latitude of 55 gr.

But if this difference of latitude were to be found by the common sea-chart, it should seeme to be 8 gr. 13 *m.* and so the second latitude should be 58 gr. 13 *m.* which is aboue 3 gr. more then the truth.

### 7 *By one latitude, rumb, and distance, to find the difference of longitude.*

As if the places given were *A* in the latitude of 50 gr. *C* in a greater latitude but unknowne, the distance upon the Rumb being 6 gr. betweene them, and the Rumb the third from the meridian.

In

In the chart, let a meridian A B, and a parallell A D be drawne through A, and in A, with A B, make an angle B A C for the Rumb from the meridian; then open the compasses according to the latitude of the places to E F, the quantitie of 6 gr. in the meridian, transferring them into the Rumb from A to C, and through C draw another meridian D C, crossing the parallell drawne through A in D: so the degrees intercepted in the parallell from A to D, shall shew the difference of longitude required to be about 5 gr. ½. Wherefore the proportion holds for the Sector.

As A C the Radius, (meridian:
is to A D, equall to B C, the sine of the *Rumb* from the
So A C as proper distance upon the *Rumb*,
to A D the difference of longitude.

According to this I take the sine of 33 *gr*. 45 *m*. for the angle of the Rumb from the meridian, and make it a parallell Radius; then keeping the *Sector* at this angle, I take 6 *gr*. for the distance out of the *meridian* line, according to the estimated latitudes of both places, and lay it on both sides of the *Sector* from the center: so the parallell taken from the termes of this distance, and measured in the lines of *lines*, shall shew the difference of longitude to be about 5 *gr*. ½.

In this and some of the *Prop*. following, where there is but one latitude knowne, there may be sometimes an error of a minute or two, in the estimation of the proper distance, yet it may be rectified at a second operation.

This proposition may also be wrought by the Tables of Rumbs. For according to the example, in the Table of the third Rumb, at the latitude of 50 *gr*. I find the longitude of 38 *gr*. 69 *p*. and the distance of 60 *gr*. 13 *p*. to this I adde 6 *gr*. for the distance given; so the compound distance will be 66 *gr*. 13 *p*. and this answers to the longitude of 44 *gr*. 19 *p*; then if I take the one longitude out of the other, the difference will be 5 gr. 50 *p*. as before.

But if this difference were to be found by the common sea-chart, it should seeme to be onely 3 gr. 20 *m*. which is more then 2 gr. lesse then the truth.

8. *By one latitude, Rumb, and difference of longitudes, to find the distance.*

As if the places were given *A*, in the latitude of 50 gr. *C* in a greater latitude but unknowne, the difference of longitude betweene them being 5 gr. $\frac{1}{2}$, and the Rumb the third from the meridian.

In the chart let A B, D C, meridians be drawne through *A* and *C*, according to the difference of longitude, and a parallell of latitude through *A*, crossing the meridian D C in D; then in *A*, with AB, make an angle of the Rumb B A C: so the distance on the Rumb from *A* to *C* taken and measured in the *meridian*, according to the estimated latitude of the places, shall be found to be 6 gr. Wherefore the proportion holds for the *Sector*.

As A D, equall to BC, the sine of the Rumb from the meridian,
is to *A C* the Radius:
So AD as difference of longitudes,
to *A C* the proper distance upon the Rumb.

According to this, I take the laterall Radius, and make it a parallell sine of 33 gr. 45 *m.* which is here the angle of the Rumb from the meridian; then I reckon 5 gr. $\frac{1}{2}$ in the lines of *lines* from the center, for the difference of longitude: so the parallell taken from the termes of this difference, and measured in the line of *meridians*, according to the latitudes of the places, shall there shew the distance required to be about 6 gr. which are 120 leagues.

Or if the Rumb fall nearer to the meridian, that the lateral Radius cannot be fitted over in his sine, this *Prop.* must be wrought by parallell entrance, and so also it gives the same distance as before.

Or we may find this distance by the Table of Rumbs. For in the tabl of the third Rumb, at the latitude of 50 gr. I find the longitude of 38 gr. 69 *p.* and the distance of 60 gr. 13. *p.*

To

To this longitude here found, I adde 5 gr. 50 *p.* for the difference of longitude given: so the compound longitude will be 44 gr. 19 *p.* and this answers to the distance of 66 gr. 15 *p.* Then if I take the one distance out of the other, the remainder will be 6 gr. 02 *p.* for the distance required.

But if this distance were to be measured on the common sea-chart, it should seeme to be almost 10 gr. or at the least 197 leagues, above 77 leagues more then the truth.

### 9 *By one latitude, distance, and difference of longitudes, to find the Rumb.*

As if the places given were *A*, in the latitude of 50 gr. *C* in a greater latitude but unknowne, the difference of longitude betweene them being 5 gr. ½, and the distance of 6 gr. upon the Rumb.

In the chart let AB, DC, meridians, be drawne through *A* and *C*, and a parallell of latitude through *A*; then open the compasses according to the latitudes of the places, to *EF* the quantity of 6 gr. in the *meridian*, and setting the one foote in *A*, the other foote shall crosse the other meridian in C, and if we draw the right line AC, the angle BAC shall shew the inclination of the Rumb to the meridian to be about 33 gr. 45 *m.* Wherefore the proportion holds for the *Sector.*

As AC the proper distance upon the Rumb,
is to AD the difference of longitude:
So AC as Radius,
to AD, equall to BC, the sine of the Rumb from the meridian.

According to this, I take the proper distance 6 gr. out of the line of *meridians*, and lay it on both sides of the *Sector* from the center; then I take the difference of longitude 5 gr. ½ out of the line of *lines*, and to it open the *Sector* in the terms of the former distance: so the parallell Radius taken from betweene 90 and 90, and measured in the *sines*, doth give about 33 gr. 45 *m.* for the Rumb required.

But if this Rumb were to be found by the common sea-chart,

chart, it should seeme to be above 66 *gr.* and so almost the sixt Rumb from the Meridian.

### 10 By the longitude and latitude of two places, to find their distance from the Rumb.

Let the *Sector* be opened in the lines of *lines*, unto a right angle (as was shewed before *Cap.* 2. *Prop.* 7.) hen take out the proper difference of latitude, and lay it on the one line, and the difference of longitude, and lay it on the other line, so as they may both meete in the center, marking how far they extend. For the line taken from the termes of their extension, and measured in the *meridian*, according to their latitudes, shall shew the distance required.

So if the places given were A and C, A in the latitude of 50 *gr.* C in the latitude of 55 *gr.* the proper difference of latitude shall be the line A B, and let B C the difference of longitude be 5. *gr.* $\frac{1}{2}$, we shall find that *A C* the distance upon the Rumb is about 6 *gr.* which make 120 leagues.

For in the chart, let an occult meridian be drawne through A, and a parallell of latitude through C, crossing the former meridian in B, and a right line for the Rumb from A to C, so have we a rectangle triangle *A B C*, whose base *A C*, taken and measured in the meridian from E below 50 *gr* to F, as much above 55 *gr.* doth containe the quantitie of 6 *gr.*

In the same manner the *Sector* being opened to a right angle, in the lines of *lines:* if we take the difference of latitude out of the line of *meridians*, in his proper place from 50 *gr.* to 55 *gr.* and place it on one of the sides from the center, to resemble *A B*, then reckon the difference of longitude on the other perpendicular line from the center to 5 *gr.* $\frac{1}{2}$, in stead of B C, we shall have the like rectangle triangle on the *Sector*, to that which we had before on the chart; and if we take out the base of it, and measure it in the line of *meridians* from below 50 *gr.* to as much aboue 55 *gr.* we shall finde as before, that it containeth about 6 *gr.* or 120 leagues.

But if this distance were to be measured on the common

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sea-chart, it should seeme to be almost 7 gr. ¼, or 145 leagues; which is 25 leagues more then the truth.

## 11 *By the latitude of two places, and the distance upon the Rumb, to find the difference of longitude.*

Let the *Sector* be opened in the lines of *lines* to a right angle, then take out the proper difference of latitudes, and lay it on one of the lines from the center, then take the proper distance with a paire of compasses, and setting one foote in the termes of the difference, turne the other foote to the other line of the *Sector*, and it shall there shew the difference of longitude required.

So if the places given were *A*, in the latitude of 50 *gr*. *C* in the latitude of 55 *gr*. with 6 *gr*. of distance one from another, we shall find their difference of longitude to be about 5 *gr*. ½.

For in the chart let a meridian *A* B be drawne for the one, and B *C*, *A D*, parallells of latitude for them both: Then open the compasses according to the latitude of the places, to *E* F the quantitie of 6 *gr*. in the *meridian*, and setting one foote in *A*, having latitude of 50 *gr*. turne the other to the parallell of 55 *gr*. and it shall there cut off the required difference of longitude B *C* 5 *gr*. ½.

In the same maner, the *Sector* being opened to a right angle, in the lines of *lines*: if we take the difference of latitude out of the line of *meridians* in his proper place from 50 *gr*. unto 55 gr. and place it on one of the lines from the center; then take 6 gr. the distance upon the Rumb out of the same line of *meridians*, according to the latitudes of the places, and set the one foote in the terme of the former difference, turning the other foote to the other perpendicular line, we shall finde that it will crosse it about 5 gr. ½ from the center: which is the difference of longitude required.

But if this difference of longitude were to be found by the common sea chart, it would seeme to be onely 3 gr. 20 *m* which is more then 2 gr. 10 *m*. lesse then the truth.

## 12. *By one latitude, distance and difference of longitudes, to finde the difference of latitudes.*

Let the *Sector* be opened in the line of *lines* to a right angle, and let the difference of longitude be reckoned in one of those lines from the center; then take the proper distance with a paire of compasses, and setting the one foote in the terme of the former difference, turne the other foote to the other line of the *Sector*, and it shall thence cut off a line, equall to the proper difference of latitude required.

So if the places given were *A* and *C*, *A* in the latitude of 50 *gr*. *C* in a greater latitude but unknowne, the difference of longitude betweene them 5 *gr*. ½, and the distance upon the Rumb 6 *gr*. or 120 leagues, we shall find the difference of latitude to be 5 *gr*.

For in the chart, let occult meridians be drawne through *A* and *C*, and a paralleil of latitude through *A*; then open the compasses according to the estimated latitudes of the places to E F the quantity of 6 *gr*. in the meridian, and setting the one foote in *A*, turne the other to the meridian drawne through *C*, and it shall there cut off the line *D C*, which is the difference of latitude required.

In the same maner, the *Sector* being opened to a right angle, in the lines of *lines*, if in the one line we reckon the difference of longitude from the center to 5 *gr*. ½, then taking 6 *gr*. for the distance out of the line of *Meridians*, according to the latitude of the places, we set the one foote in the terme of the given difference, and turne the other foote to the other perpendicular line, we shall find that it cuts a line from it, which taken and measured in the line of *meridians*, from 50 *gr*. on forward, doth shew the difference of latitude to be as before 5 *gr*.

But if this difference of latitude were to be found by the common sea-chart, it would seeme to be onely 2 *gr*. 25 *m*. which is 2 *gr*. 35 *m*. lesse then the truth. Such is the difference betweene both these charts.

# THE THIRD BOOKE

## Containing the use of the particular *Lines.*

THE lines of *lines*, of *superficies*, of *solids*, of *sines*, with the laterall lines of *tangents* and *meridians*, whereof I haue hitherunto spoken, are those which I principally intended: that little roo e on the *Sector* which remaineth, may be filled up with such particular lines as each one shall thinke convenient for his purpose. I have made choise of such as I thought might be best prickt on without hindring the sight of the former, viz. lines of *Quadrature*, of *Segments*, of *Inscribed bodies*, of *Equated bodies*, and of *Mettals*.

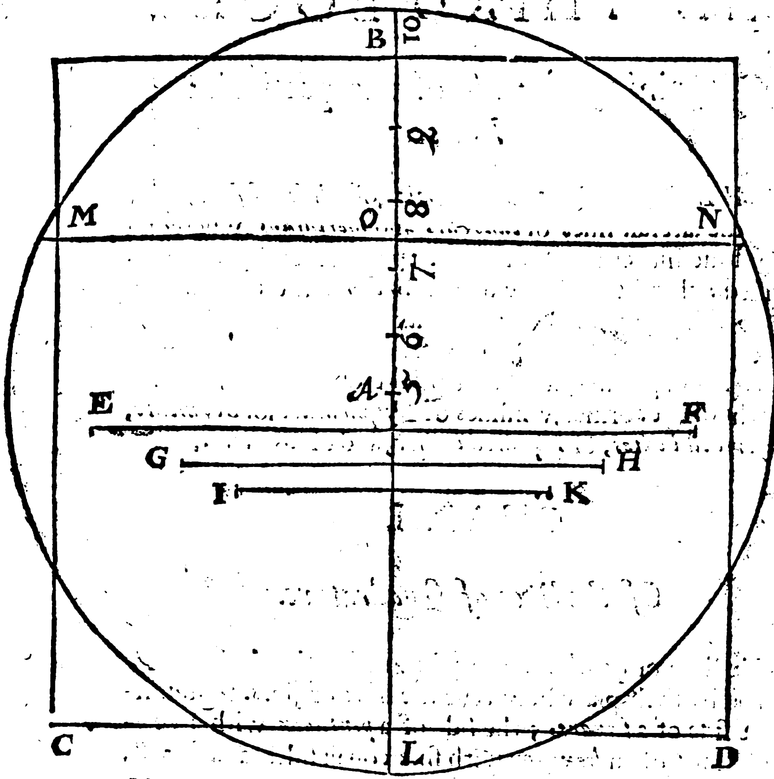
## CHAP. I.

### *Of the lines of Quadrature.*

THe lines of *quadrature* may be knowne by the letter *Q*, and by their place betweene the lines of *sines*. *Q* signifieth the side of a *square*, 5 the side of a *pentagon* with five equall sides. 6 of an *hexagon* with sixe equall sides, and so 7, 8, 9, and 10. *S* stands for the Semidiameter of a circle, and 90 for a line equall to 90 *gr.* in the circumference. The use of them may be,

1 *To make a square equall to a circle given.*
2 *To make a circle equall to a square given.*

If the circle be first given, take his semidiameter, and to it open the *Sector* in the points at S: so the parallell taken from betweene the points at *Q*, shall be the side of the square required.




If the square be given take his side, and to it open the Sector, in the points at Q: so the parallell taken from betweene the points at S, shall be the Semidiameter of the circle required.

Let the Semidiameter of the circle given be A B, the side of the square equall unto it shall be found to be C D.

8 *To reduce a circle given, or a square into an equall pentagon, or other like sided and like angled figure.*

Take the side of the figure given, and fit it over in his due points: so the parallells taken from betweene the points of the

the other figures, shall be the sides of those figures: which being made up with equall angles, shall be all equall one to the other.

Let the Semidiameter of the circle given be *AB*, the side of an *hexagon* equall to this circle, shall by these meanes be found to be *GH*; and the sides of an octagon to be *IK*. Other planes not here set downe, may first be reduced into a square, by the sixt *Prop. Superf.* and then into a circle, or other of these equall figures, as before.

### 4 *To find a right line, equall to the circumference of a circle, or other part thereof.*

Take the Semidiameter of the circle given, and to it open the *Sector* in the points at *S*; so the parallell taken from betweene the points at 90 in this line, shall be the fourth part of the circumference: which being knowne, the other parts may be found out by the second and third *Prop.* of *lines.*

Thus if the Semidiameter of the circle given be *AB*, the right line *EF* shall be found to be the fourth part of the circumference. Therefore the double of *EF* shall be equall to the circumference of 180 *gr.* and the halfe of *EF* shall be the circumference of 45 *gr.* and so in the rest.

# CHAP. II.

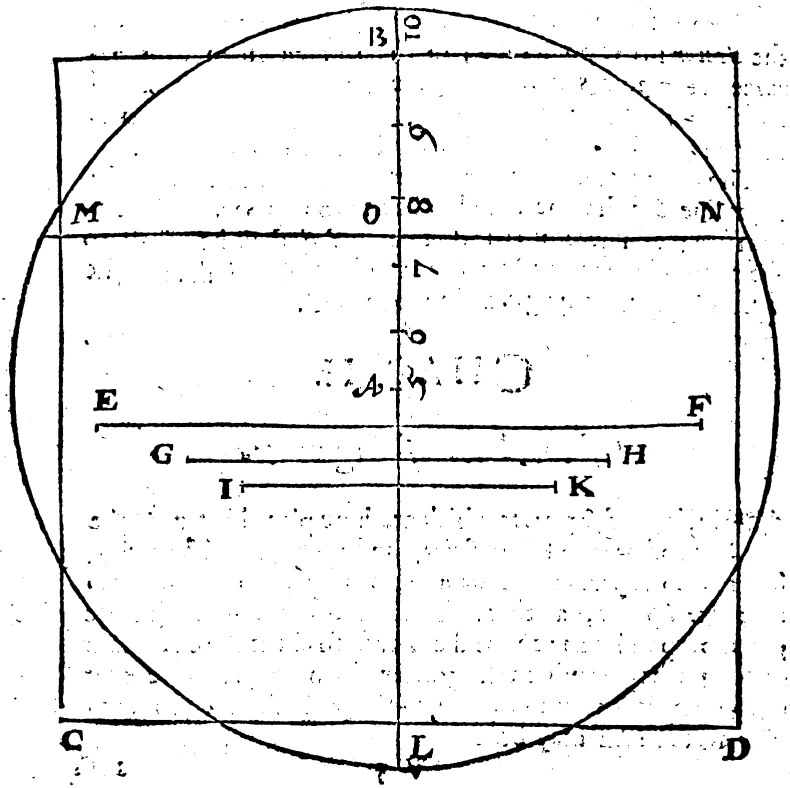
## *Of the lines of Segments.*

THe lines of *segments* which are here placed between the lines of *sines* and *superficies*, and are numbred by 5, 6, 7, 8, 9, 10. do represent the diameter of a circle, so divided into a hundred parts, as that a right line drawne through these parts, perpendicular to the diameter, shall cut the circle into two segments, of which the greater segment shall have that proportion to the whole circle, as the parts cut have to 100. The use of them may be.

### 1 *To divide a circle given into two segments according to a proportion given.*
### 2 *To find a proportion betweene a circle and his segments given.*

Let the *Sector* be opened in the points of an 100, to the diameter of the circle given: so a parallell taken from the points proportionall to the greater segment required, shall giue the depth of that greater segment.

Or if the segments be given, let the *Sector* be opened as before; then take the depth of the greater segment, and carry it



parallell to the diameter: so the number of points wherein they stay, shall shew the proportion to 100.

As if the diameter of the circle given were *B L*, the depth of the greater segment *L* O being 75, doth shew the proportion of the segment O *M L N* to the circle to be as 75 to 100 viz. three parts of foure.

Hence I might shew, if there were any use of it,

*To find the side of a square, equall to any knowne segment of a circle.*

The side of a square equall to the whole circle, may be found by the former *Cap.* and then having the proportion of the segment to the circle, we may diminish the square in such proportion, by that which hath beene shewed *Lib.* 1. *Cap.* 3. *Prop,* 3.

## CHAP. III.

### *Of the lines of Inscribed bodies.*

THe lines of *inscribed bodies* are here placed betweene the lines of *lines*, and may be knowne by the letters, *D*, *S*, I *C*, O, *T*, of which D signifieth the side of a *dodecahedron*, I of an *Icosahedron*, C of a *cube*, O of an *octahedron* and *T* of a *tetrahedron*, all inscribed into the same sphære, whose semidiameter is here signified by the letter *S*.

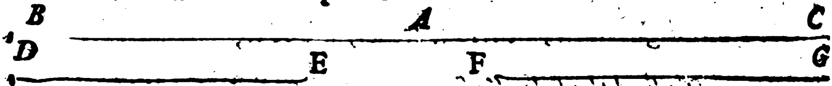
The use of these lines may be,

1 *The semidiameter of a sphære being given, to find the sides of the fiue regular bodies, which may be inscribed in the said sphære.*

2 *The side of any of the fiue regular bodies being given, to find the semidiameter of a sphære, that will circumscribe the said bodie.*

If the sphære be first given, take his semidiameter, and to it open

open the *Sector* in the points at S: if any of the other bodies be first given, take the side of it, and fit it over in his due points: so the parallell taken from betweene the points of the other bodies, shall be the sides of those bodies, and may be inscribed into the same sphære.




So if the semidiameter of the sphære be *A C*, the side of the *dodecahedron* inscribed shall be *D E*.

## CHAP. IIII.

### *Of the lines of Equated bodies.*

THe lines of *equated bodies* are here placed betweene the lines of *lines* and *solids*, noted with these letters, *D*, *I*, *C*, S, *O*, *T*, of which *D* stands for the side of a *dodecahedron*, *I*, for the side of an *Icosahedron*, *C* for the side of a *cube*, *S* for the diameter of a *sphere*, O for the side of an *octahedron*, and *T* for the side of a *tetrahedron*, all equall one to the other. The use of these lines may be.

1 *The diameter of a sphære being given, to find the sides of the fiue regular bodies, equall to that sphære.*

2 *The side of any of the fiue regular bodies being given, to find the diameter of a sphære, and the sides of the other bodies, equall to the first body given.*

If the sphære be first given, take his diameter, and to it open the *Sector* in the points at S: if any of the other bodies be first given, take the side of it, and fit it over in his due points: so the parallels taken from betweene the points of the other bodies, shall be the sides of those bodies equall to the first body given.

Thus in the last diagram, if the diameter of a sphære given be *B C*, the side of the *dodecahedron* equall to this sphære, would be found to be F G.

CHAP.

# CHAP. V.

## *Of the lines of Mettals.*

THe lines of *Mettalls* are here ioyned with those before of *equated bodies*, and are noted with these characters ☉.☿.♄.☽.♀.♂.♃. of which ☉ stands for gold, ☿ for quicksilver, ♄ for leade, ☽ for silver, ♀ for copper, ♂ for iron, and ♃ for tin. The use of them is to give a proportion betweene these severall mettals, in their magnitude and weight, according to the experiments of *Marinus Ghetaldus*, in his booke called *Promotus Archimedes.*

### 1 *In like bodies of severall mettalls and equall weight, having the magnitude of the one, to finde the magnitude of the rest.*

Take the magnitude given out of the lines of *Solids*, and to it open the *Sector* in the points belonging to the mettall given: so the parallells taken from between the points of the other mettalls, and measured in the lines of *Solids*, shall giue the magnitude of their bodies.

Thus having cubes or sphæres of equall weight, but severall mettalls, we shall finde that if those of tin containe 10000 *D*, the others of iron will containe 9250, those of copper 8222, those of silver 7161, those of lead 6435, those full of quicksilver 5453, and those of gold 3895.

### 2 *In like bodies of severall mettalls and equall magnitude, having the weight of one to finde the weight of the rest.*

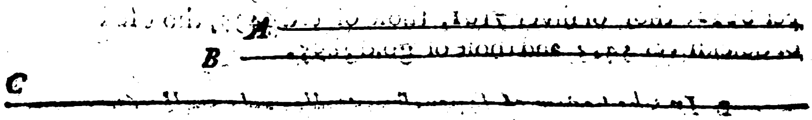
This proposition is the converse of the former, the proportion not direct, but reciprocall, wherefore having two like bodies, take the given weight of the one out of the lines of *Solids*, and to it open the *Sector* in the points belonging to the mettall of the other body: so the parallell taken from the points belonging to the body given, and measured in the lines of *Solids*, shall give the weight of the body required.

As if a cube of gold weighed 38 ℔. and it were required to know the weight of a cube of lead having equall magnitude. First I take 38 ℔. for the weight of the golden cube, out of the lines of *Solids*, and put it over in the points of ♄ belonging to lead: so the parallell taken from betweene the points of ☉ standing for gold, and measured in the lines of *Solids*, doth give the weight of the leaden cube required to be 23 ℔.

Thus if a sphære of gold shall weigh 10000. we shall finde that a sphære of the same diameter full of quicksilver shall weigh 7143, a sphære a lead 6053, a sphære of silver 5438, a sphære of copper 4737, a sphære of iron 4210; and a sphære of tinne 3895.

### 3 *A body being given of one mettall, to make another like unto it, of another mettall, and equall weight.*

Take out one of the sides of the body given, and put it over in the points belonging to his mettall: so the parallell taken from betweene the points belonging to the other mettall, shall give the like side, for the body required. If it be an irregular body, let the other like sides be found out in the same manner.



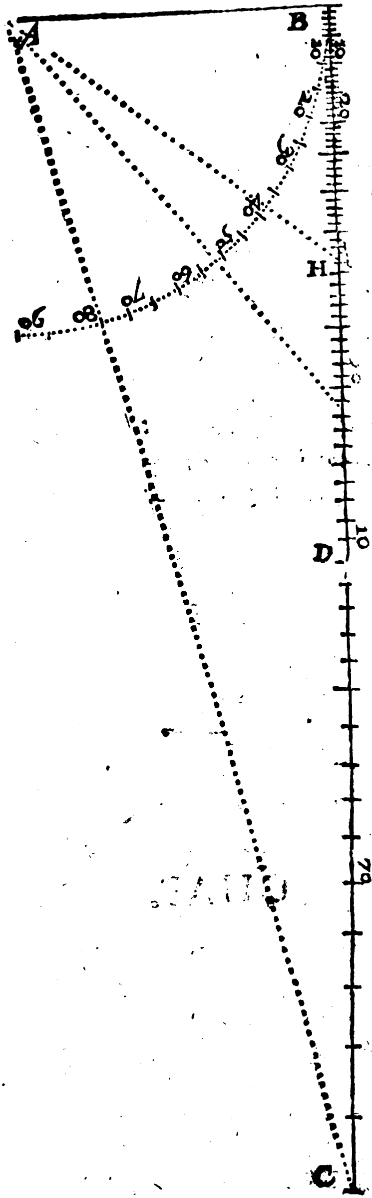

Let the body given be a sphære of lead containing in magnitude 16 *d*, whose diameter is *A*, to which I am to make a sphære of iron, of equall waight: If I take out the diameter *A*, and put it over in the points of ♄ belonging to lead, the parallell taken from betweene the points of ♂ standing for iron, shall be *B*, the diameter of the iron sphære required. And this compared with the other diameter, in the lines of *Solids*,

*Solids* will be found to be 23 *d.* in magnitude.

### 4 *A body being given of one mettall, to make another like unto it of another mettall, according to a weight given.*

First find the sides of a like body of equall weight, then may we either augment or diminish them according to the proportion given by that which we shewed before in the second and third *Prop. of Solids.*

As if the body given were a sphære of lead, whose diameter is *A*, and it were required to find the diameter of a sphære of iron, which shall weigh three times as much as the sphære of lead: I take *A*, and put it over in the points of ♄, his parallell taken from betweene the points of ♂, shall give me *B* for the diameter of an equall sphære of iron: if this be augmented in such proportion as 1 unto 3, it giveth *C* for the diameter required.




# CHAP. VI.

## *Of the lines on the edges of the Sector.*

Having shewed some use of the lines on the flat sides of the *Sector*, there remaine onely those on the edges. And here one halfe of the outward edge is divided into inches, and numbred according to their distance from the ends of the *Sector*. As in the Sector of fourteene inches long, where we find 1 and 13, it sheweth that division to be 1 inch from the nearer end, and 13 inches from the farther end of the *Sector*.

The other halfe containeth a line of lesser *tangents*, to which the gnomon is Radius. They are here continued to 75 *gr.* And if there be need to produce them farther, take 45 out of the number of degrees required, and double the remainder: so the *tangent* and *secant* of this double remainder being added, shall make up the *tangent* of the degrees required.

As if *AB* being the Radius, and *BC* the tangent line, it were required to find the tangent of 75 *gr.* If we take 45 *gr.* out of 75 *gr.* the remainder is 30 *gr.* and the double 60 *gr.* whose tangent is B D, and the secant is A D: if then we adde A D to B D, it maketh *BC* the tangent of 75 *gr.* which was required. In like sort the secant of 61 *gr.* added to the tangent of 61 *gr.* giveth the tangent of 75 *gr.* 30 *m.* and the secant of 62 *gr.* added to the tangent of 62 *gr.* giveth the tangent of 76 *gr.* and

and so in the rest. The use of this line may be

## *To obserue the altitude of the Sunne.*

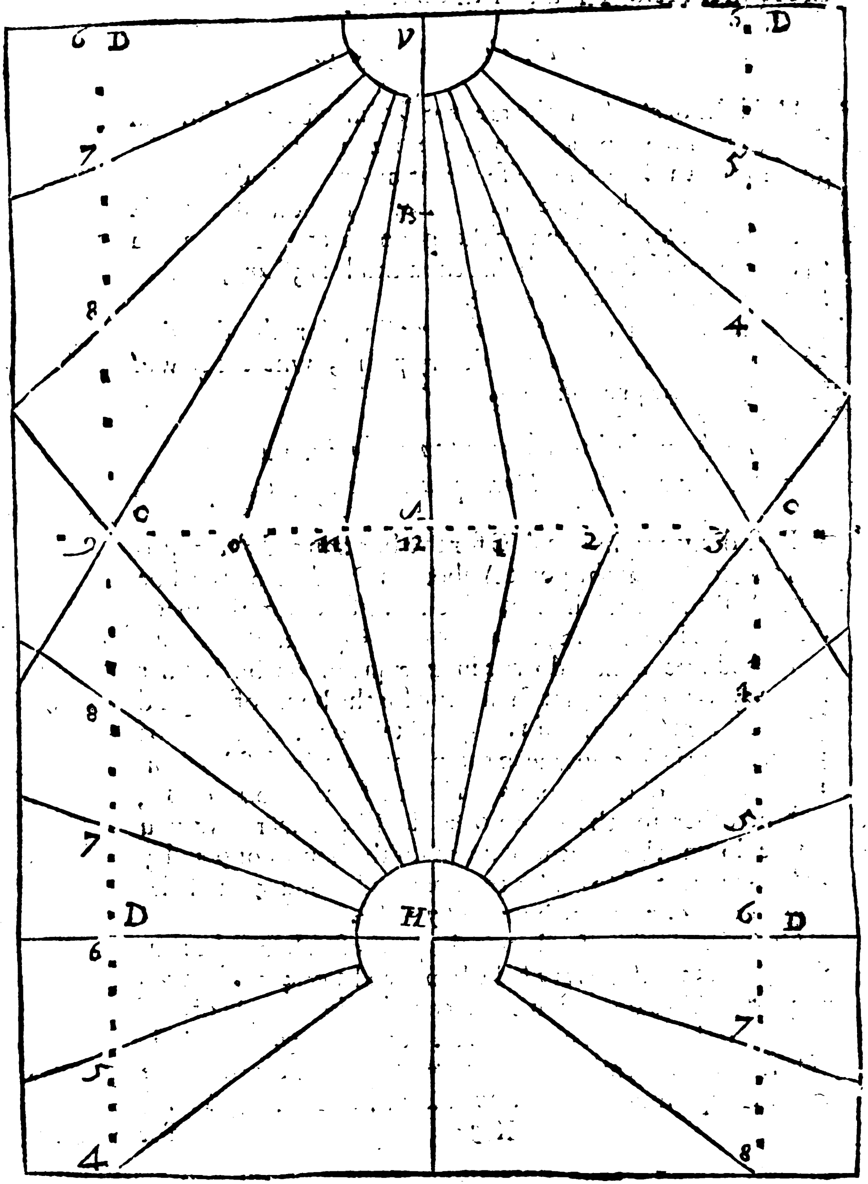
Hold the *Sector* so as the tangent *BC* may be verticall, and the gnomon *BA* parallell to the horizon; then turne the gnomon toward the Sunne, so that it may cast a shadow upon the tangent, and the end of the shadow shall shew the altitude of the Sunne. So if the end of the gnomon at *A*, do give a shadow unto *H*, it sheweth that the altitude is 38 *gr.* ½, if unto D, then 60 *gr.* and so in the rest.

There is another use of this *tangent* line, for the drawing of the houre lines upon any ordinary plane, whereof I will set downe these propositions.

1. *To draw the houre lines upon an horizontall plane.*
2. *To draw the houre lines upon a direct verticall plaine:*

First draw a right line A C for the horizon and the æquator, and crosse it at the point A about the middle of the line with A B another right line, which may serve for the meridian and the houre of 12; then take out 15 *gr.* out of the tangents, and pricke them downe in the æquator on both sides from 12: so the one point shall serve for the houre of 11, and the other for the houre of 1. Againe, take out the tangent of 30 *gr.* and pricke it downe in the æquator on both sides from 12: so the one of these points shall serue for the houre of 10, and the other for the houre of 2. In like maner may you pricke downe the tangent of 45 *gr* for the houres of 9 aud 3 and the tangent of 60 *gr.* for the houres of 8 and 4, and the tangent of 75 *gr.* for the houres of 7 and 5.

Or if any please to set downe the parts of an houre, he may allow 7 *gr.* 30 *m.* for every halfe houre, and 3 *gr.* 45 *m.* for every quarter. This done, you are to consider the latitude of the place, and the qualitie of the plane: For the *secant* of the latitude shall be the semidiameter in a vertical plane, & the *secant* of the complement of the latitude in an horizontall plane.



D
D
V
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7
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For example; about London the latitude is 51 *gr.* 30 *m.* and let the plane be verticall. If you take *AV* the secant of 51 *gr.* 30 *m.* out of the *Sector*, and pricke it downe in the meridian line from *A* unto *V*, the point *V* shall be the center: and if you draw right lines from *V* unto 11, and 10, and the rest of the houre points, they shall be the hourelines required.

But if the plane be horizontall, then you are to take out *AH* the secant of 38 *gr.* 30 *m.* for the semidiameter, and prick it downe in the meridian line from *A* unto *H*: so the right lines drawne from the center *H* unto the houre points, shall be the houre lines required; onely the houre of 6 is wanting, and that must alwayes be drawne parallell to the æquator, through the center V in a verticall, through the center *H* in an horizotall plane.

This being done, if you set the lines *AH*, *HV*, to a right angle (*HAV*) the right line *HV* the base of this triangle shall be the axis of the style for either plaine.

3 *To draw the houre lines on a polar plane.*

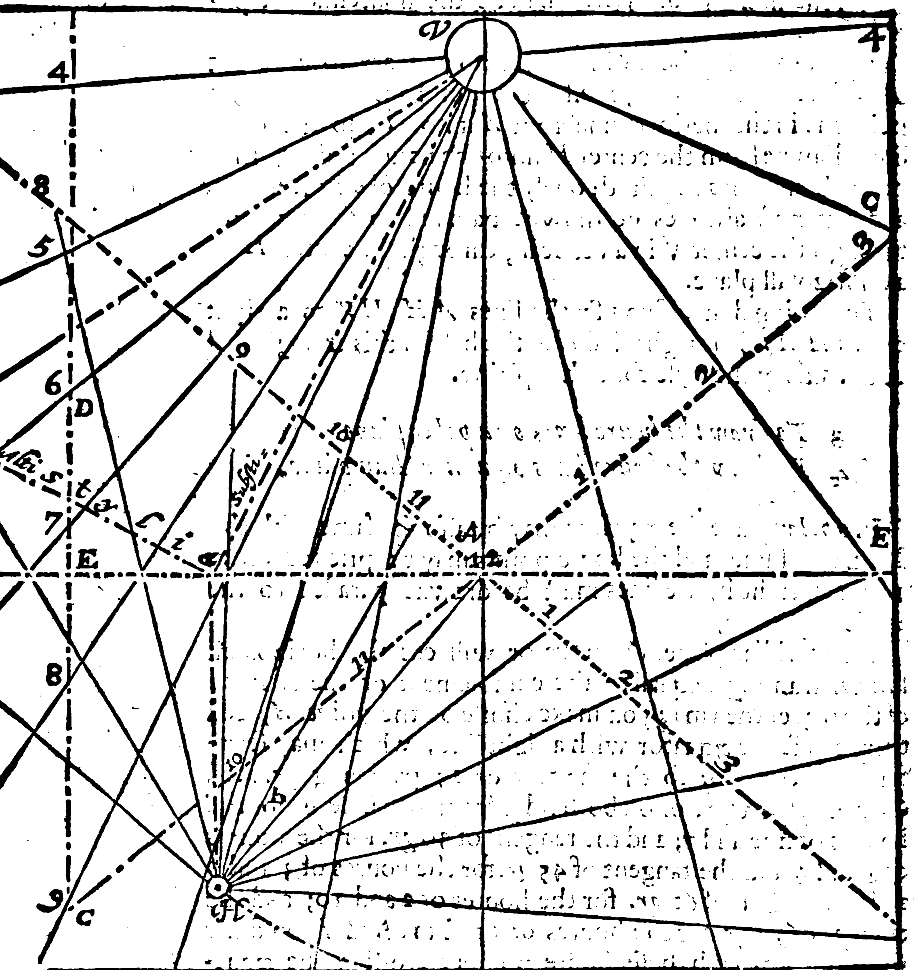
4 *To draw the houre lines on a meridian plane.*

In a *polar* plane the æquator may be also the same with the horizontall line, and the houre points may be pricked on as before, but the houre lines must be drawne parallell to the meridian.

In a meridian plane, the æquator will cut the horizontall line with an angle equall to the complement of the latitude of the place; then may you make choise of the point *A*, and there crosse the æquator with a right line, which may serve for the houre of 6: so the tangent of 15 *gr.* being pricked downe in the æquator on both sides from 6, shall serue for the houres of five and 7; and the tangent of 30 *gr.* for the houres of 8 and 4, and the tangent of 45 *gr.* for the houres of 3 and 9, and the tangent of 60 *gr.* for the houres of 2 and 10; and the tangent of 75 *gr.* for the houres of 1 and 11. And if you draw right lines through these houre points, crossing the æquator at right angles, they shall be the houre lines required.

The

The substilar will be the same with the houre of 12 in the Polar plane, and with the houre of 6 in the Meridian plane: the axis of the stile may be parallell to the substilar in either plane according to the distance of the third houre from the substilar.




The

5 *To draw the houre lines in a verticall declining plane.*

First, draw *A V* the meridian, and *A E* the horizontall line crossing one the other at right angles in the point *A.*

2 Then take out *A V*, the secant of the latitude of the place, which you may suppose to be 51 *gr.* 30 *m.* and prick it downe in the meridian line from *A* unto V.

3 Because it is a declining plane, and you may suppose it to decline 40 *gr.* Eastward, you are to make an angle of the declination upon the center *A*, below the horizontall line, and to the left hand of the meridian line, because the declination is Eastward; for otherwise it should have bin to the right hand, if the declination had bin Westward.

4 Take A *H*, the secant of the complement of the latitude out of the *Sector*, & pricke it downe in the line of declination from A unto *H*, as you did before for the semidiameter in the horizontall plane.

5 Draw a line at full length through the point A, which must be perpendicular unto A *H*, and cut the horizontall line according to the angles of declination, and it will be as the æquator in the horizontall plane.

6 Take the houre points out of the *Tangent* line in the *Sector* and pricke them downe in this æquator on both sides from the houre of 12 at A.

7 Lay your ruler, & draw right lines through the center H & each of these houre points: so have you all the houre lines of an horizontall plane, onely the houre of 6 is wanting, and that may be drawne through H perpendicular to H A.

Lastly, you are to observe and marke the intersections, which these houres lines do make with A E the horizontall line of the plane: and then if you draw right lines through the center V, and each of these intersections, they shall be the houre lines required.

The line H F drawne up to the Horizon and parallell to the meridian, will give the substilar V F: The line F G drawne Perpendicular to V F and equall to F H will give V G the axis of the stile.

## 6 To pricke downe the houre points another way.

Having drawne a right line for the æquator as before, and made choise of the point A, for the houre of 12: you may at pleasure cut of two equall lines A 10, and A 2. Then upon the distance betweene 10 and 2, make an equilaterall triangle; and you shall have B for the center of your æquator, and the line A B shall give the distance from A to 9, and from A to 3. That done take out the distance betweene 9 and 3, and this shall give the distance from B unto 8, and from 8 unto 7; and from B unto 1: and againe from B unto 4, and from 4 unto 5 and from 4 unto 11. So have you the houre points, and if you take out the distance B 1, B 3, B 5, &c. You may finde the points not onely for the halfe houres, but also for the quarters.

But if it so fall out, that some of these houre points fall out of your plane, you may helpe your selfe by the larger *tangent*, both in the verticall, and horizontall planes.

For if at the houre points of 3 and 9, in schem. *p.* 158 you draw occult lines parallell to the meridian; the distances D C betweene the houre line of 6, and the houre points of 3 and 9, will be equall to the semidiameter A V in a verticall, and A H in a horizontall plane, and if they be divided in such sort as the line A C is divided, you shall have the points of 4, and 5, and 7, and 8, with their halfes and quarters.

As in the horizontall plane, take out the semidiameter A H, and make it a parallell Radius by fitting it over in the *sines* of 90 and 90: Then take 15 *gr.* out of the larger *tangent* and lay them on the lines of *sines*, where they will reach from the center unto the sines of 15 *gr.* 32 *m.* therefore take out the parallell sine of 15 *gr* 32 *m.* and it shall give the distance from 6 unto 5, and from 6 unto 7, in your horizontall plane. That done take out 30 *gr.* out of the larger *tangent*, and lay them on the *sines*, from the center unto the sines of 35 *gr.* 16 *m.* and the parallell sine of 35 *gr.* 16 *m* shall give you the distance from 6 unto 4, and from 6 unto 8, in your horizontall plane

plane. The like may be done for the halfe houres and quarters.

So also in the verticall declining plane. If you first take out the *secant* of the declination of the plane, and prick it downe in the horizontall line from A unto E, and through E draw right lines parallell to the meridian, which will cut the former houre lines of 3 and 9, or one of them in the point C: then take out the semidiameter A V, and prick it downe in those parallells from C unto D, and draw right lines from A unto C, and from V unto D; the line V D shall be the houre of 6, and if you divide these line A C and D C, in such sort as you divided the like line D C in the horizontal plane, you shall have all the houre points required.

Or you may find the point D, in the houre of 6, without knowledge either of H or C. For having prickt downe A V in the meridian line, and A E in the horizontall line, and drawne parallels to the miridian through the points at E, you may take the *tangent* of the latitude out of the *Sector*, and fit it over in the sines of 90 and 90: so the parallell sine of the declination measured in the same *tangent* line, shall there shew the complement of the angle D V A, which the houre line of 6 maketh with the meridian; then having the point D, take out the semidiameter V A, and pricke it downe in those parallels from D unto C: so shall you have the lines D C and A C to be divided as before.

The like might be used or the houre lines upon all other planes. But I must not write all that may be done by the *Sector*. It may suffice that I have wrote something of the use of each line, and thereby given the ingenuous Reader occasion to thinke of more.

# The conclusion to the Reader.

*IT is well knowne to many of you, that this Sector was thus contrived, the most part of this booke written in latin, many copies transcribed and dispersed more then sixteene yeares since. I am at the last contented to give way that it come forth in English. Not that I thinke it worthy either of my labour or the publique view, but partly to satisfie their importunity, who not understanding the Latine, yet were at the charge to buy the instrument, and partly for my owne ease. For as it is painefull for others to transcribe my copie, so it is troublesome for me to give satisfaction herein to all that desire it. If I finde this to give you content, it shall incourage me to do the like for my* Crosse-staffe, *and some other Instruments. In the meane time beare with the Printers faults, and so I rest.*

Gresham Coll. 1. Maij. 1623. *E. G.*

**FINIS.**

# THE FIRST BOOKE OF THE *CROSSE-STAFFE.*

## CHAP. I.

### *Of the description of the Staffe.*

THe *Crosse Staffe* is an instrument well known to our Sea-men, and much used by the ancient Astronomers & others, serving Astronomically for obseruation of altitude and angles of distance in the heauens, Geometrically for perpendicular heights and distances on land and sea.

The description and seuerall vses of it are extant in print, by *Gemma Frisius* in Latine, in English by *Dr. Hood.* I differ something from them both, in the proiection of this *Staffe*, but so, as their rules may be applied vnto it, and all their propositions be wrought by it: and therefore referring the Reader to their bookes, I shall be briefe in the explanation of that which may be applied from theirs vnto mine, and so come to the vse of those lines which are of my addition, not extant heretofore.

The necessary parts of this Instrument are five: the *Staffe*, the *Crosse*, and the three *sights*. The Staffe which I made for my owne use, is a full yard in length, that so it may serue for measure.

The Crosse belonging to it is 26 inches $\frac{1}{7}$ betweene the two outward sights. If any would have it in a greater forme, the proportion betweene the Staffe and the Crosse, may bee such as 360 vnto 262.

The lines inscribed on the Staffe are of foure sots. One of them serues for measure and protraction: one for obseruation of angles: one for the Sea-cart; and the foure other for working of proportions in seuerall kindes.

The line of measure is an *inch line*, and may be knowne by his equall parts. The whole yard being divided equally into 36 inches, and each inch subdiuided, first into ten parts, and then each tenth part into halfes.

The line for obseruation of angles may bee knowne by the double numbers set on both sides of the line, beginning at the side at 20, and ending at 90: on the other side at 40, and ending at 180: and this being divided according to the degrees of a quadrant, I call it the *tangent line on the Staffe*.

The next line is the meridian of a Sea-chart, according to *Mercators* proiection from the Equinoctiall to 58 *gr*. of latitude, and may be knowne by the letter *M*, and the numbers 1.2.3.4. unto 58.

The lines for working of proportions, may be knowne by their vnequall diuisions, and the numbers at the end of each line.

1 The line of *numbers* noted with the letter N, diuided vnequally into 1000 parts, and numbred with 1.2.3.4. vnto 10.

2 The line of *artificiall tangents* is noted with the letter *T*, divided unequally into 45 degres, and numbred both wayes, for the Tangent and the complement.

3 The line of *artificiall sines*. noted with the letter *S*, divided unequally into 90 degrees, and numbred with 1.2.3.4. unto 90.

4 The line of *versed sines* for more easie finding the houre and azimoth, noted with V, divided vnequally into about 164 *gr*. 50 *m*. numbred backward with 10.20.30. vnto 164.

Thus there are seven lines inscribed on the Staffe: there are five lines more inscribed on the Crosse.

1 A Tangent line of 36 *gr.* 3 *m.* numbred by 5. 10. 15. unto 35: the midst whereof is at 20. *gr*; and therefore I call it the *tangent of* 20; and this hath respect vnto 20 *gr.* in the Tangent on the Staffe.

2 A Tangent line of 49 *gr.* 6 *m.* numbred by 5. 10. 15. unto 45; the midst whereof is at 30 *gr.* and hath respect unto 30 *gr.* in the Tangent on the Staffe, whereupon I call it the *tangent of* 30.

3. A line of *inches* numbred with 1. 2. 3. vnto 26; each inch equally subdiuided into ten parts, answerable to the inch line upon the Staffe.

4 A line of seuerall *chords*, one answerable to a circle of twelue inches semidiameter, numbred with 10. 20. 30. unto 60. another to a semidiameter of a circle of six inches; and the third to a semidiameter of a circle of three inches; both numbred with 10. 20. 30. unto 90.

5 A continuation of the *meridian* line from 57 *gr.* of latitude unto 76 *gr*; and from 76. to 84 *gr.*

For the inscription of these lines. The first for measure is equally diuided into inches and tenth parts of inches.

The tangent on the Staffe for obseruation of angles, with the tangent of 20 and the tangent of 30 on the Crosse, may all three be inscribed out of the ordinary *table of tangents.* The Staffe being 36 inches in length; the Radius for the tangent on the Staffe will be 13 inches and 103 parts of 1000: so the whole line will be a tangent of 70 *gr.* and must be numbred by their complements, and the double of their complements, the tangent of 10 *gr.* being numbred with 80 and 160.

The Radius for the tangent of 20 on the Crosse, will bee 36 inches, and the whole line betweene the sights a tangent of 36 *gr.* 3 *m.* according as it is numbred. The Radius for the tangent of 30 *gr.* on the Crosse, will be 22 inches and 695 parts of 1000: so the whole line betweene the sights will containe a tangent of 49 *gr.* 6 *m.* in such sort as they are numbred.

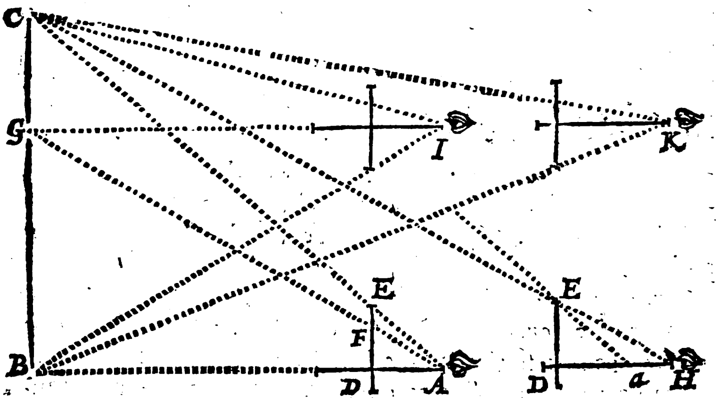
The meridian line may be inscribed out of the Table which I set downe for this purpose in the vse of the Sector.

The line of numbers may be inscribed out of the first Chiliad of Master *Briggs* Logarithmes: and the rest of the lines of proportion out of my *Canon of artificiall sines and tangents*; and in recompence thereof this booke will serue as a comment to explaine the use of my *Canon*.

## CHAP. II,

### *The use of the lines of* inches *for perpendicular heights and distances.*

IN taking of heights and distances, the Staffe may be held in such sort, that it may be even with the distance, and the Crosse parallel with the height: and then if the eye at the beginning of the Staffe shall see his markes by the inward sides of the two first sights, there will be such proportion between the distance and the height, as is betweene the parts intercepted on the Staffe and the Crosse. Which may be farther explained in these propositions.




### 1 *To find an height at one station, by knowing the distance.*

Set the middle sight unto the distance upon the Staffe, the height

height will bee found vpon the Crosse. For.

As the segment of the Staffe
vnto the segment on the Crosse:
So is the distance given,
unto the height.

As if the distance A B being knowne to bee 256 feete, it were required to find the height B C: first I place the middle sight at 25 *inches* and 6 *parts* of 10; then holding the Staffe levell with the distance, I raise the Crosse, parallell vnto the height, in such sort, as that my eye may see from *A* the beginning of the inches on the Staffe by the sight *E*, at the beginning of the inches on the Crosse unto the mark *C*: which being done, if I find 19 inches and 2 parts of 10 intercepted on the Crosse betweene the sights at *E* and *D*, I would say the height *B C* were 192 feete.

Or if the obseruation were to be made before the distance were measured, I would set the middle sight either vnto 10 inches, or 12, or 16, or 20, or, 24, or some such other number as might best be divided into severall parts, and then worke by proportion. As if in the former example the middle sight were at 24 on the Staffe, and 18 on the Crosse, it should seem that the height is $\frac{3}{4}$ of the distance; and therefore the distance being 256, the height should be 192.

## 2 *To finde an height, by knowing some part of the same height.*

As if the height from G to C were knowne to be 48, and it were required to find the whole height B C: either put the third sight or some other running sight vpon the Crosse betweene the eye and the marke G. For then

As the difference betweene the sights,
vnto the whole segment of the Crosse:
So is the part of the height given,
vnto the whole height.

If then the difference betweene the sights E and F, shall be 45, and the segment of the Crosse E D 180, the whole height *B C* will be found to be 192.

### 3 *To find an height at two stations, by knowing the difference of the same stations.*

As the difference of segments on the Staffe,
unto the difference of stations:
So is the segment of the Crosse,
unto the height.

Suppose the first station being at *H*, the segment of the Crosse *E D* were 180, and the segment of the Staffe *H D* 300: then comming 64 feete nearer vnto *B*, in a direct line, vnto a second station at *A*, and making another obseruation; suppose the segment of the Crosse *E D* were 180, as before, and the segment of the Staffe *A D* 240; take 240 out of 300, the difference of segments will be 60 parts. And

As 60 parts unto 64 the difference of stations:
So *D E* 180 unto *B C* 192 the height required.

In these three *Prop.* there is a regard to be had of the height of the eye. For the height measured, is no more then from the levell of the eye upward.

### 4 *To finde a distance, by knowing the height.*

As the segment of the Crosse,
unto the segment of the Staffe:
So is the height giuen,
unto the distance.

So the segment E D being 18, and D A 24, the height *C B* 192, will shew the distance *A B* to be 256.

### 5 *To finde a distance, by knowing part of the height.*

As the difference betweene the sights,
unto the segment of the Staffe:

So

So is the part of the height given,
unto the distance.

And thus the difference betweene *E* and *F* being 45, and the segment D A 240; the part of the height *G C* 48, will give the distance *A* B to be 256.

### 6 *To finde a distance at two Stations, by knowing the difference of the same stations.*

As the difference of segments on the Staffe;
unto the difference of stations:
So is the whole segment,
unto the distance.

And thus the segment of the Crosse being 180, the segment of the Staffe at the first station 240, at the second 300, the difference of the segments 60, and the difference of stations 64, the distance A B at the first station will be found to be 256, and the distance H B at the second station 320.

### 7 *To find a breadth by knowing the distance perpendicular to the breadth.*

This is all one with the first *Prop.* For this bredth is but an height turned sidewayes: and therefore
As the segment of the Staffe,
unto the segment of the Crosse;
So is the distance
unto the breadth.

And thus the segment of the Staffe being 24, and the segment of the Crosse 18, the distance A B 256, will give the breadth B C to be 192.

### 8 *To find a breadth at two Stations in a line perpendicular to the bredth, by knowing the difference of the same Stations.*

This is also the same with the third *Prop.* and therefore

As

As the difference of segments on the Staffe,
unto the difference of stations:
So the segment on the Crosse betweene the two sights,
unto the bredth required.

And thus the difference betweene the stations at *A* and *H* being 64, the difference of segments on the Staffe 60, the segment of the Crosse 180, the bredth B C will bee found to be 192.

In like manner may we finde the breadth *G C* for having found the bredth B C the proportion will hold.

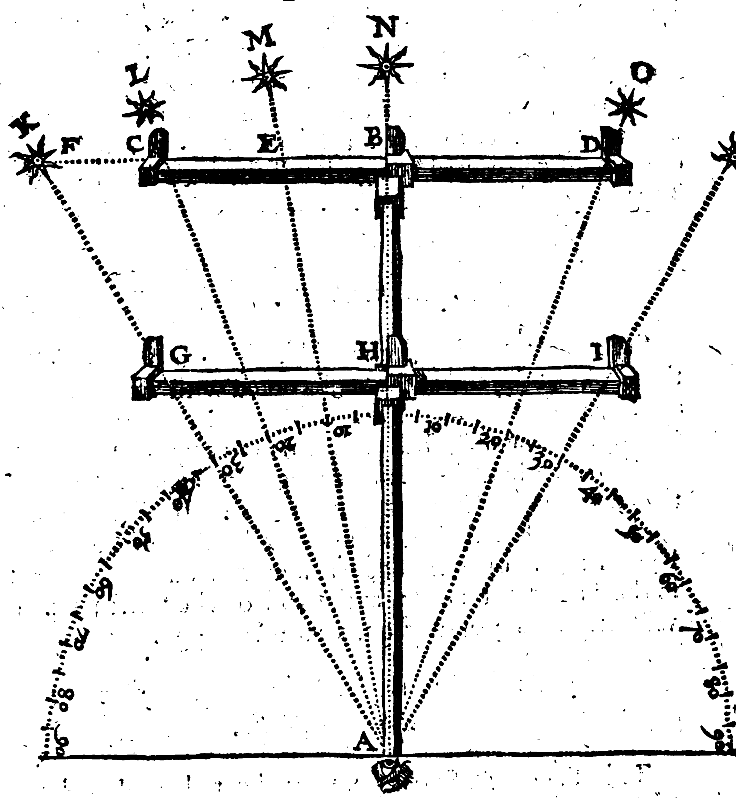
As D E is unto F E, so B *C* unto *G C*. Or otherwise,
As H *a* unto H A, so F E unto *G C*.

Neither is it materiall whether the two stations be chosen at one end of the bredth proposed, or without it, or within it, if the line betweene the stations be perpendicular unto the bredth: as may appeare if in stead of the stations at *A* and H, we make choise of the like stations at *I* and *K*.

There might be other wayes proposed to work these *Prop.* by holding the Crosse even with the distance, and the Staffe parallell with the height: but these would proove more troublesome, and those which are delivered are sufficient, and the same with those which others have set down under the name of the *Iacobs Staffe*.

CHAP.

## CHAP. III.
### *The use the Tangent lines in taking of Angles.*




1 *To finde an angle by the Tangent on the Staffe.*

IF the midle sight be alwaies set to the middle of the Crosse, noted with 20 and 30, and then the Crosse

 drawne

drawne nearer the eye, untill the markes may be seene close within the sights. For so if the eye at *A* (that end of the Staffe which is noted with 90 and 180) beholding the marks *K* and *N*, betweene the two first sights, *C* and *B*, or the markes *K* and *P* betweene the two outward sights, the Crosse being drawne downe unto H, shall stand at 30 and 60, in the Tangent on the Staffe: it sheweth the angle *K A N* is 30 *gr.* the angle *K A P* 60 *gr.* the one double to the other; which is the reason of the double numbers on this line of the Staffe: and this way will serve for any angle from 20 *gr.* toward 90 *gr.* or from 40 *gr.* toward 180 *gr.* But if the angle bee lesse then 20 *gr.* we must then make use of the Tangent vpon the Crosse

## 2 *To finde an angle by the Tangent of 20 upon the Crosse.*

Set 20 unto 20, that is, the middle sight to the middest of the Crosse at the end of the Staffe, noted with 20: so the eye at *A*, beholdng the marks *L* and *N*, close betweene the two first sights, *C* and *B*, shall see them in an angle of 20 *gr.*

If the markes shall be nearer together, as are *M* and *N*, then draw in the Crosse from *C* vnto *E*: if they be farther asunder, as are K and N, then draw out the Crosse from G vnto F; so the quantity of the angle shall be still found in the Crosse in the Tangent of 20 *gr.* at the end of the Staffe; and this will serue for any angle from 20 toward 35 *gr.*

## 3 *To finde an angle by the Tangent of 30 upon the Crosse.*

This Tangent of 30 is here put the rather, that the end of the Staffe resting at the eye, the hand may more easily remooue the Crosse: for it supposeth the Radius to be no longer then *A H*, which is from the eye at the end of the Staffe unto 30 *gr.* about 22 *inches* and 7 *parts.* Wherefore here set the middle sight unto 30 *gr.* on the Staffe, and then either draw the Crosse in or out, untill the markes be seene between

the

the two first sights; so the quantitie of the angle will be found in the Tangent of 30, which is here represented by the line *GH*; and this will serve for any angle from 0 *gr.* toward 48 *gr.*

### 4 *To obserue the altitude of the Sunne backward.*

Here it is fit to have an horizontall sight set to the beginning of the Staffe, and then may you turne your backe toward the Sun, and your Crosse toward your eye. If the altitude be vnder 45 *gr.* set the middle sight to 30 on the Staffe, and looke by the middle sight through the horizontall vnto the horizon, mouing the Crosse vpward or downeward, untill the upper sight doe shadow the upper halfe of the horizontall sight: so the altitude will be found in the Tangent of 30.

If the altitude shalbe more then 45 *gr.* set the middle sight unto the middest of the Crosse, and look by the inward edge of the lower sight throungh the horizontall to the horizon, moving the middle sight in or out, untill the upper sight doe shadow the upper halfe of the horizontall sight: so the altitude will be found in the degrees on the Staffe betweene 40 and 180.

### 5 *To set the Staffe to any angle given.*

This is the conuerse of the former *Prop.* For if the middle-sight be set to his place and degree, the eye looking close by the sights as before, cannot but see his obiect in the angle given.

### 6 *To obserue the altitude of the Sunne another way.*

Set the middle sight to the middle of the Crosse, and hold the horizontall sight downward, so as the Crosse may be parallell to the horizon, then is the Staffe verticall; and if the outward sight of the Crosse do shadow the horizontall sight, the complement of the altitude will be found in the Tangent on the Staffe.

## 7 *To obserue an altitude by thread and plummet.*

Let the middle sight be set to the middest of the Crosse, and to that end of the Staffe which is noted with 90 and 180; then having a thread and a plummet at the beginning of the Crosse, and turning the Crosse upward, and the *Staffe* toward the *Sunne*, the thread will fall on the complement of the altitude above the horizon. And this may be applied to other purposes.

## 8 *To apply the lines of inches to the taking of angles.*

If the angles be observed betweene the two first sights, there will be such proportion betweene the parts of the Staffe and the parts of the Crosse, as betweene the Radius and the Tangent of the angle.

As if the parts intercepted on the Staffe were 20 inches, the parts on the Crosse 9 inches. Then by proportion as 20 vnto 9, so 100000 unto 45000 the tangent of 24 *gr.* 14. *m.*

But if the angle shall be observed betweene the two outward sights, the parts being 20 and 9 as before, the angle will be 48 *gr.* 28 *m.* double vnto the former.

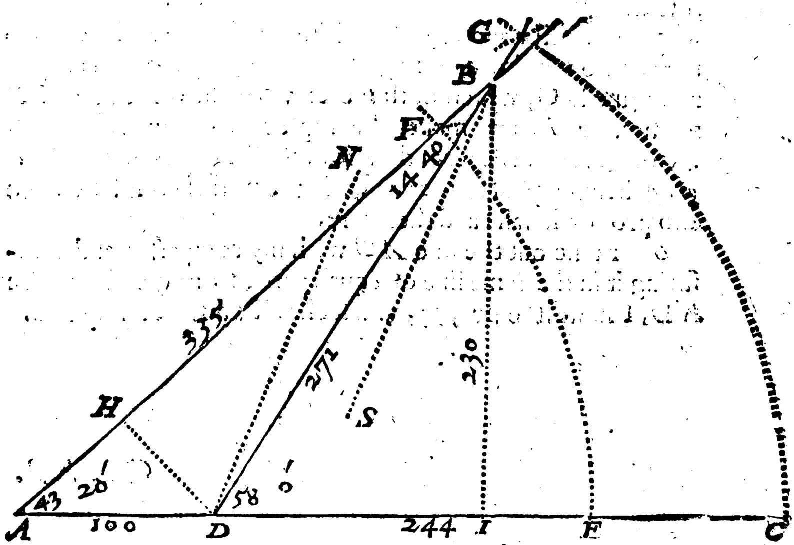
In all these there is a regard to be had to the parrallax of the eye, and his height above the Horizon in observations at Sea; to the semidiameter of the sunne, his parallax and refraction, as in the vse of other staves. And so this will be as much, or more then that whch hath beene heretofore performed by the *Crosse-Staffe.*

CHAP.

## CHAP. IIII.

### The use of the lines of equall parts ioyned with the lines of Chords.

THe lines of equall parts doe serue also for protraction, as may appeare by the former *Diagrams*; but being ioyned with the lines of Chords, which I place upon one side of the Crosse, they will farther serve for the protraction and resolution of right line triangles; whereof I will give one example in finding of a distance at two stations otherwise then in the second *Chap*.




Let the distance required be *AB*. At *A* the first station I make choise of a station line toward *C*, and obserue the angle *BAC* by the tangent lines, which may be 43 *gr*. 20 *m*; then

 having

having gon an hundred paces toward *C*, I make my second station at D, where suppose I finde the angle B D C to be 58 *gr.* or the angle *B D A* to be 122 *gr*; this being done, I may finde the distance *A B* in this maner.

1 I draw a right line *A C*, representing the station line.

2 I take 100 out of the lines of equall parts, and pricke them downe from *A* the first station unto *D* the second.

3 I open my compasses to one of the chords of 60 *gr.* and setting one foote in the point *A*, with the other I describe an occult arke of a circle intersecting the station line in *E*.

4 I take out of the same line of *chords* a chord of 43 *gr.* 20 *m.* (because such was the angle at the first station) and this I inscribe into that occult arke from *E* unto *F*, which makes the angle F A D equall to the angle obserued at the first station.

5 I describe another like arke upon the center D, and inscribe into it a chord of 58 *gr.* from *C* unto *G*, and draw the right line D G, which doth meete with the other line *A E* in the point *B*, and makes the angle B D C equall to the angle observed at the second station. So the angles in the *Diagram* being equall to the angles in the field, their sides will be also proportionall: and therefore,

6 I take out the line *A B* with my compasses, and measuring it in the same line of equall parts, from which I tooke A D, I finde it to be 335, and such is the distance required.

CHAP.

# CHAP. V.

## *The use of the Meridian line.*

1 THe Meridian line, noted with the letter *M*, may serue for the more easie division of the plane sea-cart, according to *Mercators* proiection, For if you shall draw parallell meridians, each degree being halfe an inch distant from other, the degree of this meridian line on the Staffe, shall give the like degrees for the meridians on the chart, from the Equinoctiall toward to Pole: and then if through these degrees you draw straight lines perpendicular to the meridians, they shall be parallels latitude.

If any desire to have the degrees of his chart larger then those which I have put on the Staffe, he may take these and increase them in a double, or treble, or a decuple proportion at his pleasure.

2 This *meridian* line being ioyned with the line of *chords*, may serue for the protraction and resolution of such right line triangles as concerne latitude, longitude, rumb and distance in the practice of navigation. As may appeare by this example.

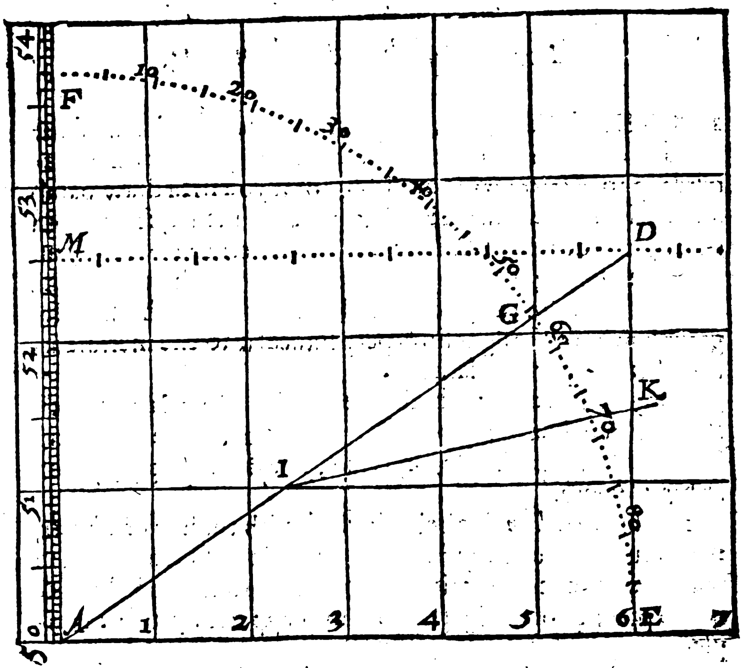
Suppose two places given, *A* in the latitude of 50 *gr.* D in the latitude of 52 *gr.* ½, the differēce of longitude between them being 6 *gr.* and let it be required to know, first what Rumbe leadeth from the one place to the other, secondly how many degrees distant they are a sunder.

1 I draw a right line *AE*, representing the parallell of the place from whence I depart.

2 I take 6 *gr.* for the difference of longitude, either out of the line of *inches*, allowing halfe an inch for every degree, or out of the beginning of the *Meridian* line; (for there the meridian degrees differ very little from the equinoctiall degrees) and these 6 *gr.* I pricke downe in the parallell from *A* to *E*.

3 In

3 In *A* and *E*, I erect two perpendiculars, A M and E D, represnting the meridians of both places.




4 I take the difference of the latitude from 50 *gr.* to 52 *gr.* 30 *m.* out of the *meridian* line, and prick it down in the meridians from *A* vnto *M*, and from E to D, and draw the right line M D for the parallell of the second place, and the right line A D for the line of distance betweene both places; so the angle M A D shall give the Rumb that leadeth from the one place to the other.

5 To find the quantitie of this angle M A D, I may either make use of the Protractor, or else of a line of *chords*, and so I open my compasses vnto one of the chords of 60 *gr.* and setting one foote in the point *A*, with the other I describe an

an occult arke of a circle, intersecting the meridian in *F*, and the line of distance in G; then I take the chord F G with my compasses, and measuring it in the same line of *chords* as before, I finde it 56 *gr* $\frac{1}{4}$: and such is the inclination of the Rumb to the Meridian, which is the first thing that was required.

6 To finde the quantitie of the line of distance A D, I take it out with my compasses, and masuring it in the meridian line, setting one foote beneath the lesser latitude, and the other foote as much above the greater latitude, I find about 4 *gr.* $\frac{1}{2}$ intercepted betweene both feet: and such is the distance upon the Rumb, which is the second thing that was required.

But if this example were protracted according to the common Sea-chart, where the degrees of the equinoctiall and meridian are both alike; the Rumb M A D would be found to be aboue 67 *gr.* and A D the distance upon the Rumbe about 6 *gr.* $\frac{1}{2}$.

Suppose farther, that having set forth from *A* toward D, upon the former Rumb of 56 *gr.* 15 *m.* *N E b E*, after the ship had run 36 leagues, the wind changing, it ran 50 leagues more upon the seuenth Rumb of *E b N*, whose inclination to the meridian is 78 *gr.* 45 *m.* And let it be required to know what longitude and latitude the ship is in, by pricking downe the way thereof upon the Chart.

Having drawne a blank chart as before, with meridians and parallels, according to the latitude of the places proposed.

1 I would make an angle *M A D* of 56 *gr.* 15 *m.* for the Rumb of *N E b E*, which is done after this manner: I open my compasses to one of the *chords* of 60 *gr.* and setting one foote in the point *A*, with the other I describe an occult arke of a circle, intersecting the meridian in *F*; then I take 56 *gr.* 15 *m.* out of the same line of *chords*, and pricke them downe from F unto G: so the right line *A G* shall be the Rumb of *N E b E*.

2 I would take 36 leagues out of the *meridian line*, ex-

tending my compasses from 50 *gr.* 51 48 *m.* or rather from much below 50 as above 51, and prick them downe upon the Rumb from *A* unto *I*; so the point, *I* shall represent the place wherein the ship was when the winde changed. And this is in the latitude of 51 *gr.* 0 *m.* and in the longitude of 2 *gr.* 21 *m.* Eastward from the meridian *A M.*

3 By the same reason, I may draw the right line *I K* for the Rumb of *E b N*, and pricke downe the distance of 50 leagues from I unto K: so the point K shall represent the place whither the ship came, after the running of these 50 leagues: and this is in the latitude of 51 *gr.* 30 *m.* and in longitude 6 *gr.* 16 *m.* Eastward from the first meridian *A M* and therefore 16 *m.* Eastward from the second meridian, E D.

But if these two courses were to be pricked downe by the common Sea-chart, the point *I* would fall in the latitude of 51 *gr.* 0 *m.* and the point *K* in the latitude of 51 *gr.* 30. *m.* But the longitude of *I* would be onely 1 *gr.* 30 *m.* and the longitude of *K* only 3 *gr.* 57 *m.* more: both these do make but 5 *gr.* 27 *m.* for the difference of longitde betweene the first Meridian A M, and the point K: whereby it should seeme that the point K is yet 33 *m.* Westward from the Meridian of the place to which the ship was bound.

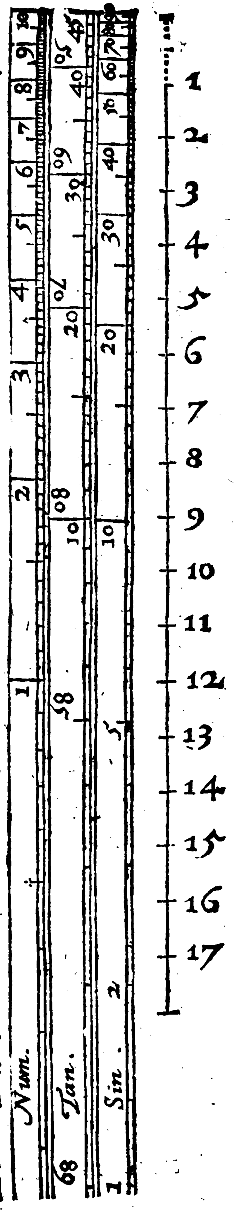
Such is the difference betweene both these charts,

CHAP.

# CHAP. VI.

## *The uſe of the line of Numbers.*

THe line of Numbers here noted with 1. 2. 3. 4 unto 10, is compleat in thoſe diviſions which are betweene 1 and 10: the other like diviſions at the beginning of the line doe ſerue rather to anſwere to the firſt degrees of the two other lines of Sines and Tangents then for any neceſſity, which is the cauſe why ſome of them are omitted. And here as in the uſe of other Scales the figures 1. 2. 3. 4. and ſet downe upon the line doe ſometimes ſignifie themſelues alone, ſometimes 10. 20. 30. 40. ſometimes 100. 200. 300, 400, and ſo forward as the matter ſhall require. The firſt figure of every number is alwaves that which is here ſet downe, the reſt muſt be ſupplied according to the nature of the queſtion.




### 1 *Having two numbers given to finde a third in continuall proportion, a fourth, a fifth, and ſo forward.*

Extend the compaſſes from the firſt number unto the ſecond; then may you turne them, from the ſecond to the third, and from the third to the fourth, and ſo forward.

Let the two numbers given bee 2 and 4.

Extend the compasses from 2 to 4, then may you turne them from 4 to 8, and from 8 to 16, and from 16 to 32, and from 32 to 64, and from 64 to 128.

Or if one foote of the compasses being set to 64, the other fall out of the line, you may set it to another 64 neerer the beginning of the line, and there the other foot will reach to 128, and from 128 you may turne them to 256, and so forward.

Or if the two first number given were 10 and 9: extend the compasses from 10 at the end of the line, backe unto 9, then may you turne them from 9 unto 8. 1, and from 8. 1 unto 7. 29. And so if the two first numbers given were 1 and 9, the third would be found to be 81, the fourth 729, with the same extent of the compasses

In the same maner, if the two first numbers were 10 and 12, you may finde the third proportionall to be 14. 4, the fourth 17. 28. And with the same extent of the compasses, if the two first numbers were 1 and 12, the third would bee found to be 144, and the fourth to be 1728.

## 2 *Having two extreme numbers given, to find a meane proportionall betweene them.*

Divide the space betweene the extreame numbers into two equall parts, and the foote of the compasses will stay at the meane proportionall. So the extreme numbers given being 8 & 32, the meane betweene them will be found to be 16, which may be prooved by the former *Prop.* where it was shewed, that as 8 to 16, so are 16 to 32.

## 3 *To find the square roote of any number given.*

The square roote is alwayes the meane proportionall betweene 1 and the number given, and therefore to be found by dividing

dividing the space betweene them into two equall parts. So the roote of 9 is 3, and the roote of 81 is 9, and the roote of 144, is 12, and the roote of 1440 almost 38.

If you suppose pricks under the number given, (as in Arithmeticall extraction) and the last pricke to the left hand shall fall under the last figure, which will be as oft as there be odde figures the unitie will be best placed at 1 in the middle of the line: so the roote and the square will both fall forward toward the end of the line. But if the last pricke shall fall under the last figure but one, which will bee as oft as there be euen figures, then the unitie may be placed at 1 in the beginning of the line and the square in the second length or rather the unitie may be placed at 10 in the end of the line of the roote and the square will both fall backward toward the middle of the line, in the second length.

### 4 *Having two extreme numbers given, to find two meane proportionals betweene them.*

Divide the space betweene the two extreme numbers given, into three equall parts. As if the extreme numbers given were 8 and 27. divide the space betweene them into three equall parts, the feete of the compasses will stand in 12 and 18.

### 5 *To find the cubique roote of a number given.*

The cubique roote is alwayes the first of two meane proportionals betweene 1 and the number given, and therefore to be found by dividing the space betweene them into three equall parts.

So the roote of of 1728 will be found to be 12. The roote of 17280 is almost 26: and the roote of 172800 is almost 56.

If you suppose pricks under the number given after the maner of Arithmeticall extraction, & the last prick to the left hand shall fall under the last figure as it doth in 1728, the unitie will be best placed at 1 in the middle of the line, and the roote the square and the cube will all fall forward toward the end of the line.

If the last pricke shall fall vnder the last figure but one as in 17280, the unitie may be placed at 1 in the beginning of the line, & the cube in the second length. or the unitie may be placed at 10 in the end of the line: and the cube in the first length; or if the cube fall out of the line you may helpe your selfe as in the first *Prop.*

But if the last prick shall fall under the last figure but two, as in 172800, then place the unitie alwaies at 10 in the ende of the line: so the roote the square and the cube will all fall backward and be found in the second length between the middle and end of the line.

## 6 *To multiply one number by another.*

Extend the compasses from 1 to the multiplicator; the same extent applied the same way, shall reach from the multiplicand to the product.

As if the numbers to be multiplied were 25 and 30: either extend the compasses from 1 to 25, and the same extent will give the distance from 30 to 750; or extend them from 1 to 30, and the same extent shall reach from 25 to 750.

## 7 *To divide one number by another.*

Extend the compasses from the divisor to 1, the same extent shall reach from the dividend to the quotient.

So if 750 were to be divided by 25, the quotient would be found to be 30.

8 *Three*

## 8 *Three numbers being given to finde a fourth proportionall.*

This golden rule, the most usefull of all others, is performed with like ease. For extend the compasses from the first number to the second, the same extent shall give the distance from the third to the fourth.

As for example, the proportion betweene the diameter and the circumference, is said to bee such as 7 to 22 : if the diameter be 14, how much is the circumference? Extend the compasses from 7 to 22, the same extent shall give the distance from 14 to 44 : or extend them from 7 to 14, and the same extent shall reach from 22 to 44.

Either of these wayes may be tried on severall places of this line; but that place is best, where the feete of the compasses may stand nerest together.

## 9 *Three numbers being given to finde a fourth in a duplicated proportion.*

*If any have daily use of this proposition he may cause another line of Numbers to be made.*

This proposition concernes questions of proportion betweene *Lines* and *Superfices*; where if the denomination be of lines, extend the compasses from the first to the second nmmber of the same denomination : so the same extent being doubled, shall give the distance from the third number unto the fourth.

The diameter being 14, the content of the circle is 154 : the diameter being 28, what may the content be? Extend the compasses from 14 to 28, the same extent doubled will reach from 154 to 616. For first it reacheth from 154 unto 308; and turning the compasses once more, it reacheth from 308, unto 616 : and this is the content required.

But if the first denomination be of the superficiall content, extend the compasses unto the halfe of the distance, betweene the first number and the second of the same denomination: so the same extent shall give the distance from the third to the fourth.

The content of a circle being 154, the diameter is 14: the content being 616, what may the diameter be? Divide the distance betweene 154 and 616 into two equall parts, then set one foote in 14, the other will reach to 28 the diameter required.

## 10 *Three numbers being given to find a fourth in a triplicated proportion.*

This proposition concerneth questions of proportion betweene *lines* and *sollids*; where if the first denomination bee of lines, extend the compasses from the first number to the second of the same denomination: so the extent being tripled, shall give the distance from the third number unto the fourth.

Suppose the diameter of an iron bullet being 4 inches, the weight of it was 9 ℔: the diameter being 8 inches, what may the waight be? Extend the compasses from 4 to 8, the same extent being tripled, will reach from 9 unto 72. For first it reacheth from 9 unto 18; then from 18 to 36; thirdly from 36 to 72. And this is the weight required.

But if the first denomination shall be of the Solid content, or of the weight, extend the compasses to a third part of the distance betweene the first number and the second of the same denomination: so the same extent shall give the distance from the third number unto the fourth.

The weight of a cube being 72 ℔, the side of it was 8 inches; the weight being 9 ℔, what may the side be? Divide the distance betweene 72 and 9, into three equall parts; then set one foote to 8, the other will reach to 4, the side required.

CHAP.

# CHAP. VII.

## *The use of the line of artificiall Sines.*

THis line of *sines* hath such use in finding a fourth proportionall, as the ordinary *Canon* of *Sines*: and the maner of finding it, is alwayes such as in this example.

As the sine of 90 *gr.* unto the sine of 30 *gr.*
So the sine of 20 *gr.* unto a fourth sine.

Extend the compasses from the Sine of 90 *gr.* unto the sine of 30 *gr.* the same extent will reach from the sine of 20 *gr.* unto the sine of 9 *gr.* 50 *m.*

Or you may extend them from the sine of 90 *gr.* unto the sine of 20 *gr.* the same extent will reach from the sine of 30 *gr.* unto the sine of 9 *gr.* 50 *m.* and such is the fourth proportionall sine required,

In like maner if the question proposed were

As the sine of 30 *gr.* unto the sine of 52 *gr.*
So the sine of 38 *gr.* to a fourth sine.

Extend the compasses in the line of *sines* from 30 *gr.* unto 52 *gr*; the same extent shall give the distance from 38 *gr.* unto 76 *gr.* Or extend them from 30 *gr.* unto 38 *gr.* the same extent will reach from 52 *gr.* unto 76 *gr.* which is the fourth proportionall sine required.

And thus may the rest of all sinicall proportions bee wrought two wayes. The minutes which are wanting in the first degree, may be supplied by the line of *Numbers*, as I shew in the next *Chapter*.

## CHAP. VIII.

### *The use of the line of artificiall Tangents.*

THis line of *Tangents* hath like use, but commonly ioyned with the line of *sines*: the manner of working by it, may appeare by this example.

As the Tangent of 38 *gr.* 30 *m.*
is the Tangent of 23. *gr.* 30. *m.*
So the Sine of 90 *gr.*
to a fourth Sine.

This *Prop.* and such others upon two lines, may bee wrought two wayes. For extend the compasses from the Tangent of 38 *gr.* 30 *m.* to the Tangent of 23 *gr.* 30 *m*; the same extent shall give the distance from the sine of 90 *gr.* to the sine of 33 *gr.* 8 *m.* Or else extend them from 38 *gr.* 30. *m.* in the Tangents unto 90. *gr.* in the line of *Sines*; the same extent from the Tangent of 23 *gr.* 30 *m.* shall reach to the sine of 33 *gr.* 8 *m.* which is the fourth proportionall sine required.

And this crosseworke in many cases is the better, in regard the tangents which should passe on from 40 *gr.* to 50 *gr.* and so forward, doe turne backe at 45 *gr.* These two lines of *Sines* and *Tangents*, may serue for the resolution of all sphericall triangles, according to those Canons which I have set downe in the use of the Sector. Onely two cases the 19 and 20 will bee more easily resolued by that which followeth in the last Chapter of this booke.

Or if at any time one meete with a *Secant*, Let him account the sine of 80 *gr.* for a *Secant* of 10 *gr.* and the sine of 70 *gr.* for a *Secant* of 20 *gr.* and so take the sine of of the complement in stead of the *Secant.*

As if the proposition were,
As the Radius to the secant of 51 *gr.* 30. *m.*
So the sine of 23 *gr.* 30. *m.*
to a fourth sine.

Extend the compasses from the Radius that is the sine of 90 *gr.* to the sine of 38 *gr.* 30 *m.* the same extent will give the distance from the sine of 23. *gr.* 30 *m.* both to the sine of 14. *gr.* 22 *m* to the sine of 39 *gr.* 50 *m.* But in this case, the sine of 39 *gr* 50 *m.* is the fourth required. For the first number being lesse then the second, that is, the Radius lesse then the secant, the sine of 23 *gr.* 30 *m.* which is the third, must also be lesse then the fourth.

If the fourth proportionall number shall at any time fall out of the line, by reason of the minutes that are wanting in the first degree, it may be supplied by resoluing the third number given into minutes, and then working by the line of numbers.

As if the proposition were,

As the Sine of 90 *gr.*
to the Sine of 10 *gr.*
So the sine of 5 *gr.*
to a fourth sine.
Or the Tangent of 5 *gr.*
to a fourth Tangent.

Extend the compasses from the sine of 90 *gr.* unto the sine of 10 *gr.* the same extent will reach from the Sine or Tangent of 5 *gr.* beyond the end of the staffe. Wherefore I resolve these 5 *gr.* into 300 minutes and find the former extent to reach in the line of numbers from 300 *m.* unto 52 *m.* and such is the fourth proportionall required.

If the the extent from the sine of 90 *gr.* unto the sine of 10 *gr.* be too large for the compasses we may use the Sine of

5 *gr.* 44 *m.* instead of the signe of 90 *gr.*

And so extending the compasses from the sine of 5 *gr.* 44 *m.* unto the sine of 10 *gr.* we shall finde the same extent to reach in the line of Numbers from 300 unto 52 as before.

And by the same reason wee may use the tangent of 5 *gr.* 43 *m.* instead of the tangent of 45 *gr.* as I farther shew in the next *Chapter.*

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## CHAP. IX.

### *The use of the line of Sines and Tangents ioyned with the line of Numbers.*

THe lines of *Sines* and *Tangents* another like use joyned with the the line of *Numbers*, especially in the resolution of right line triangles, where the angles are measured by degrees and minutes, and the sides measured by absolute numbers, whereof I will set downe these propositions.

#### 1 *Having three angles and one side, to finde the two other sides.*

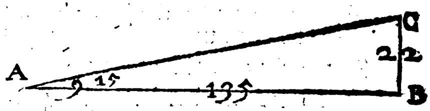
If it be a rectrangle triangle wherein one side about the right angle being knowne it were required to finde the other. This may be found by the line of Tangents and line of Numbers. For

As the Tangent of 45 *gr.*
to the tangent of the angle opposite to the side required,
So the number belonging to the side given

to

to the number belonging to the side required.

As in the rectangle A B C knowing the angle C A B to




be 9 *gr.* 15 *m.* and the side A B to be 135 parts; if it were required to finde the other side B C about the right angle.

Extend the compasses from the Tangent of 45 *gr.* unto the Tangent of 9 *gr.* 15 *m.* the same extent will reach in the line of Numbers from 135 unto 22, and such is the length of the side B C. Or in the crosse worke extend the compasses from the Tangent of 45 *gr.* unto 135 in the line of numbers the same extent will reach from the Tanget of 9 *gr.* 15 *m.* unto 22 in the line of Numbers.

If this extent from the tangent of 45 *gr.* to 9 *gr.* 15 *m.* or 135 parts bee too large for the compasses, you may use the Tangent of 5 *gr.* 43 *m.* instead of the Tangent of 45 *gr.* because both alike answer to 10. &c, parts in the line of Numbers.

And then either extend the compasses from 5 *gr.* 43 *m.* unto 9 *gr.* 15 *m.* in the line of Tangents the same extent will reach from 135 unto 22 in the line of numbers, or else extend them from the tangent of 5 *gr.* 43 *m.* unto 135 in the line of Numbers the same extent will reach from the Tangent of 9 *gr.* 15 *m.* unto 22 in the line of Numbers as before.

In like manner if the same rectangle A B C knowing the angle A C B to be 80 *gr.* 45 *m.* and the side B C to bee 22 parts, it were required to finde the other side B A. You may use the Tangent of 84 *gr.* 17 *m.* instead of the Tangent of 45 *gr.* and so the side B A will be found to bee 135 parts.

This holdeth for finding of the sides of rectangle triangles but generally in all triangles, whither they be right or obtuse angles having three angles and one side wee may finde the two other sides by the line of *Sines* and line of *Numbers*.

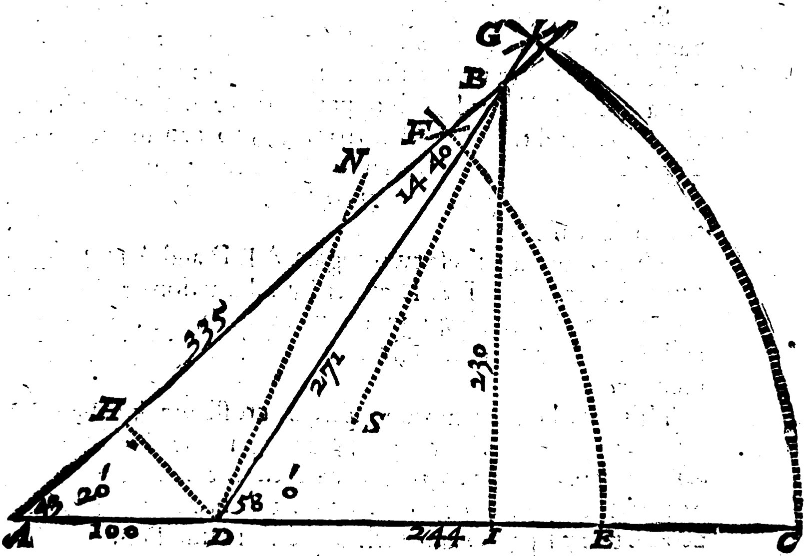
As the Sine of angle opposite to the side given,
is to the number belonging to that side given,
So the Sine of the angle opposite to the side required,
to the number belonging to the side required.

As in the example of the fourtth *Chapter.* of this booke, where knowing the distance betweene two stations at *A* and *D* to be 100 paces, the angle *B A C* to be 43 *gr.* 20 *m* and the angle *B D C* to be 58 *gr.* it was required to find the distance *A B.*

First having these two angles, I may finde the third angle *A B D* to be 14 *gr.* 40 *m.* either by substraction or by complement unto 180. Then in the Triangle *B A D*, I have three angles, and one side, whereby I may finde both *A B* and *D B.*

I know the angle *A B D* opposite to the measured side *A D* to bee 14 *gr.* 40 *m.* and the angle *A D B* opposite to the side required, to bee 122 *gr:* wherefore I extend the compasses in the line of *Sines* from 14 *gr.* 40 *m.* unto 122 *gr.* or (which is all one) to 58 *gr.* (for after 90 *gr.* the sine of 80 *gr.* is also the sine of 100 *gr.* and the sine of 70 *gr.* the sine of 110 *gr.* and so in the rest) so shall I finde the same extent to reach in the line of *numbers*, from 100 unto 335. And such is the distance required betweene *A* and *B:*

In




In like maner if I extend my compasses from the sine of 14 *gr.* 40 *m.* to the sine 43 *gr.* 20. *m.* the same extent will reach in the line of *Numbers* from 100 to 271. And such is the distance betweene D and B.

Or in crosse worke, I may extend the compasses from 14 *gr.* 40 *m.* in the *Sines*, unto 100 parts in the line of *Numbers*: so the same extent will give the distance from 58 *gr.* to 335 parts, and from 43 *gr.* 20 *m.* to 271 parts.

## 2 *Having two sides given, and one angle opposite to either of these sides, to finde the other two Angles and the third side.*

As the side opposite to the angle given,
is to the sine of the angle given:
So the other side given,
to the sine of that angle to which it is opposite.

So

So in the former triangle, having the two sides *AB* 335 paces, and A D 100 paces, and knowing the angle A D B, which is opposite to the side *A* B, to be 122 *gr.* I may find the angle A B D, which is opposite to the other side A D. For if I extend the compasses from 335 to 100 in the line of *Numbers*, I shall finde the same extent to reach in the line of *Sines* from 122 *gr.* to 14 *gr.* 40 *m*; and therefore such is the angle A B D.

Then knowing these two angles A B D and A D B, I may find the third angle B A D either by subtraction or by complement to 180, to be 43 *gr.* 20 *m.*; and having three angles and two sides, I may well finde the third side D B, by the former. *Prop.*

This may be done more readily by crosse worke. For if I extend the compasses from 335 parts, in the line of *numbers*, to the sine of 122 *gr.* the same extent will reach from 100 parts to the sine of 14 *gr.* 40 *m.* and backe from 43 *gr.* 20 *m.* to 271 parts; and such is the third side D B.

### 3 *Having two sides and the angle betweene them, to find the two other angles and the third side.*

If the angle contained betweene the two sides bee a right angle, the other two angles will be found readily by this Canon.

As the greater side given,
is to the lesser side:
So the tangent of 45. *gr.*
to the tangent of the lesser angle.

So in the rectanle triangle *A I B*, knowing the side *A I* to be 244, and the side *I B* to be 230: if I extend the compasses from 244 to 230 in the line of *numbers*, the same extent will reach from 45 *gr.* to about 43 *gr.* 20 *m.* in the line of of Tangents; and such is the lesser angle *B A I*, and the complement 46 *gr.* 40 *m* shewes the greater angle *A B I*. The angles being knowne, the third side A B may bee found by the first *Prop.*

So likewise in the example of the third Chapter of this booke, concerning taking of angles by the line of Inches, where the parts intercepted on the Staffe being 20 Inches, and the parts on the Crosse 9 Inches, it was required to finde the angle of the altitude. For,

I may extend the compasses in the line of *Numbers*, from 20 unto 9, the same extent will reach in the line of *Tangents*, from 45 *gr.* to 24 *gr.* 14 *m.*

Or in crosse worke,

I may extend the compasses from 20 parts in the line of *Numbers* to the tangent of 45 *gr*; the same extent shall give the distance from 9 parts unto the Tangent of 24 *gr.* 14 *m.*

And such is the angle of the altitude required.

If the parts intercepted on the staffe being 20 inches and the parts on the Crosse 9 tenth parts of an inch it were required to finde the angle of the altitude. Here the angle would be much lesse, and the 9 would fall out of the line of numbers.

To supplie this defect, I use the Tangent of 5 *gr.* 43. *m.* instead of the tangent of 45 *gr.* And then if I extend the compasses in the line of Numbers from 20 unto 9 the same extent will reach in the line of Tangents from 5 *gr.* 43 *m.* unto 2 *gr.* 35 *m.*

Or in Crosse worke if I extend them from 20 partes in the one line of numbers unto the Tangent of 5 *gr.* 43 *m.* the same extent will give the distance from 9 in the line of Numbers unto the Tangent of 2 *gr.* 35 *m.*

And such is this angle of the altitude required.

But if it be an oblique angle that is contained betweene the the two sides given, the triangle may be reduced into two rectangle triangles and then resolued as before.

As in the triangle ADB, where the side A B is 335, and the side AD 100, and the angle B A D 43 *gr.* 20 *m:* if I let downe the perpendiculor D H upon the side A B, I shall have two rectangle triangles, A H D, D H B; and in the rectangle A H D, the angle at *A* being 43. *gr.* 20 *m.* the other angle A D H will be 46. *gr.* 40 *m*; and with these angles and the side *AD*, I may find both *AH* and DH, by the first *Prop.*

Then taking *AH* out of *AB*, there remaines H B for the side of the rectangle D H B; and therefore with this side H B and the other side H D, I may finde both the angle at B, and the third side D B, as in the former part of this *Prop.*

Or I may find the angles required, without letting downe any perpendicular, For,

As the summe of the sides,
is to the difference of the sides:
So the tangent of the halfe summe of the opposite angles,
to the Tangent of halfe the difference betweene those angles.

As in the former triangle *AD*B, the summe of the sides *A*B, *A*D, is 435, and the difference betweene them 235; the angle contained 43 *gr.* 20. *m*; and therefore the summe of the two opposite angles 136 *gr.* 40 *m.* and the halfe summe 68 *Gr.* 20 *m.* Hereupon I extend the compasses in the line of *Numbers* from 455 to 235, and I finde them to reach in the line of *Tangents* from 68 *Gr.* 20 *m.* unto 53 *Gr.* 40 *m*; and such is the halfe difference betweene the opposite angles at B and *D*. This halfe difference being added to the halfe sum, doth give 120 *Gr.* for the greater angle *AD* B: and being subtracted, it leaveth 14 *Gr.* 40 m. for the lesser angle *A* B D. Then the three angles being knowne, the third side B D may be found by the first Prop.

A 4 Having

4 *Having the three sides of a right line triangle, to find the three angles.*

Let one of the three sides given be the base, but rather the greater side, that the perpendicular may fall within the triangle; then gather the summe, and the difference of the two other sides, and the proportion will hold.

As the base of the triangle,
is to the summe of the sides:
So the difference of the sides
to a fourth, which being taken forth of the base, the perpendicular shall fall on middle of the remainder.

As in the former triangle A D B, where the base A B is 335, the summe of the sides A D and D B 371, and the difference of them 171. If I extend the compasses in the line of *Numbers* from 335 unto 371, I shall finde the same extent to reach from 171 unto 189 4. This fourth number I take out of the base 335. 0, and the remainder is 145. 6, the halfe whereof is 72. 8, and doth shew the distance from A unto *H*, where the perpendicular shall fall, from the angle D, upon the base *A* B, dividing the former triangle A D B into two right angle triangles, D H A and D H B, in which the angles may be found by the second *Prop.*

And this may suffice for the right line triangles. But for the more easie protraction of these triangles, I will set downe one proposition more concerning *chords*.

5 *Having the semidiameter of a circle, to finde the Chords of every Arke.*

**As the sine of the Semiradius of 30 *gr.***
**to the sine of halfe the arke proposed :**
**So is the semidiamiter of the circle given,**
**to the chord of the same arke.**

As if in the protracting the former triangle A D B, it were required to find the length of a chord of 43 *gr.* 20 *m.* agreeing to the semidiameter *A E*, which is known to be 3 inches. The halfe of 43 *gr.* 20. *m.* is 21 *gr.* 40 *m*; wherefore I extend the compasses from the sine of 30 *gr.* to the sine of 21 *gr.* 40 *m.* and I finde the same extent to reach in the line of *Numbers* from 3. 000 *parts* to 2. 215; which shewes, that the semidiameter being 3 inches, the chord of 43 *gr.* 20 *m.* will be 2 *inches* and 215 parts of 100.

In like maner the chord of 58 *gr.* agreeing to the same semidiameter, would be found to be 2 inches and 909 parts. For the halfe of 58 being 29; if I extend the compasses in the line of Sines from 30 *gr.* to 29 *gr.* the same extent will reach in the line of *Numbers* from 3. 000. unto 2. 909.

Or in crosse worke, if I extend the compasses from the *Sine* of 30 *gr.* to 3. 000 in the line of *Numbers*, I shall finde the same extent to reach from 21 *gr.* 40 *m.* to 2. 215 *parts*, and from 29 *gr.* to 2 909 *parts*, and from 7 *gr.* 20 *m.* to 765. *parts*; for the chord of 14 *gr.* 40 *m.* for the third angle A B D.

CHAP.

## CHAP. X.

### *The use of the line of versed Sines.*

THis line of *versed Signes* is no necessary line. For all triangles, both right lined and sphericall, may be resolued by the three former lines of Numbers, Sines and Tangents; yet I thought good to put it on the *Staffe* for the more easie finding of an angle having three sides, or a side having three angles of a sphericall triangle given.

Suppose the three sides to be, one of them 100 *gr.* the other 78 *gr.* and the third 38 *gr.* 30 *m.* and let it be required to find the angle, whose base is 110 *gr.*

I first adde them together, and from halfe the summe subtract the base, noting the difference after this maner.

| | | |
|---|---|---|
| The base | 110 *gr.* | 0 *m.* |
| The one side | 78 | 0 |
| The other side | 38 | 30 |
| The summe of all three | 226 | 30 |
| The halfe summe | 113 | 15 |
| The difference | 3 | 15 |

For so the proportion will holde,

1 As the Radius the Sine of the one side
So the Sine of the other Side to the fourth Sine.

2 As this fourth Sine to the Sine of the halfe Summe
So the Sine of the difference to a seventh Sine.

3 The meane proportionall betweene this seventh sine and the Radivs will shew the sine of the complement of halfe the angle required.

 This

This done, I come to the Staffe, and extend the compasses from the sine of 90 *gr.* to the sine of 78 *gr.* which is one of the sides; and applying this extent from the line of the other side 38 *gr.* 30 *m.* I find it to reach to a fourth sine, about 37 *gr.* 30 *m.* From this fourth sine of 37 *gr.* 30 *m.* I extend the compasses againe, to the sine of the halfe summe 113 *gr.* 15 *m.* (which is all one with the sine of 66 *gr.* 45 *m.*) and this second extent will reach from the sine of the difference 3 *gr.* 15 *m.* to the sine of 4 *gr.* 54 *m.*

Then to finde the meane proportionall sine betweene this seventh sine of 4 *gr.* 54 *m.* and the sine of 90 *gr.* I might divide the space betweene them into two equall parts, and so I should finde the compasses to stay at 17 *gr.* whose complement is 73 *gr.* and the double of 73 *gr.* is 146 *gr.* the angle opposite to 110 *gr.* which was required.

But because this division is somewhat troublesome I have therefore added this line of *versed Sines* that having found the seuenth Sine you might looke over against it and there finde the angle. And so in this example having found the seventh sine to be 4 *gr.* 54. *m.* over against this sine you shall finde 146 *gr.* in the line of *versed Sives* for the angle required as before.

CHAP.

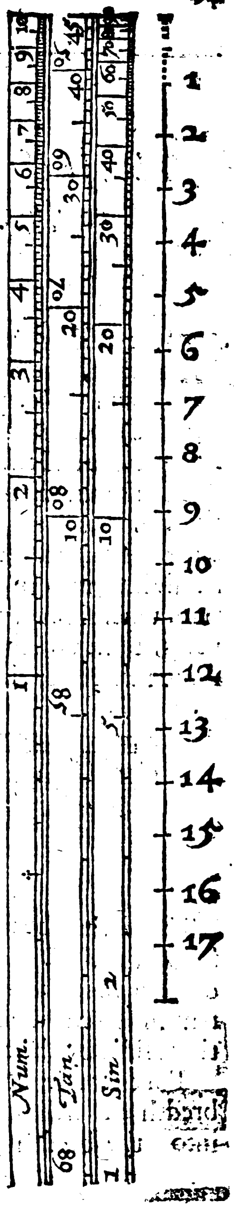
# THE SECOND BOOKE OF THE *CROSSE-STAFFE.*

## *Of the use of the former lines of proportion more particularly exemplified in severall kind.*

THe former Booke containing the generall use of each line of proportion, may bee sufficient for all those which know the rule of *Three*, and the doctrine of triangles.

But for others, I suppose it would be more difficult to finde either the declination of the Sunne, or his amplitude, or the like, by that which hath beene said in the use of the line of *Sines*, unlesse they may haue the particular proportions, by which such propositions are to be wrought.

And therefore for their sakes I have adjoyned this second booke, containing severall proportions for propositions of ordinary use, and set them downe in such order, that the Reader considering which is the first of the three numbers giuen, may easily apply them to the Sector, and also resolue them by Arithmetique, beginning with those which require helpe onely of the line of *Numbers.*



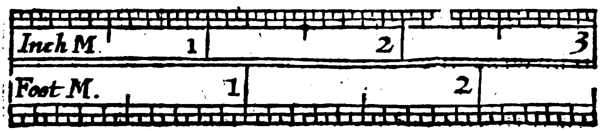

CHAP.

# CHAP. I.

## *The use of the line of Numbers in broade measure, Such as boord, glasse, and the like.*

THe ordinary measure for bredth and length are feete and inches, each foote divided into 12 inches, and euery inch into halues and quarters, which being parts of seuerall denominations, doth breed much trouble both in Arithmeticke and the use of instuments.

For the auoiding whereof, where I may prevaile I give this cousell, that such as are delighted in measure would use seueral lines, first a line of inch measure, wherin euery inch may be divided into 10 or 100 parts; secondly a line of foot measure, wherein every foote may be divided into 100 or 1000 parts, both which lines may be set on the same side of a two foote ruler, after this or the like manner.




Then if they be to give the content of any superficies or solid in inches, they may measure the sides of it by the line of inches and parts of inches; but if they be to give the content in feete, it would be more easie for them to measure those sides by the foote line and his parts.

For example, let the length of a plane be 30 inches, and the bredth 21 inches and $\frac{6}{10}$ of an inch; this length multiplied into the bredth, would give the content to bee 648 inches:

inches: but if I were to finde the content of the same plane in feet, I would measure the sides of it by the foote line and his parts; so the length would proue to bee 2 feete $\frac{50}{100}$, and the bredth 1 foote $\frac{80}{100}$, and the length multiplied by the bredth, cutting off the foure last figures, for the foure figures of the parts, would give content to bee 4.5000, which is 4 foote and 5000 parts of a foote, divided into 10000 parts.

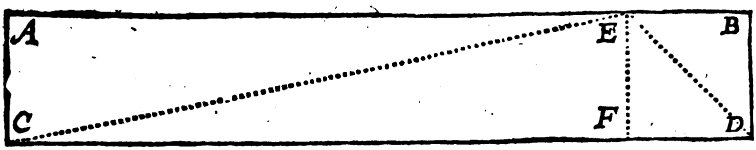
| | |
|---|---|
| 21.6 | 2.50 |
| 30.0 | 1.80 |
| 648.00 | 20000 |
| | 250 |
| | 4.5000 |

¶ The like reason holdeth for yards and elnes, and all other measures divided into 10, 100, or 1000 parts.

This being presupposed, the worke will be more easie both by Arithmeticke and the line of *Numbers*, as may appeare by these propositions

1 *Having the bredth and length of an oblong superficies given in inch-measure, to finde the content in inches.*

As 1 inch unto the bredth in inches.
So the length in inches unto the content in inches.




Suppose in the plane A D, the bredth A C to be 30 inches; and

and the length *A B* to be 183 inches; extend the compasses from 1 unto 30, the same extent will reach from 183 unto 5490; or extend them from 1 unto 183, the same extent will reach from 30 unto 5490. So both wayes the content required is found to be 5490 inches.

As 1 unto 30: so are 183 unto 5490.

### 2. *Having the breadth and length of any oblong superficies given in inches, to finde the content in feete.*

As 144 inches vnto the breadth in inches:
So the length in inches unto the content in feet.

And thus in the former plane A D, working as before, the content will be found to bee 38. 125, which is 38 foote and $\frac{1}{8}$ of a foote.

As 144 unto 30: so are 183 unto 38. 125.

### 3. *Having the length and breadth of any oblong superficies given in foote measure, to finde the content in feet.*

As 1 foote unto the bredth in foote measure:
So the length in feete unto the content in feet.

And thus in the former plane A D, the bredth will be 2 feete 50 parts, and the lengt 15 foote 25 parts; then working as before, the content will be found to be 38. 125.

As 1 unto 2. 50: so are 15. 25 unto 38. 125.

### 4 *Having the bredth of any oblong superficies given in inches and the length in foote measure, to find the content in feet.*

As 12 inches to the bredth in inches:
So the length in feete to the content in feet.

So

So also in the former plane, the content will be found to be 38. 125.

As the 12 unto 30: so are 15. 25 unto 38. 125.

5 *Having the breadth of an oblong superficies given in inches, to finde the length of a foot superficiall in inch measure.*

As the breadth in inches, unto 144 inches:
So 1 foote vnto the length in inch measure.

So the bredth being 30 inches, the length of a foote will be found to be 4 inches 80 parts, the length of two feet 9 inches 60 parts.

As 30 vnto 144: so are 1 unto 4. 80.

6 *Having the bredth of an oblong superficies given in feet, to find the length of a foote superficiall in foot measure.*

As the bredth in foote measure to 1 foote:
So the number of feet to the length in foot measure.

So the breadth being 2 foote 50 parts, the length of a foot will be found to be 40 parts, the length of 2 feet 80 parts, and the length of 3 feete 1 foot 20 parts, &c.

As 250 unto 1: so are 1 unto 0. 40.

7 *Having the length and breadth of an oblong superficies, to finde the side of a sqare equall to the oblong.*

Divide the space betweene the length and the bredth into two equall parts, and the foote of the compasses will stay at the side of the square.

So the length being 183 inches, and the bredth 30 inches, the side of the square wil be found to be almost 74 inches and 10 parts of 100.

Or the bredth being 2 foote and 50 parts, the length 15 foote and 25 parts, the side of the square will be found to be about 6 feet and 17 parts.

As 30 unto 74. 10. so are 74. 10 unto 183. 027.
And as 2. 50 unto 6. 174: so are 6. 174 unto 15. 247.

8 *Having the diameter of a circle, to find the side of a square equall to that circle.*

As 10000 to the diameter:
So 8862 unto the side of the square.

So the diameter of a circle being 15 inches, the side of the square will be found about 13 inches and 29 parts.

As 10000 unto 8862: so are 15 unto 13. 29.

9 *Having the circumference of a circle to finde the side of a square equall to the same circle.*

As 10000 to the circumference:
So 2821 to the side of the square.

So the circumference of a circle being 47 inches 13 parts, the side of the square will be about 13 inches 29 parts.

As 10000 unto 2821: so are 47. 13 unto 13. 29.

10 *Having the diameter of a circle, to finde the circumference.*

11 *Having the circumference of a circle, to finde the diameter.*

As 1000 to the diameter:
So 3142 to the circumference.

So

So the diameter being 15 inches, the circumference will be found about 47 inches 13 parts: or the circumference being 47. 13, the diameter will be 15.

## CHAP. II.

### *The use of the line of Numbers in the measure of land by pearch and acres.*

1 *Having the bredth and length of an oblong superfices, given in perches, to finde the content in perches.*

As 1 perch to the bredth in perches:
So the length in perches to the content in perches.

So in the former plane A D, if the bredth *A C* be 30 perches, and the length *A B* 183 perches, the content will be found to be 5490 perches.

2 *Having the length and breadth of an oblong superficies given in perches, to finde the content in acres.*

As 160 to the bredth in perches:
So the length in perches to the content in acres.

So in the former plane *A D*, the content will be found to be 34 acres, and 31 centesms or parts of an 100.
As 160 unto 30: so are 183 unto 34. 31.

To augment a superficies in a proportion,
To diminish a superficies in a proportion given.

 3 Ha-

## 3. *Having the length and bredth of an oblong superficies given in chaines, to finde the content in acres.*

It being troublesome to divide the content in perches by 160, we may measure the length and breadth by chaines, each chaine being 4 perches in length, and divided into 100 linkes, then will the worke be more easie in Arithmetique. For

As 10 to the bredth in chaines:
So the length in chaines to content in acres.

And thus in the former plane A D, the breadth *A C* will be 7 chaines 50 linkes, and the length *A B* 45 chaines 75 links; then working as before, the content will bee found as before, 34 acres 31 part.

## 4 *Having the perpendicular and base of a triangle given in perches, to find the content in acres.*

If the perpendicular goe for the bredth, and the base for the length, the triangle will be the halfe of the oblong, as the triangle C E D is the halfe of the oblong A D, whose content was found in the former *Prop.* Or without halfing,

As 320 to the perpendicular:
So the base to the content in acres.

So in the triangle C E D, the perpendicular being 30, and the base 183, the content will be found to be about 17 acres and 15 parts.

## 5 *Having the perpendicular and base of a triangle given in chaines, to find the content in acres.*

As 20 to the perpendicular:
So the base to the content in acres.

And

And so the triangle C E D, the perpendicular *E F* being 7.50, and the base C D 45.75, the content will be found as before to be about 17 acres 15 parts.

### 6. *Hauing the content of a superficies after one kind of perch, to finde the content of the same superficies according to another kind of pearch.*

As the length of the second perch
to the length of the first perch:
So the content in acres to a fourth number;
and that fourth to the content in acres required.

Suppose the plane A D measured with a chaine of 66 feete, or with a pearch of 16 feete and an halfe, contained 34 acres 31 parts; and it were demanded how many acres it would containe if it were measured with a chaine of 18 foot to the perch: these kind of propositions are wrought by the backward rule of *three*, after a duplicated proportion. Wherefore I extend the compasses from 16.5 unto 18.0, and the same extent doth reach backward, first from 34.31 to 31.45, and then from 31.45 to 28.84, which shewes the content to be 28 acres 84 parts.

### 7. *Having the plot of a plaine with the content in acres, to finde the scale by which it was plotted.*

Suppose the plane, A D contained 34 acres 31 centesmes; if I should measure it with a scale of 10 in the inch, the length *A B* would be 38 chaines and about 12 centesmes, and the bredth *A C* 6 chaines and 25 centesmes; and the content would be found by the third *Prop.* of this Chapter, to be about, 23 acres 82 parts, wheras it should be 34 acres 31 parts.

Where-

Wherefore I divide the distance betweene 23. 82, and 34. 31, upon the line of *numbers* into two equall parts; then setting one foote of the compasses upon 10, my supposed scale, I find the other to extend to 12, which is the scale required.

## 8 *Having the length of the furlong to finde the breadth of the acre.*

As the length in perches to 160.
So 1 acre to the bredth in perches.

So the length of the furlong being 40 perches, the bredth of an acre will be found to be 4 perches. If the length be 50 the bredth for one acre must be 3. 20. the bredth for two acres 6, 40.

Or if the length be measured by chaines.

As the length in chaines unto 10
So 1 acre to his bredth in chaine measure.

So the length of the furlong being 12 Chaines 50 Linkes, the bredth for one acre will bee found to be 80 Links, the bredth for two acres 1 Chaine 60 Links.

As 12. 50 unto 10: so 1 unto 0. 80.

Or if the length be measured by feet measure.

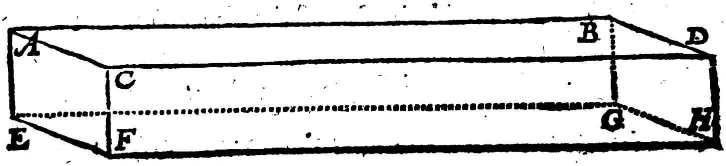
As the length in feete unto 43560.
So 1 acre to his bredth in foot measure.

So the length of the furlong being 792 feet, the breadth for one acre will be found to be 55 feet, the bredth for two acres 110 feet.

CHAP.

# CHAP. III.

## *The use of the line of Numbers in solid measure, such as stone, timber, and the lke.*




### 1 *Having the side of a square equall to the base of any solid given in inch measure to find the length of a foot solid in inch measure.*

THe side of a square equall to the base of a solid, may bee found by dividing the space betweene the length and bredth into two equall parts, as in the 7 *Prop.* of broad measure. Then

As the side of the square in inches to 41.57:
So is 1 foote to a fourth number;
and that fourth to the length in inches.

So in the solid *A H*, the side of the square equall to the base *E C*, being about 25 inches 45 parts, the length of a foot solid will be found about 2 inches 67 parts, and the length of two foot solid 5 inches 33 parts.

As 25.45 vnto 41 57: so 1.00 unto 1. 63:
and so are 1. 63 unto 2. 67.

2 *Having the side of a square equall to the base of any solid given in foote measure, to find the length of a foot solid in foot measure.*

As the side of the square in feet unto 1:
So is 1 unto a fourth number;
And that fourth to the length in foot measure.

So in the solid *AH*, the side of the square equall to the base *E C*, being about 2 foote 120 parts, the length of a foot solid will be found about 222 parts of a foote.

As 2.120 unto 1.000: so 1.000 unto 0.471:
and so are 471 unto 222.

3 *Having the bredth and depth of a squared solid given in foot measure, to finde the length of a foot solid in foote measure.*

As 1 unto the bredth in foote measure:
So the depth in feet to a fourth number;
which is the content of the base in foot measure. Then

As this fourth number unto 1:
So 1 unto the length in foote measure.

So in the solid *A H*, the bredth being 2 foote 50 parts, the depth 1 foot 80 parts, the content of the base *E C* will bee found 4 foote 50 parts, and the length of one foot solid about 222 parts, the length of two foot solid about 444 parts of 1000.

As 1.00 unto 2.50: so are 1.80 unto 4.50.
As 4.50 unto 1.00: so 1.000 unto 0.222.

4 Ha-

4 *Having the bredth and depth of a squared solid given in inches, to finde the length of a foot solid in inch measure.*

As 1 hath to the breadth in inches:
So the depth in inches to a fourth number;
which is the content of the base in inches. Then

As this fourth number unto 1728:
So 1 unto the length of a foot in inch measure.

So in the solid *AH*, the breadth *AC* being 30 inches, and the depth *AE* 21 inches 60 parts, the content of the base *EC* will be found to be 648 inches, and the length of a foote solid about 2 inches 67 parts, the length of a foot solid 5 inches 33 parts.

As 1 unto 21. 6: so 30 unto 648;
As 648 unto 1728; so 1 unto 2.667.

Or as 12 to the bredth in inches;
So the depth in inches to a fourth number:

As this fourth number to 144;
So 1 unto the length of a foote solid in inch measure.

So in the solid *AH*, the breadth being 30 inches, the depth 21 inches 6 parts, the fourth number will be found to be 54, and the depth o foote solid 2 inches 67 parts.

As 12 untō 21. 6; so 30 unto 54.
As 54 unto 144; so 1 unto 2.667:

*5 Having the side of a square equall to the base of any solid, and the length thereof given in inch measure, to find the content thereof in feet.*

As 41. 57 to the side of the square in inches:
So the length in inches to a fourth number;
and that fourth to the content in foot measure.

So in the solid *A H*, the length *A B* being 183 inches, and the side of the square equall to the base *E C* about 25 inches 45 parts, the fourth number will be found about 112, and the whole solid content about 68 feet 62 parts.

As 41. 57 unto 25. 45: so 183 unto 112:
and so are 112 unto 68. 62.

*6 Having the side of a square equall to the base of any solid, and the length thereof given in foot measure, to find the content thereof in feet.*

As 1 to the side of the square in foot measure:
So the length in feet to a fourth number;
and that fourth to the content in foot measure.

So in the former solid *A H*, the side of the square equall to the base *A E*, being about 2 foot 12 parts, and the length *A B* 15 foot 25 parts, the content will be found to bee about 68 foot 62 parts.

As 1 unto 2. 12: so 15. 25 unto 32. 35:
and so are 32. 35 unto 68. 62.

*7 Ha-*

7 *Having the side of a square equall to the base of any solid given in inch measure, and the length of the solid given in foote measure, to find the content thereof in feet.*

As 12 to the side of the square given in inches:
So the length in feet to a fourth number;
and that fourth to the content in foot measure.

So in the former solid *A H*, the side of the equall square being 25 inches 45 parts, the content will be found to bee about *68* feet *62* parts.

As 12 unto 25.45: so 15.25 unto 32.35:
and so are 32.35 vnto *68*.*62*.

8 *Having the length, bredth and depth of a squared solid given in inches, to find the content in inches.*

As 1 unto the bredth in inches:
*S*o the depth in inches unto the base in inches. Then

As 1 unto the base:
*S*o the length in inches unto the solid content in inches.

*S*o in the solid *A H*, whose bredth *A C* is 30 inches, the depth *A E* 21 inches and *6* parts of 10, and length *A B* 183, the content of the base *E C* will be found 648 inches, and the whole solid content about 118500 inches.

As 1 unto 21. *6*: so are 30 unto 648:
As 1 unto 648: so are 183 to 118584.

 9 *Ha-*

9 *Having the length, bredth and depth of a squared solid given in inches, to finde the content in feete.*

As 1 to the bredth in inches:
So the depth in inches to the base in inches.

As 1728 to that base:
So the length in inches to the content in feet.

So in the solid *AH*, the content will be found to be about 68 feete 62 parts.

As 1 unto 21.6: so 30 unto 648:
As 1728 unto 648: so 183 to 68.62.

Or as 12 to the bredth in inches:
So the depth in inches to a fourth number.

As 144 to that fourth number:
So the length in inches to the content in feet.

And so also in the same solid AH, the content will bee found to be about 68 feet 62 parts.

As 12 unto 21.6: so 30 unto 54:
As 144 unto 54: so 183 unto 68.62.

10 *Having the length, bredth and depth of a squared solid given in foot measure, to finde the content in feete.*

As 1 unto the bredth in foote measure:

So the depth in feet to the base in feet.

As 1 unto that base:
So the length in feet to the content in feet.

And thus in the former solid A H, the bredth *A C* will be 2 foot 50 parts, the depth *A E* 1 foot 80 parts, and the length *A B* 15 foot 25 parts; then working as before, the content of the base *A F* will be found 4 feet 50 parts, and the whole solid content about 68 foot 62 parts, which of all others may very easily be tried by Arithmetique.

As 1 unto 2.50: so 1.80 unto 4.50.
As 1 unto 4.50: so 15.25. unto 68.625.

11 *Having the bredth and depth of a squared solid given in inches, and the length in feet measure, to find the content thereof in feet.*

As 1 unto the bredth in inches:
So the depth in inches unto a fourth number:
which is the content of the base in inches.

As 144 hath unto that fourth number:
So the length in feet to the content in feet.

And so in the same solid *A H*, the content will be found to be about 68 feet 62 parts.

As 1 unto 21. 6: so 30 unto 648.
As 144 unto 15, 25. so 648, unto 68. 62.

Or as 144 unto the bredth in inches:
So the depth in inches unto a fourth number:

which

which is the content of the base in feet.

As 1 hath unto that fourth number:
So the length in feet to the content in feet.

And so in the same solid A H, the content will be found to be about 68 feet 62 parts.

As 144 unto 21. 6 : so 30 unto 4.50.
As 1 unto 4. 50 : so 15. 25 unto 68. 62.

Or as 12 unto the bredth in inches:
So the depth in inches unto a fourth number.

As 12 unto this fourth number:
So the length in feet to the content in feet.

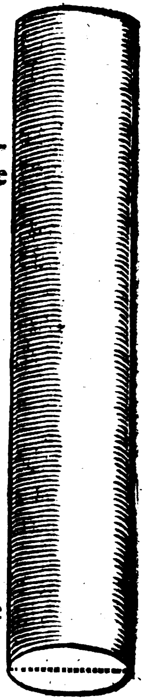
And so also in the same solid *A H*, the content will bee found to be about 68 feet 62 parts.

As 12 unto 21. 6 : so 30 unto 54.
As 12 vnto 54 : so 15. 25 unto 68. 62.

All these varieties (and such like not here mentioned) doe follow upon making of the base of the solid, to be *E C*; there would be as many more if any shall begin with the base E H, and so likewise if they make the base to be F D.

12 Ha-

*12 Having the diameter of a Cylinder given in inch measure, to find the length of a foot solid in inches.*



As the diameter in inches unto 46.90:
So is 1 unto a fourth number:
and that fourth to the length in inches.

So the diameter of a Cylinder being 15 inches, the fourth number will be about 3.12, and the length of a foote solid 9 inches 78 parts.

As 15 unto 46.90: so 1 vnto 3. 127:
and so are 3.127 unto 9. 778.

*13 Having the diameter of a Cylinder given in foote measure, to finde the length of a foote solid in foote measure.*

As the diameter in feet unto 1. 128:
So is 1 unto a fourth number;
and that fourth to the length in foote measure.

So the diameter being 1 foote 25 parts, the length of a foot solid will be found about 8. 14 parts of 1000.

As 1. 25 unto 1.128: so 1.00 to 0. 9027:
and so are 9027 unto 8148.

*14 Having the circumference of a Cylinder given in inches, to finde the length of a foot solid in inch measure.*

As the circumference in inches to 147.36:
So is 1 to a fourth number;
and that fourth to the length in inches.

So the circumference being 47 inches 13 parts, the length of a foote solid will be found about 9 inches 78 parts.

As 47.13 unto 147.36: so 1.00 to 3.13.
and so are 3.13 unto 9.78.

*15 Having the circumference of a Cylinder given in foot measure, to finde the length of a foot solid in foote measure.*

As the circumference in feete to 3.545:
So is 1 to a fourth number;
and that fourth to the length in foote measure.

So the circumference being 3 foot 927 parts, the length of a foot solid will be found to be about 815 parts.

As 3.927 unto 3.545: so 1.000 unto 0.90.3:
and so are 903 unto 815.

*16 Having the side of a square equall to the base of a Cylinder, to finde the length of a foot solid.*

The side of a square equall to the circle, may bee found by the eighth *Prop.* of broad measure, and then this *Prop.* may be wrought by the first and the second *Prop.* of solid measure.

17 *Ha-*

17 *Having the diameter of a Cylinder, and the length given in inches, to finde the content in inches.*

As 1.128 unto the diameter in inches:
So the length in inches to a fourth number;
and that fourth number to the content in inches.

So the diameter being 15 inches, and the length 105, the content of the Cylinder will bee found to bee about 18560 inches.

As 1.1284 unto 15: so are 105 unto 1395.87:
and so are 1395.87 unto 18555.34.

18 *Having the diameter and length of a Cylinder in foote measure, to finde the content in feete.*

As 1.128 to the diameter in feet:
So the length in feet to a fourth number;
and that fourth to the content in feet.

So the diameter being 1 foote 25 parts, and the length 8 foot and 75 parts, the content of the Cylinder will bee found about 10 foote 74 parts.

As 1.128 unto 1.25: so 8.75 unto 9.69:
and so are 9.69 unto 10.737.

19 *Having the diameter of a Cylinder, and the length given in inches, to find the content in feet.*

As 46.90 to the diameter in inches:
So the length in inches to a fourth number;
and that fourth to the content in feet.

So the diameter being 15 inches, and the length 105, the content will be found about 10 foote 74 parts.

As 46. 906 unto 15: so 105 unto 33. 58:
and so are 33. 58 unto 10. 737.

20 *Having the diameter of a Cylinder, given in inches and the length in feete, to find the content in feete.*

As 3. 54 the diameter in inches:
So the length in feete to a fourth number;
and that fourth to the content in feete.

So the diameter being 15 inches, and the length 8 foote 75 parts, the content will be found about 10 foot 74 parts.

As 13. 54 unto 15: so 8. 75 unto 9. 69:
and so are 9. 69 unto 10. 74.

21 *Having the circumference and length of a Cylinder given in inches to find the content in inches.*

As 3. 545 to the circumference in inches:
So the length in inches to a fourth number;
and that fourth to the content in inches.

So the circumference being 47 inches 13 parts, and the length 105 inches, the content will bee found about 18560 inches.

As 3. 545 unto 47. 13: so 105 unto 1396:
and so are 1396 unto 18555.

22 *Hee*

22 *Having the circumference and length of a cylinder given in inches, to find the content in feet.*

As 147.36 to the circumference in inches:
So the length in inches to a fourth number;
and that fourth to the content in feet.

So the circumference being 47 inches 13 parts, and the length 105 inches, the content will bee found about 10 foote 74 parts.

As 147.36 unto 47.13: so 105 unto 33.58:
and so are 33.58 unto 10.74.

23 *Having the circumference and length of a Cylinder given in foote measure, to find the content in feete.*

As 3.545 to the circumference in feet:
So the length in feet to a fourth number;
and that fourth to the content in feet.

So the circumference being 3 foote 927 parts, and the length 8 foot 75 parts, the content will be found to be 10 foot 74 parts.

As 3.545 unto 3.927: so 8.75 unto 9.69.
and so are 9.69 unto 10.74.

24 *Having the circumference of a Cylinder given in inches and the length in foot measure, to find the content in feete.*

As 42. 54 to the circumference in inches:
So the length in feet to a fourth number;
and that fourth to the content in feet.

So the circumference being 47 inches 13 parts, and the length 8 foote 75 parts, the content will bee found as before, 10 foot 74 parts.

As 42. 54 unto 47. 13: so 8. 75 unto 9.69:
and so are 9.69 unto 10. 74.

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## CHAP. IIII.

### *The use of the line of Numbers in gaugeing of vessell.*

THe vessels which are here measured, are supposed to be Cylinders, or reduced unto cylinders, by taking the mean betweene the diameter at the head and the diameter at the bongue, after the vsuall maner.

1 *Hauing the diameter and the length of a vessell with the content thereof, to finde the gavge point.*

Extend the compasses in the line of Numbers to halfe the distance betweene the content and the length of the vessell, the same extent will reach from the diameter to the gauge point.

I put this proposition first, because these kind of measures are not alike in all places.

Here

Here at London it is said that a wine vessell being *66* inches in length, and 38 inches the diameter, would containe 324 gallons. which if it be true, we may divide the space betweene 324 and *66* into two equall parts, and the middle will fall about 146, and the same extent which reacheth from 324 to 146, will reach from the diameter 38 unto 17. 15 the gauge point for a gallon of wine or oyle after London measure.

The like reason holdeth for the like measure in all other places.

## 2 *Having the meane diameter and the length of a vessell, to finde the content.*

Extend the compasses from the gauge point to the meane diameter, the same extent being being doubled, shall give the distance from the length to the content.

So the meane diameter of a wine vessell being 20 inches, and the length 25 inches, the content will be found to be 34 gallons after London measure.

For extend the compasses from 17. 15. unto 20, the same extent will reach from 25 unto 29. 15, and from 29. 15 unto 34.

In like maner if the meane diameter were 16 inches, and the length 23, the content would bee found to bee about 20 gallons.

For the same extent which reacheth backe from 17. 15 unto 16, will reach from 23 to 21. 45, and from 21. 45 unto 20.

So that if the meane diameter shall be 17 inches and 15 centesmes or parts of 100, the number of inches in the length of the vessell, will give the number of inches in the length of the vessell, will give the number of gallons contained in the same vessell: if the diameter shall be more or lesse then 17. 15, the content in gallons will bee accordingly more or lesse then the length in inches.

3 *Ha-*

### 3 *Having the diameter and content, to find the length.*

Extend the compasses from the diameter to the gauge point, the same extent being doubled shall give the distance from the content to the lenghth of the vessell.

*S*o the gauge point standing as before, if the diameter bee 38 inches, and the content 324 gallons wine measure, the length of the vessels will bee found about 66 inches.

### 4 *Hauing the length of a vessell and the content, to finde the diameter.*

Extend the compasses to halfe the distance betweene the length and the content, the same extent shall reach from the gauge point to the diameter.

So the length being 66 inches, and the content 324 gallons wine measure, the gauge point standing as before, the diameter of the vessell well bee found to be about 38 inches.

CHAP.

## CHAP. V.

### *Containing such Astronomicall propositions as are of ordinary use in the practise of Navigation.*

**1** *To finde the altitude of the Sunne by the shadowes of a gnomon set perpendicular to to the horizon.*

As the parts of the shadow
are to the parts of the gnomon:
So the tangent of 45 *gr.*
to the tangent of the altitude.

Extend the compasses in the line of Numbers, from the parts of the shadow to the parts of the gnomon; the same extent will give the distance from the Tangent of 45 *gr.* to the Tangent of the Sunnes altitude.

So the gnomon being 36, and the shadow 27, the altitude will be found to be 36 *gr.* 52 *m.* Or the gnomon being 27, and the shadow 36, the altitude will bee found to bee 53 *gr.* 8 *m.* Or the shadow being 20, and the gnomon 9, the altitude will be found to be 24 *gr.* 14 *m.* as in the eighth *Prop.* of the use of the Tangent line. Pag. 12.

If the gnomon be 22 and the shadow 135 the altitude is 9 *gr.* 15 *m.* as I shewed before Pag. 24.

**2** *Having the distance of the Sunne, from the next equinoctiall point, to find his declination.*

As the Radius is in proportion

to the sine of the Sunnes greatest declination:
So the sine of the Sunnes distance from the next equinoctiall point,
to the sine of the declination required.

Extend the compasses in the line of *sines*, from 90 *gr.* to 23 *gr.* 30 *m.* the same extent will give the distance from the Sunnes place unto his declination.

So the Sunne being either in 29 *gr.* of ♉, or 1 *gr.* of ♒, or 1 *gr.* of ♌, or 29 *gr.* of ♏, that is 59 *gr.* distant from the next equinoctiall point, the declination will be found about 20 *gr.*

If the Sunne be so neare the equinoctiall point, that his declination fall to be under 1 *gr.* it may be found by the line of *numbers*. As if the Sunne were in 2 *gr.* 5 *m.* of ♈, that is 125 *m.* from the equinoctiall point, the former extent of the compasses from the sine of 90 *gr.* to the sine of 23 *gr.* 30 *m.* will reach in the line of *numbers* from 125 unto 50, which shewes the declination to be about 50 *m.*

### 3. *Having the latitude of the place, and the declination of the Sun, to find the time of the Suns rising and setting.*

As the cotangent of the latitude
to the tangent of the Suns declination:
So is the Radius
to the sine of the ascentionall difference betweene the houre of 6 and the time of the Suns rising or setting.

Extend the compasses from the tangent of the complement of the latitude, to the tangent of the declination: the same extent will reach from the sine of 90 *degr.* to the sine of the ascentionall difference.

Or extend the compasses from the cotangent of the latitude to the sine of 90 *gr.* the same extent will reach from the

the tangent of the declination, to the sine of the ascentionall difference.

So the latitude being 51 *gr.* 30 *m.* Northward, and the declination. 20 *gr.* the difference of ascention will be found to be 27 *gr.* 14 *m.* which resolved into houres and minutes, doth give 1 houre and almost 49 *m.* for the difference betweene the Sunnes rising or setting, and the houre of 6, according to the time of the yeare.

### 4 *Having the latitude of the place, and the distance of the Sun from the next equinoctiall point, to find his amplitude.*

As the cosine of the latiude
  to the sine of the Sunnes greatest declination:
So the sine of the place of the Sun,
  to the sine of the amplitude.

So the latitude being 51 *degree* 30 *minutes*, and the place of the Sunne in 1 *degree* of ♒, that is 59 *degrees* distant from the next equinoctiall point, the amplitude will bee found about 33 *degrees* 20 *m.* For extend the compasses in the line of *sines*, from 38 *degrees* 30 *m.* the sine of the complement of the latitude, unto 23 *degrees* 30 *m.* the sine of the Sunnes greatest declination; the same extent will reach from 59 *degrees* unto 33 *degr.* 20 *m.* Or extend them from 38 *degrees* 30 *min.* unto 59 *degrees*, the same extent will reach from 23 *gr.* 30 *m.* unto 33 *gr.* 20 *m.* as before.

### 5 *Having the latitude of the place, and the declination of the Sun, to find his amplitude.*

As the cosine of the latitude
  is to the Radius:
So the sine of the declination,
  to the sine of the amplitude.

Extend the compasses from the cosine of the latitude to the sine of 90 *gr* the same extent will reach from the sine of the Sunnes declination to the sine of the amplitude.

Or extend them from the tangent of the latitude to the sine of the declination, the same extent will reach from the sine of 90 *gr.* to the sine of the amplitude.

So the latitude being 51 *gr.* 30 *m.* and the declination 20 *gr.* the amplitude will be found to bee 33 *gr.* 20 *m.*

### *6 Having the latitude of the place, and the declination of the Sun, to finde the time when the Sun commeth to be due East or West.*

As the tangent of the latitude,
is to the tangent of the decination:
So the Radius
to the cosine of the houre from the meridian.

Extend the compasses from the tangent of the latitude to the tangent of the declination; the same extent will reach from the sine of 90 *gr.* to the sine of the complement of the houre.

Or extend them from the tangent of the latitude to the sine of 90 *gr.*; the same extent will reach from the tangent of the declination to the sine of the complement of the houre.

So the latitude being 51 *gr.* 30 *m.* and the declination 20 *gr.* the Sunne will bee 73 *gr.* 10 *m.* that is 4 houres and 53 *m.* from the meridian, when he cometh to be in the East or West.

### 7 *Having the latitude of the place, and the declination of the Sunne, to find what altitude the Sun shall have, when he commeth to be due East or West.*

As

As the sine of the latitude
is to the sine of the declination:
So the Radius
to the sine of the altitude.

Extend the compasses in the line of *Sines* from the latitude to the sine of the declination, the same extent will reach from the sine of 90 *gr.* to the sine of the altitude.

Or extend them from the sine of the latitude to the sine of 90 *gr*; the same extent will reach from the sine of the declination to the sine of the altitude.

So the latitude being 51 *gr.* 30. *m.* and the declination 20 *gr.* the altitude will be found about 25 *gr.* 55 *m.*

8 *Having the latitude of the place, and the declination of the Sunne, to find what altitude the Sunn shall have at the houre of six.*

As the Radius is in proportion
to the sine of the Suns declination:
So the sine of the latitude.
to the sine of the altitude.

Extend the compasses in the line of *Sines*, from 90 *gr.* to the declination; the same extent will reach from the latitude to the altiude.

Or extend them from 90 *gr.* to the latitude, the same extent will hold from the declination to the altitude.

So the latitude being 51 *gr.* 30 *m.* and the declination of the Sunne 20 *gr.* the altitude of the Sunne will be found to be about 15 *gr.* 30.

9 ***Having the latitude of the place, and the declination of the Sun, to find what Azimuth the Sun shall haue at the houre of six.***

As the cosine of the latitude
is to the Radius:
So the cotangent of the Suns declination,
to the tangent of the Azimuth from the North part
of the meridian.

So the latitude being 51 *gr.* 30 *m.* and the declination 20 *gr.* the Azimuth will be found to be 77 *gr.* 14 *m.* For extend the compasses in the line of *sines,* from 38 *gr.* 30 *m.* to 90 *gr.* the same extent will reach from the tangent of 70 *gr.* to the tangent of 77 *gr.* 14 *m.*

10 ***Having the latitude of the place, and the declination of the Sun, and the altitude of the Sun, to find the Azimuth.***

First consider the declination of the *Sunn*, whether it be toward the North or the *South*, so have you his distance from your pole: then adde this distance, the complement of his altitude, and the complement of your latitude, all three together, and from halfe the summe subtract the distance from the pole, and note the difference.

1 As the Radius is in proportion
to the cosine of the altitude:
So the cosine of the latitude,
to a fourth sine.
2 As this fourth sine
is to the sine of the halfe summe:

So

So the sine of the difference,
to a seventh sine.

Then find a meane proportionall betweene this seventh sine and the Radius, this meane shall be the sine of the complement of halfe the Azimuth from the North part of the meridian.

*Suppose* the declination of the *Sun* being knowne by the time of the yeare to be 20 *degrees* Southward, the altitude aboue the horizon found by obseruation 12 *degrees*, and the latitude Northwards 51 *degrees* 30 *m.* it were required to find the Azimuth.

The declination is Southward, and therefore the distance from the pole 110 *degrees*; then turning the altitude and latitude unto their complements, I adde them all three together, and from halfe the summe subtract the distance from the pole, noting the difference after this maner.

| | | | | | |
|---|---|---|---|---|---|
| Declin. *South* | 20 *gr.* | 0 *m.* | The distance | 110 *gr.* | 0 *m.* |
| Altitude | 12 | 0 | The complement | 78 | 0. |
| Latitude N. | 51 | 30 | The complement | 38 | 30. |
| | | | The summe of all three | 226 | 30 |
| | | | The halfe summe | 113 | 15 |
| | | | The difference | 3 | 15 |

This done, I come to the *Staffe*, and extend the compasses from the sine of 90 *gr.* to the sine of 78 *gr.* and find he same extent to reach from the sine of 38 *gr.* 30 *m.* unto 37 *gr*; 30 *m.* Or if I extend them from 90 *gr.* to 38 *gr.* 30 *m.* the same extent doth reach from 78 *gr.* unto 37 *gr.* 30 *m.* which is the fourth sine required.

Then I extend the compasses againe, from this fourth sine of 37 *gr.* 30 *m.* unto the sine of the halfe summe 113 *gr.* 15 *m.* that

that is to the sine of *66 gr. 45 m.* (for after *90 gr.* the sine of *80 gr.* doth stand for a sine of *100 gr.* and the sine of *70 gr.* for a sine of *110 gr.*) and so the rest for those which are their complements to *180 gr.*) and this second extent doth reach from the sine of the difference *3 gr. 15. m.* to the sine of *4 gr. 54 m.* Or if I extend them from the fourth sine of *37 gr. 30 m.* to the sine of the difference *3 gr. 15 m.* the same extent will reach from the sine of the halfe summe *113 gr. 15 m.* unto *4 gr. 54 m.* which is the seventh sine required.

Lastly, I divide the space betweene this seventh sine of *4 gr. 54 m.* and the sine of *90 gr.* into two equall parts, and I finde the meane proportionall sine to fall on *17 gr.* whose complement is *73 gr*; the double of *73 gr.* is *146 gr.* and such is the Azimuth required.

Or having found the seventh sine to be *4 gr. 54 m.* I might looke over against it, in the line of *versed sines*, and there I should finde *146 gr.* for the azimuth from the North part of the meridian; and the complement of *146 gr.* to a semicircle being *34 gr.* will give the azimuth from the South part of the meridian.

But if it were required to find the azimuth in the same latitude of *51 gr. 30.* Northward, with the same altitude of *12 gr.* and like declination of *20 gr.* to the Northward, it would be found to be onely *72 gr. 52 m.* though the maner of worke be the same as before.

| | | | | | |
|---|---|---|---|---|---|
| Declin. North | 20 *gr.* | 0 *m.* | The distance is | 70 *gr.* | 0 *m.* |
| Altitude | 12 | 0 | The complement | 78 | 0 |
| Latitud. North | 51 | 30 | The complement | 38 | 30 |
| | | | The summe of all three | 186 | 30 |
| | | | The halfe summe | 93 | 15 |
| | | | The difference | 23 | 15 |

Here as the Radius is to the sine of *78 gr*: so the sine of *38 gr. 30 m.*:

*gr.* 30 *m.* to the sine of 37 *gr.* 30 *m.* which is the fourth sine, and the same as before.

Then as this fourth sine of 37 *gr.* 30 *m.* is to the sine of 93 *gr.* 15 *m.* so the sine of 23 *gr.* 15 *m.* to the sine of 40 *gr.* 20 *m.* which is the seventh sine.

The halfe way betweene this seventh sine and the sine of 90 *gr.* doth fall at 53 *gr.* 34 *m.* whose complement is 36 *gr.* 26 *m.* and the double of that is 72 *gr.* 52 *m.* the Azimuth required.

Or I may find this same Azimuth in the line of *versed sines*, over against the seventh sine of 40 *gr.* 20 *m.*

11 *Having the latitude of the place, the declination of the Sun, and the altitude of the Sun, to find the houre of the day.*

Adde the complement of the Sunnes altitude, and the distance of the Sunne from the pole, and the complement of your latitude, all three together, and from halfe the summe subtract the complement of the altitude, and note the difference.

1 As the Radius is in proportion
 to the sine of the Suns distance from the pole
 So the sine of the complement of the latitude,
 to a fourth sine.

2 As this fourth sine
 is to the sine of the halfe summe:
 So the sine of the difference
 to a seventh sine.

The meane proportionall betweene this seventh sine and the sine of 90 *gr.* will be the sine of the complement of halfe the houre from the meridian.

Thus in our latitude of 51 *gr.* 30 *m.* the declination of the Sunne being 20 *gr.* Northward, and the altitude 12 *gr.* I might find the Sunne to be 95 *gr.* 52 *m.* from the meridian.

Altitude 12 *gr.* 0 *m.* The complement is 78 *gr.* 0 *m.*

| | | | | | | |
|---|---|---|---|---|---|---|
| Declin. North | 20 | 0 | the dist. from the pole | | 70 | 0 |
| Latitude | 51 | 30 | the complement is | | 38 | 30 |
| | | | The summe of all three | | 186 | 30 |
| | | | The halfe summe | | 93 | 15 |
| | | | The difference | | 15 | 15 |

Here as the Radius, is to the sine of 70 *gr.*
So the sine of 38 *gr.* 30 *m.* to the sine of 35 *gr.* 48 *m.*
As this sine of 35 *gr.* 48. *m,* is to the sine of 93 *gr.* 15 *m.*
So the sine of 15 *gr.* 15 *m,* to the sine of 26 gr. 40 *m.*

The halfe way between this seventh sine of 26 gr. 40 *m,* and the sine of 90 gr. doth fall at 42 gr. 4 m, whose complement is 47 gr. 56 *m.* and the double of that, 95 gr. 52 m. which conuerted into houres, doth give 6 houres and almost 24 *m.* from the meridian.

Or I might find these 95 gr. 52 *m.* in the line of *versed sines,* ouer against the seuenth sine of 26 gr. 40 m.

12 *Hauing the azimuth, the Suns altitude, and the declination, to find the houre of the day.*

As the cosine of the declination
is to the sine of the azimuth:
So the cosine of the altitude
to the sine of the houre.

Thus the declination being 20 gr. Southward, the altitude 12 gr. and the azimuth found by the tenth *Prop.* 146 gr. I might finde the time to be 35 gr. 36 *m.* that is 2 houres 22 *m.* from the meridian.

13 *Having the houre of the day, the Sunnes altitude, and the declination, to find the azimuth.*

As the cosine of the altitude
is to the sine of the houre:

So

So the cosine of the declination,
to the sine of the azimuth.

So the altitude of the Sun being 12 gr. and the declination 20 gr. Southward, and the angle of the houre 35 gr. 36 m. I shou'd find the azimuth to be 34 gr. And so it is if it be reckoned from the South; but 146 gr. if it be taken from the North part of the meridian.

14 *Having the distance of the Sun from the next equinoctiall point, to find his right ascension.*

As the Radius
to the cosine of the greatest declination:
So the tangent of the distance,
to the tangent of the right ascension.

So the Sun being in the first degree of ♒, that is 59 gr. distant from the next equinoctiall point, and the greatest declination 23 gr. 30 m. the right ascension will be found to be 56 gr. 46 m. short of the beginning of ♈, and therefore 303 gr. 14 m.

15 *Having the declination of the Sun, to find his right ascention.*

As the tangent of the greatest declination
is to the tangent of the declination giuen:
So the Radius
to the sine of the right ascension.

So the greatest declination being 23 *gr.* 30 *m.* and the declination of the Sun giuen 20 *gr.* the right ascension will be found about 56 *gr.* 50 *m.*

16 *Having the longitude and latitude of a starre*
*To finde the right ascension of that starre*
17 *To finde the declination of that Starre.*



The

The starres have little or none alteration in their latitude, in their longitude they moue forward, about 1 *gr.* 25 *m.* in an hundred yeares. These being knowne,

As the Radius
to the sine of the starres longitude from the next equinoctiall point:
So the cotangent of the starres latitude
to the tangent of a fourth arke.

Compare this fourth arke, with the arke of distance betweene the poles of the world and of the ecliptique. If the longitude and latitude of the starre be both a like, as when the longitdde falleth to bee amonge the Northerne sines ♈ ♉ ♎ ♋ ♌ ♍, and the latitude is North from the ecliptique: or the longitude among the Southerne signes ♎ ♏ ♐ ♑ ♒ ♓, and the latitude Southward, then shall the difference betweene this fourth arke and the distance of poles, be your fifth arke.

But if the longitude and latitude shall be unlike, as the longitude in a Northerne signe, and the latitude South, or the longitude in a Southerne sine, and the latitude North, then adde this fourth arke to the distance of both poles, the sume of both shall be your fith arke. And

As the sine of the fourth arke:
to the sine of the fifth arke,
So the tangent of the starres longitude
to the tangent of the starres right ascention,
from the next equinoctiall point.

As the cosine of the fourth arke
to the cosine of the fifth arke,
So the sine of the starres latitude,
to the sine of the starres declination.

Then for proofe of the worke, if there bee no former errour, the proportion will hold.

As

As the Cosine of the latitude
to the Cosine of the right ascention:
So the Cosine of the declination
to the Cosine of the longitude.

For example, take the vpper of the two former starres in the square of the little Beare, which sea-men call the *Former Guard.* This in the yeare 1625, will be in 7 *degr.* 38 *m.* of ♌. and so his longitude from the beginning of ♎ 52 *degr.* 22 *m.* But his latitude is still the same 72 *gr.* 51 *m.* Northwards. Wherefore

As the sine of 90 *gr.* is to the sine of 52 *gr.* 22 *m.*
So the cotangent of 72 *gr.* 51 *m.*
to the tangent of 13 *gr.* 44 *m.*

Which is the fourth arke. Then because the longitude and latitude are both Northward, the difference betweene this fourth arke and 23 *gr.* 31 *m.* the distance of both poles will give you 9 *gr.* 47 *m.* for the fifth arke. And

As the sine of 13 *gr.* 44 *m.*
to the sine of 9 *gr.* 47 *m.*
So the tangent of 52 *gr.* 22 *m.*
to the tangent of 42 *gr.* 53 *m.*

Which is the right ascention of this starre, from the beginning of ♎ but 222 *gr.* 53 *m.* from the beginning of ♈.

As the cosine of 13 *gr.* 44 *m.*
to the cosine of 9 *gr.* 47 *m.*
So the sine of 72 *gr.* 51 *m.*
to the sine of 75 *gr.* 46 *m.*

Which is the declination of this starre from the æquator.

As the cosine of 72 *gr.* 51 *m.*

to the cosine of 42 *gr.* 53 *m.*
So the cosine of 75 *gr.* 46 *m.*
to the cosine of 52 *gr.* 23 *m.*

Which agreeing so well with the longitude of the starre proposed is a good proofe, that the right ascension and declination were truly found.

These are such Astronomicall propositions as I take to be vsefull for *Sea-men*. For the first and second will help them to find their latitude; the third to find the Suns rising and setting; the 4.5.6.7.8.9.10.13. *Prop.* to finde the variation of their compasse; the 11 and 12 *Prop.* to find the houre of the day; and the rest toward the finding of the houre of the night. For hauing the latitude of the place, with the declination and altitude of any starre, they may find the houre of the starre from the meridian, as in the 11 *Prop.* Then comparing the right ascension of the starre with the righ ascension of the *Sunne*, they may haue the houre of the night.

All these propositions and such others may be wrought also by the tables of *sines* and *tangents*. For where foure numbers do hold in proportion; as the first to the second, so the third to the fourth; there if we multiply the second into the third, and diuide the product by the first the quotient will giue the fourth required. As in the example of the 15 *Prop.* where the declination being giuen, it was required to find the right ascension. The tangent of 20 *gr.* the declination giuen is 3639702, whith being multiplied by the Radius, the product is 363970200000000, and this diuided by 4348124 the tangent of 23 *gr.* 30 *m.* the quotient is 8370741 the sine of 56 *gr.* 50 *m.* for the right ascension required.

Or if any will vse my tables of *artificiall sines* and *tangents*, they may adde the second and the third together, and from the summe subtract the first, the remainder will giue the fourth required And so my tangent of 20 *gr.* is 9561.0658, which being added to the Radius, makes 19561.0658; from this if they subtract 9638.3019 the tangent of 23 *gr.* 30 *m.* they

they shall find the remainder to be 9922.7639; which in my *Canon* is the sine of 56 *gr*. 49 *m*. 56 *seconds*; & such is the right ascension required, if it be reckoned from the next equinoctiall point.

The like reason holdeth for all other Astronomicall propositions, as I will farther shew by those two examples which I gaue before for the finding of the azimuth in the 10 *Prop.* because they are thought to be harder then the rest, and require three operations.

In the first example.

| | | | | | |
|---|---|---|---|---|---|
| Declin. *South* | 20 *gr*. 0 *m*. | | The distance | 110 *gr*. 0 *m*. | |
| Altitude | 12 | 0 | the complement | 78 | 0 |
| Latitude Nor. | 51 | 30 | the complement | 38 | 30 |
| | | | The summe of all three | 226 | 30 |
| | | | The halfe summe | 113 | 15 |
| | | | The difference | 3 | 15 |

The first operation will be to finde the fourth sine; and that is done by adding the sine of the complement of the altitude to the sine of the complement of the latitude, and subtracting the Radius: so adding 9990.4044 the sine of 78 *gr*. vnto 9794.1495 the sine of 38 *gr*. 30 *m*. the summe will be 19784.5539. And the Radius being subtracted, the remainder 9784.5539 is the fourth sine, and belongeth to 37 *gr*. 30 *m*.

The second operation will be to find the seuenth sine; and that is done by adding the sine of the halfe summe to the sine of the difference, and subtracting the fourth sine. So the halfe summe being 113 *gr*. 15 *m*. I take his complement to a semicircle, and so find his sine to be 9963.2168, to which I adde 8753.5278, the sine of the difference 3 *gr*. 15 *m*; and the summe is 18716.7446. From this I take the fourth sine 9784.5539, and the remainder will be 8932.1907, which is the seuenth sine, and belongeth to 4 *gr*. 54 *m*.

The third operation will be to finde the meane proportionall sine betweene the seuenth sine and the Radius. This in

common

common Arithmetique is done by multiplying the to extremes, and taking the square roote of the product. As in finding a meane proportionall betweene 4 and 9, we multiply 4 into 9, and the product is 36, whose square root is 6, the meane proportionall betweene 4 and 9. But here it is done by adding the sine and the Radius, and taking the halfe of them. So the summe of the last seventh sine and the Radius is 18932. 1907 and the halfe of that 9466.0953, which is the meane proportionall sine required, and belongeth to 17 *gr.* whole complement is 73 *gr.* and the double of that 146 *gr.* the same Azimuth as before.

In the second example.

| | | | | | | |
|---|---|---|---|---|---|---|
| Declin. North | 20 *gr.* | 0 *m.* | The distance | | 70 *gr.* | 0 *m.* |
| Altitude | 12 | 0 | the complement | | 78 | 0 |
| Latitud. North | 51 | 30 | the complement | | 38 | 30 |
| | | | The summe of all three | | 186 | 30 |
| | | | The halfe summe | | 93 | 15 |
| | | | The difference | | 23 | 15 |

The first operation will be to find the fourth sine; and that is here 9784. 5539, as in the former example.

The second operation will be to find the seventh sine; and so here the sine of the halfe summe 93 *gr.* 15 *m.* being the same with the sine of 86 *gr.* 45 *m.* his complement to 180 *gr.* I find it to be 9999.3009, to which I adde 9596. 3153 the the sine of the difference 23 *gr.* 15 *m.* and the summe is 19595. 6162. From this I take the fourth sine 9784. 5539, and the remainder will be 9811. 0623 for the seventh sine, and belongeth to 40 *gr*, 20 *m.*

The third operation will be to find the meane proportionall sine betweene the seventh sine and the Radius. And so here the Radius being added to the seventh sine, the summe will be 19811. 0623, and the halfe of that 9905. 5311, doth give the meane proportionall sine belonging to about gr. 34 m. whose complement is 36 gr. 26 m. & the double of that 72 gr. 52 m. the same Azimuth as before.

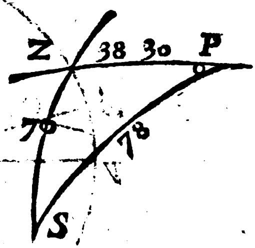
I haue set downe these three examples thus particularly, that I might shew the agreement betweene the *Staffe* and the *Canon*. But otherwise I might deliuer both the precept and the worke, for the two last, more compendiously. For generally in all sphericall triangles, where three sides are knowne, and an angle required, make that side which is opposite to the angle required, to be the base; and gather the summe, the halfe summe, and the difference as before.

As the rectangle contained vnder the sines of the sides,
is to the square of the whole sine:
So the rectangle contained vnder the sines of the halfe summe and the difference,
to the square of the cosine of halfe the angle.

Then for the worke, we may for the most part leaue out the two last figures, and if they be aboue 50, put an vnitie to the sixt place, after this maner.

The second example.

| | | | |
|---|---|---|---|
| 70 gr. | 9 m. | | |
| 78 | 0 | 9990 | 40 |
| 38 | 30 | 9794 | 15 |
| 186 | 30 | 19784 | 55 |
| 93 | 15 | 9999 | 30 |
| 23 | 15 | 9596 | 32 |
| | | 20000 | 00 |
| | | 39595 | 52 |
| | | 19811 | 07 |
| 36 | 26 | 9905 | 53 |
| 72 | 52 | | |




53 gr. 34 m.
107 8

Or for such numbers as are to be subtracted, I may take

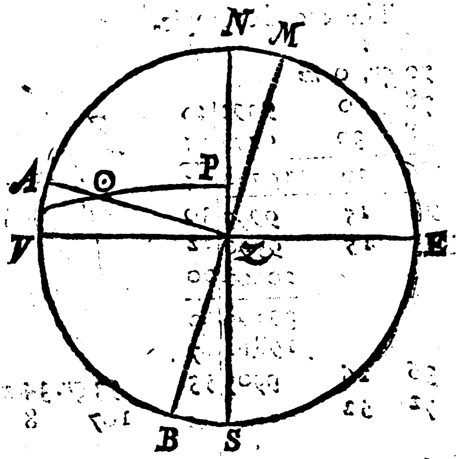


them

them out of the Radius, and write downe the residue, and then adde them together with the rest. As in the same second example, the sines of 78 *gr.* and of 38 *gr.* 30 *m.* being the numbers to be subtracted; if I take 9990. 4044 the sine of 78 *gr.* out of the Radius 10000.0000, the residue is 9. 5956: and so the residue of 9794. 1495 is 205. 8505. Wherefore in head of subtracting those sines, I may adde these residues after this maner:

| | | | | | |
|---|---|---|---|---|---|
| 70 *gr.* | 0 *m.* | | | | |
| 78 | 0 | 9 | 59 | | |
| 38 | 30 | 205 | 85 | | |
| 186 | 30 | | | | |
| 93 | 15 | 9999 | 30 | | |
| 23 | 15 | 9596 | 32 | | |
| | | 19811 | 06 | | |
| 36 | 26 | 9905 | 53 | 53 *gr.* | 34 *m.* |
| 72 | 52 | | | 107 | 8 |

Hauing these meanes to find the Sunnes azimuth, we may compare it with the magneticall azimuth, and so finde the variation of the needle.




For let the circle *AMB*, drawne by the center *Z*, be a

plane

plane, parallell to the horizon; *A* the point whereon the Sun beareth from vs, *M* the North point of the magneticall needle, and the angle *AZM* the magneticall Azimuth. If we find the *S*unnes Azimuth as before, to be 72 *gr.* 52 *m.* from the North to the Westward, we may allow so many degrees from *A* vnto *N*, and so we haue the true North point of the meridian; and consequently the East, South, & West points of the horizon; and the distance betweene *N* and *M* shall be the variation of the needle. So that if the magneticall Azimuth *AZM* shall be 84 *gr.* 7, *m.* and the Suns azimuth *AZN* 72 *gr.* 52 *m.* then must *NZM* the difference betweene the two meridians, giue the variation to be 11 *gr.* 15 *m.* as Mr. *Bourough* heretofore found it by his obseruations at *Limhouse* in the yeare 1580. But if the magneticall Azimuth Z*M* shall be 79 *gr.* 7 *m.*, and the Suns Azimuth *AZ*N 72 *gr.* 52 *m.* then shall the variation *NZM* be only 6 *gr.* 15 *m*, as I haue sometimes found it of late. Herevpon I enquired after the place where Mr. *Bourough* obserued, and went to *Limehouse* with some of my friends, and tooke with vs a quadrant of 5 foote semidiameter, and two needles, the one aboue 6 inches, and the other 10 inches long, where I made the semidiameter of my horizontall plane *AZ* 12 inches: and toward night the 13 of Iune 1622, I made obseruation in seuerall parts of the ground, and found as followeth.

| *Alt.* ☉ | | *AZM* | | *AZN* | | *Variat* | |
|---|---|---|---|---|---|---|---|
| *Gr.* | *M.* | *Gr.* | *M.* | *Gr.* | *M.* | *Gr.* | *M.* |
| 19 | 0 | 82 | 2 | 75 | 52 | 6 | 10 |
| 18 | 5 | 80 | 50 | 74 | 44 | 6 | 6 |
| 17 | 34 | 80 | 0 | 74 | 6 | 5 | 54 |
| 17 | 0 | 79 | 15 | 73 | 20 | 5 | 55 |
| 16 | 18 | 78 | 12 | 72 | 32 | 5 | 40 |
| 16 | 0 | 77 | 50 | 72 | 10 | 5 | 40 |
| 10 | 10 | 71 | 2 | 64 | 49 | 6 | 13 |
| 9 | 52 | 70 | 12 | 64 | 25 | 5 | 47 |

# CHAP. VI.

## *Containing such nauticall questions, as are of ordinary vse, concerning longitude, latitude, Rumb, and distance.*

### 1 *To keepe an account of the ships way*

THe way that the ship maketh, may be knowne to an old sea-man by experience, by others it may be found for some small portion of time, either by the logge line, or by the distance of two knowne markes on the ships side.

The time in which it maketh this way may be measured by a watch, or by a glasse, or by the pulse or by repeating a certaine number of words. Then as long as the wind continueth at the same stay it followeth by proportion,

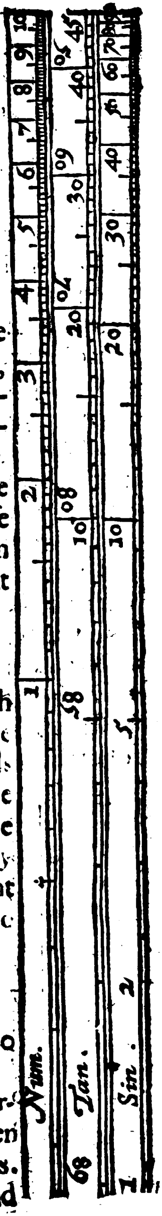
As the time giuen is to an houre:
So the way made, to an houres way.

Suppose the time to be 15 seconds, which make a quarter of a minute, and the way of the ship 88 feet: then because there are 3600 seconds in an houre, I may extend the compasses in the line of *numbers*, from 15 unto 3600, and the same extent will reach from 88 unto 21120. Or I may extend them from 15 unto 88, and this extent will reach from 3600 unto 21120; according to the ordinary worke in Arithmetique,

As 15 vnto 3600
So 88 vnto 21120

which shewes that an houres way came to 21120 feete.

But this were an vnnecessary businesse, to hearken after feet or fadoms. It sufficeth our sea-men to find the way of their ship in leagues or miles.




And

And they say that there are 5 feet in a pace, 1000 paces in a mile, and 60 miles in a degree, and therefore 300000 feete in a degre. Yet comparing seuerall obseruations, and their measures with our feete vsuall about *London*, I finde that we may allow 352000 feete to a degree; and then if I extend the compasses in the line of *numbers* from 352000 vnto 21120, I shall find the same extent to reach from 20 leagues the measure of one degree, to 1.2, and from 60 miles to 3.6; according to Arithmetique which shewes the houres way to be 1 league and 2 tenths of a league, or 3 miles and 6 tenths of a mile.

| | | | |
|---|---|---|---|
| As | 352000 | vnto | 21120 |
| So | 20-00 | vnto | 1-20 |
| and | 60-00 | vnto | 3-60 |

But to auoid these fractions and other tedious reductions, I suppose it would be much better to keepe this account of the ships way (as also of the difference of latitude, and the difference of longitude) by *degrees* and parts of *degrees* allowing in 100 parts to each *degree*, which we may therfore call by the name of *centesmes*. For so doing there would be some agreement betweene the account and the dayes sayling. Ordinarily the ship goes a degree in a day, as it may appeare by comparing severall Iournalls to the east and west *Indies*. The time of passage betweene the lizard and the souther-most Cape of *Africa* is commonly said to be about three moneths and the distance is not much different from 90 degrees.

Againe this account by degrees and Centesmes would be more exact and the addition, subtraction, multiplication, diuision of them more easie. Neither would this be hard to conceaue. For,

| | *Centesm's,* | | *Minutes,* | | *leagues,* |
|---|---|---|---|---|---|
| If | 100 | do equall | 60 | and | 20 |
| then | 50 | shall equall | 30 | and | 10 |
| and | 5 | be equall | 3 | and | 1 |

And so in the former example of 88 feet in 15 seconds hauing first found that the houres way is about 21120 feet.

If I extend the compasses from 352000 vnto 21120 as before I shall find the same extent to reach from 100 vnto 6 as before, which shewes that the houres way required is *6 cent.* such as 100 do make a degre, & 5 do make an ordinary league.

This might also be done at one operation. For vpon these suppositions, diuide 44 feet into 45 lengths, and set as many of them as you may conueniently betweene two markes on the ships side, and note the seconds of time in which the ship goeth these lengthes; so the proportion will hold,

As the seconds, to the lengths.
So 1 houre, vnto the Centesmes

The lengths diuided by the time, shall giue the *cent.* which the ship goeth in an houre.

Suppose the distance betweene the two markes to be 60 lengths (which are 58 feet and 8 inches) & let the time be 12 seconds: extend the compasses from 12 to 1, in the line of *numbers*; so the same extent will reach from 60 vnto 5. Or extend them from 12 vnto 60, & the same extent will reach from 1 vnto 5. This shewes that the ships way is according to 5 *Cent.* in an houre.

This may be found yet more easily, if the logg line shal be fitted to the time. As if the time be 45 seconds, the log line may haue a knot at the end of euery 44 feete; then doth the ship run so many *cent.* in an houre, as there are knots vered out in the space of 45 seconds. If 30 seconds do seeme to be a more conuenient time, the loggline may have a knot at the end of euery 29 feet and 4 inches; and then also the *centesmes* will be as many as the knots. Or if the knots be made to any set number of feet, the time may be fitted vnto the distance. As if the knots be made at the end of euery 24 feet, the glasse may be made 24 second & somewhat more then an halfe of a second, and so these knots will shew the *cent.* If there be 5 knots vered out in a glasse, the *5 cent*; if 6 knots, then the ship goeth *6 cent.* in the space of an houre; & so in the rest. For vpon this supposition the proportiõ between the time & the feet will be as 45 vnto 44. But according to the common supposition it should seeme to be as 45 vnto $37\frac{1}{2}$, or in lesser termes as 6 vnto 5. Those which are vpon the place, may make proofe of both, and follow that which agrees best with their experience.

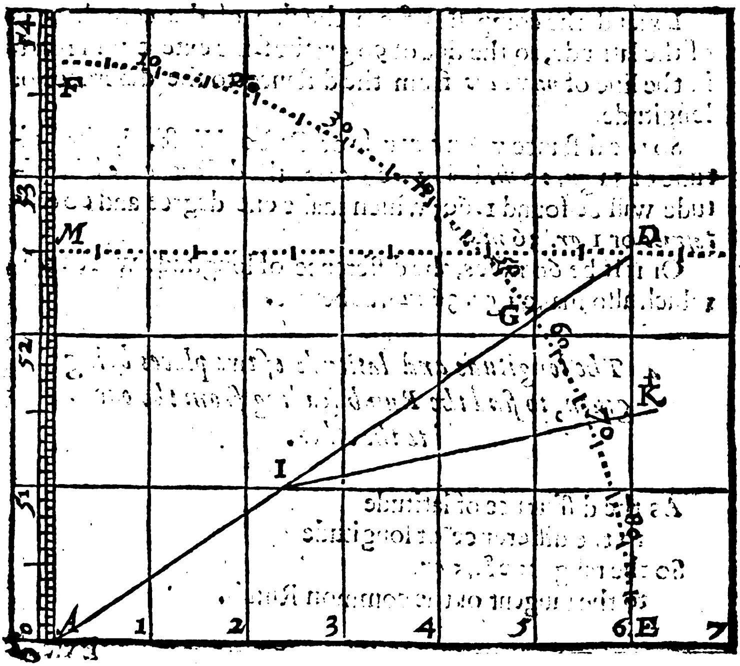
2. *By the latitude and difference of longitude, to find the distance upon a course of East and West.*

As the sine of 90 *gr.*
to the cosine of the latitude
So the difference of longitude at the æquator
to the distance required on the parallell.

Extend the compasses from the sine of 90 *gr.* vnto the sine of the complement of the latitude; the same extent shall reach in the line of *numbers* from the difference of longitude to the distance.

So the measure of one degree in the æquator, being 100 *cent.* the distance belonging to one degree of longitude in the latitude of 51 *gr.* 30 *m.* will be found about 62 *cent.* and $\frac{1}{4}$.

Or if the measure of a degree be 60 miles, the distance will be found about 37 miles and $\frac{1}{3}$. If the measure be 20 leagues, then almost 12 leagues and $\frac{1}{2}$. If the measure be 17 $\frac{1}{2}$, as in



the Spanish charts, them somewhat lesse then 11 leagues sailing vpon this parallell, will giue an alteration of one degree of longitude.

### 3 *By the latitude and distance vpon a course of East or West, to find the difference of longitude.*

If the distance be giuen in leagues or miles reduce them into centesmes, then will the proportion holde.

As the cosine of the latitude
to the sine of 90 *gr.*
So the distance on the parallell
to the difference of longitude.

Extend the compasses from the sine of the complement of the latitude, to the sine of 90 *gr*; the same extent will reach in the line of *numbers* from the distance to the difference of longitude.

So the distance vpon a course of East or West, in the latitude of 51 *gr*, 30 *m*. being 100 *cent.* the difference of longitude will be found 1.60, which make one degree and 60 *centesmes* or 1 *gr.* 36 *m.*

Or if it be 60 miles, the difference of longitude will be 96, which also make 1 *gr.* 36 *m.* as before.

### 4 *The longitude and latitude of two places being giuen, to find the Rumb leading from the one to the other.*

As the difference of latitude
to the difference of longitude
So the tangent of 45 *gr.*
to the tangent of the common Rumb.

Extend

Extend the compasses in the line of *numbers* from the difference of latitudes to the difference of longitudes; the same extent will giue the distance from the tangent of 45 *gr.* vnto the tangent of the Rumb, according to the proiection of the common sea-chart.

So the latitude of the first place being 50 *degree* the latitude of the second 52 *degree* 30 *m.* and the difference of longitude 6 *gr.* the Rumb will be found to be about 67 *gr.* 23 *m.* which is neare the inclination of the sixth Rumb to the meridian. But this Rumb so found, is alwayes greater then it should be, and therefore to be limited; which may be done sufficiently for the *Sea-mans* vse, after this maner:

As the sine of 90 *gr.*
to the cosine of the midle latitude
So the tangent of the common Rumb
to the tangent of the Rumb required.

Extend the compasses either from the sine of 90 *degree* vnto the sine of the complement of the midle latitude, the same extent will reach from the tangent of the Rumb before found, to the tangent of the Rumb limited.

Or else extend them from the sine of 90 *degree* vnto the tangent of the Rumb before found; the same extent will reach from the sine of the complement of the middle latitude, vnto the tangent of the Rumb limited.

So the middle latitude between 50 *gr.* and 52 *gr.* 30 *m.* being 51 *gr.* 15 *m.* and the Rumb before found 67 *gr.* 23 *m.* the Rumb limited will be found to be about 56 *gr.* 20 *m.* which is but fiue minutes more then the inclination of the fift Rumb to the meridian.

If any please to worke by the *Canon* he may ioine both these in one operation.

As the difference of latitude
to the difference of longitude
So the cosine of the midle latitude
to the tangent of the Rumb required.

2 This Rumb may be found by the helpe of the *meridian line* vpon the Staffe. For if I take the difference of latitude out of the *meridian line* from 50 *degree* vnto 52 *degree* 30 *m.* and measure it in his equinoctiall, or at the beginning of the *meredian line*, I shall find it there to be equal to 4 *degree* with may be called the difference of latitude in larged. Wherefore I work as if the difference of latitude were 4 *gr.*

As the difference of latitude in larged
to the difference of longitude
So the tangent of 45 *gr.*
to the tangent of the Rumb required.

And extend the compasses in the line of *numbers* from 4 vnto 6: so shall I finde the same extent to reach from the tangent of 45 *degree* vnto the tangent of 56 *degree* 20 *m.* and this is the inclination of the Rumb required.

6 *By the Rumb and both latitudes, to find the distance upon the Rumb.*

As the cosine of the Rumb from the meridiall
to the sine of 90 *gr.*
So the difference between both latitudes
to the distance vpon the Rumb.

Extend the compasses from the sine of the complement of the Rumb, vnto the sine of 90 *gr.* the same extent in the line

line of *numbers* shall reach from the difference of latitude vnto the distance vpon the Rumb.

*So* the latitude of the first place being 50 *gr.* the latitude of the second 52 *gr.* 30 *m.* and the Rumb the fift from the meridian. If I extend the compasses from 33 *gr.* 45 *m.* vnto the sine of 90 *gr.* I shall find the same extent in the line of *numbers* to reach from 2 *gr.* 50 *cent.* to 4 *gr.* 50 *cent.* and such is the distance required.

## 7 *By the distance and both latitudes to find the Rumb.*

As the distance on the Rumb
 to the difference between both latitudes
So the sine of 90 *gr.*
 to the cosine of the Rumb from the meridian.

Extend the compasses in the line of *numbers* from the distance vnto the difference of latitudes; the same extent will reach in the line of *sines*, from 90 *gr.* vnto the complement of the Rumb.

*So* the one place being in the latitude of 50 *degree* the other in the latitude of 52 *degree* 30 *m.* and the distance between them 4 *degres* 50 *cent.* If I extend the compasses from 4. 50 vnto 2. 50. in the line of *numbers*, I shall find the same extent to reach from the sine of 90 *degree* vnto the complement of 56 *degree* 15 *m.* and such is the inclination of the Rumb required.

## 8 *By one latitude, Rumb, and distance, to find the difference of latitudes.*

As the sine of 90 *gr*
 to the cosine of the Rumb from the meridian

So the distance vpon the Rumb
to the difference between both latitudes.

Extend the compasses in the line of *sines*, from 90 *gr.* vnto the complement of the Rumb; the same extent in the line of *numbers*, will reach from the distance, vnto the difference of latitudes.

So the lesser latitude being 50 *degres* and the distance 4 *degres* 50 *cent.* vpon the fifth Rumb from the meridian: if I extend the compasses from the sine of 90 *gr.* to 33 *gr.* 45 *m.* I shall finde the same extent to reach from 4.50 in the line of *numbers*, vnto 2.50; and therefore the second latitude to be 52 *gr.* 30 *m.*

## 9 By the Rumb and both latitudes, to find the difference of longitudes.

As the tangent of 45 *gr.*
to the tangent of the Rumb from the Meridian;
So the difference of latitude
to the difference of longitude in the common sea-chart.

Extend the compasses from the tangent of 45 *gr.* vnto the tangent of the Rumb; the same extent will reach in the line of *numbers* from the difference of latitudes vnto the difference of longitude, according to the proiection of the common sea chart.

So the first latitude being 50 *gr*, and the second 52 *gr.* 30 *m.* and the Rumb the fifth from the meridian: if I extend the compasses from the tangent of 45 *gr.* vnto 56 *gr.* 15 *m.* I shall find the same extent to reach from 2.50 in the line of *numbers* to about 3.75, which make 3 *gr.* 45 *m.* But this difference of longitude so found, is alwayes lesser then it should be, and therefore to be enlarged, which may be done sufficiently for the sea-mens vse, after this maner:

As the cosine of the middle latitude
to the sine of 90 *gr.*
So the difference of longitude in the common sea-chart
to the difference of longitude inlarged.

Extend the compasses from the sine of the complement of the middle latitude, vnto the sine of 90 *gr.* the same extent will reach in the line of *numbers* from the difference of longitude before found, vnto the difference of longitude inlarged.

So the middle latitude in this example being 51 *gr.* 15 *m.* and the difference of longitude before found 3 *gr.* 75 *cent.* the difference of longitude inlarged will be found about 5 *gr.* 99 *cent.* which are neare 6 *gr.*

If any please to worke by the *Canon* he may ioyne both these in one operation.

As the cosine of the middle latitude
to the tangent of the Rumbe from the meridian:
So the difference of latitude
to the difference of longitude required.

F. 2 This difference of longitude may be found by helpe of the *meridian line* vpon the Staffe. For if I take the proper difference of latitude out of the meridian line, and measure it in his equinoctiall, or at the beginning of the meridian line, I shall find the latitude inlarged to be equall to foure of those degrees.

As the tangent of 45 *gr.*
to the tangent of the Rumb from the meridian
So the difference of latitude inlarged
to the difference of longitude required.

Wherefore hauing extended the compasses as before from the tangent of 45 *gr.* vnto the tangent of 56 *gr.* 15 *m.*

the same extent will reach from 400 in the line of *numbers*, vnto 5. 99; which shewes the difference of longitude to be about 5 *gr*.99 *cent*. or about halfe a minute short of six degrees.

### 10 *By the Rumb and both latitudes, to finde the distance belonging to the chart of* Mercators *projection.*

Take the proper difference of latitudes out of the meridian line of the chart, and measure it in his equinoctiall, or one of the parallels, and it will there giue the difference of latitudes inlarged.

As the cosine of the Rumb from the meridian
to the sine of 90 *gr.*
So the difference between both latitudes
to the distance vpon the Rumb.

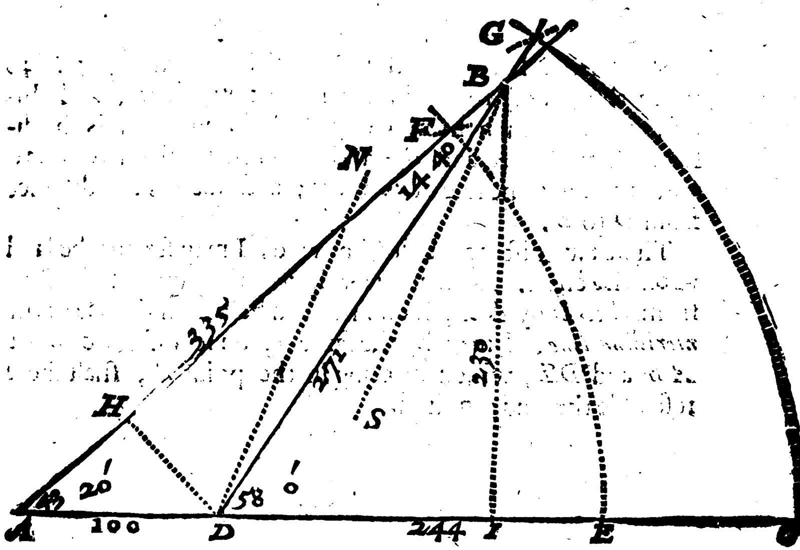
Then extend the compasses from the sine of the complement of the Rumb vnto the sine of 90 *gr.* the same extent will reach in the line of *numbers*, from the latitude inlarged, vnto the distance required. Or extend them from the complement of the Rumb to the latitude inlarged, the same extent will reach from 90 *gr.* vnto the distance.

For example, let the place giuen be *A* in the latitude of 50 *gr.* *D* in the latitude of 52 *gr.* 30 *m.* *A M* the difference of latitudes, and the Rumb *M A D* the fifth from the meridian. First I take out *A M* the difference of latitudes, and measure it in *A E* one of the parallels of the æquinoctiall; I find it to be very neare 4 *gr.* this is the difference of latitudes inlarged. Then if I extend the compasses from the sine of 33 *gr.* 45 *m.* the complement of the fifth Rumb vnto the sine 90 *gr.* I shall find the same extent to reach in the line of *numbers* from 400 vnto 7:20. And this is the distance belonging to the chart. Wherefore I take out these 7 *gr.* 20 *cent.* out of the

the scale of the parallell *A E*, and pricke it downe vpon the Rumb from *A* vnto *D*, where it meeteth with the parallell of the second latitude. Lastly, I measure it in the *meridian line*, setting one foote of the compasses as much below the lesser latitude as the other aboue the greater latitude, and find it to be 4 *gr.* 50 *cent.* which is the same distance that I found before in the 5. *Prop.*

### 11 *By the way of the ship, and two angles of position, to find the distance betweene the ship and the land.*

The way of the ship may be knowne as in the first *Prop.* The angles may be obserued either by the Staffe, or by a needle set on the *Staffe*. For example, suppose that being at *A*,




I had sight of the land at *B*, the ship going East Northeast from

from *A* toward *C*, and the angle of the ships position *B A C* being 43 *gr.* 20 *m*: and after that the ship had made 10 *cent.* or 2 leagues of way from *A* vnto *D*, I obserued againe, and found the second angle of the ships position *B D C* to be 58 *degree* or the inward angle *B D A* to be 112 *degree* then may I finde the third angle *A B D* to be 14 *degree* 40 *m.* either by subtraction or by complement vnto 180 *gr.*

In this and the like cases, I haue a right line triangle, in which there is one side and three angles knowne, and it is required to finde the other two sides and the *Canon* for it, is this:

As the sine of the angle opposite to the knowne side,
is to that knowne side:
So the sine of the angle opposite to the side required,
is to the side required.

Wherefore I extend the compasses from 14 *gr.* 40 *m.* in the *sines*, to 10 in the line of *numbers*, and this extent doth reach from 58 *gr.* to 33½, and such is the distance between *A* and *B*, and it reacheth from 43 *gr.* 20 *m.* vnto 27 in the line of *numbers*; and such is the distance from *D* to *B*.

These two distances being knowne, I may set out the land vpon the chart. For hauing set downe the way of the ship from *A* to *D* by that which I shewed before in the vse of the *meridian line*, I may by the same reason set off the distance *A B* and *D B*, which meeting in the point *B*, shall there resemble the land required.

## 11 By knowing the distance between two places on the land, and how they beare one from the other, and hauing the angles of position at the ship to find the distance betweene the ship and the land.

If it may be conueniently, let the angle of position be obserued at such time as the ship cometh to be right ouer against one of the places. As if the places be East and West, seeke to bring one of them South or North from you, and then obserue the angle of position: so shall you haue a right line triangle, with one side and three angles, whereby to find the two other sides. First you haue the angle of position at the ship; then a right angle at the place that is ouer against you; and the third angle at the other place is the complement to the angle of position. Wherefore

As the sine of the angle position,
is to the distance betweene the two places:
So the cosine of the angle of position,
to the distance betweene the ship and the nearer place.
And so is the sine of 90 *gr.*
to the distance from the ship to the farther place.

So the places being 15 *cent.* or three leagues one from the other, and the angle of position 29 *gr*, the nearer distance will be found about 27 *cent.* and the farther distance about 31 *cent.*

Or howsoeuer the angle of position were obserued, the distance betweene the ship and the land may be found generally as in this example:

Suppose *A* and *D* were two head lands knowne to be East Northeast, and West Southwest, 10 *cent.* or two leagues one from the other; and that the ship being at *B*, I obserued the angle of the ships position *DBA*, and found it to be 14 *gr.* 40 *m.* and that *D* did beare 9 *gr.* 30 *m.* and *A* 24 *gr.* 10 *m.* from the meridian B *S*, this example would be like the former. For if the angle S*BD* be 9 *gr.* 30 *m.* from the South to the Westward, then shall NDB be 9 *gr.* 30 *m.* from the North to the Eastward. Take these 9 *gr.* 30 *m.* out of the angle NDE which is 67 *gr.* 30 *m.* because the two head lands lie East Northeast, and there will remaine 58 *gr.* for the angle BDE, and the inward angle BDA shall be 122 *gr.* Take these two angles ABD and BDA out of 180 *gr.* and there wil remaine 43 *gr.* 20 *m.* for the third angle BAD. Wherefore here also are three angles and one side, by which I may find the two other sides, as in the last *Prop.*

These propositions thus wrought by the *Staffe*, are such as I thought to be vsefull for sea-men, and those that are skilfull may apply the example to many others. Those that begin, and are willing to practise, may busie themselues with this which followeth.

Suppose foure ports, L, N, O, P; of which L is in the latitude of 50 *degrees* N is North from L 200 leagues or 1000 *centesmes*; O West from L 1000 *centesmes* and P West from N 1000 *centesmes* so that L and O will be in the same latitude of 50 *gr.* N and P both in the latitude of 60 *gr*, Then let two ships depart from L, the one to touch at O, the other at *N*, and then both to meet at P, there to lade, and from thence to returne the nearest way vnto L. Here many questions may be proposed,

1 What is the longitude of the port at O?

2 What is the longitude of P? And why O and P should not be in the same longitude?

3 What is the Rumb from O vnto P?

4 What is the distance from O vnto P? And why the way should be more from L vnto P, going by O, then by N?

5 What

5 What is the Rumb from P vnto L?
6 What is the distance from P vnto L?
7 What is the Rumb from N vnto O?
8 What is the distance from N vnto O? And why it should not be the like Rumb and distance from N vnto O, as from P vnto L?

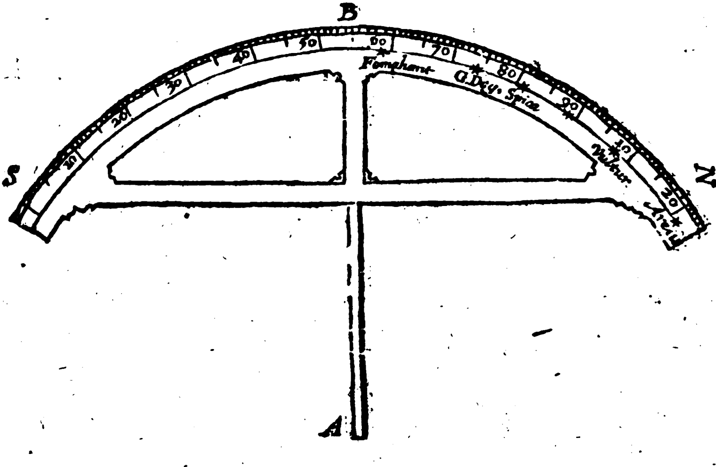
These questions well considered, and either resolued by the Staffe, or pricked downe on the Chart, and compared with the globe and the common *Sea-chart*, shall giue some light to the direction of a course, and reduction of places to their due longitude, which are now fouly distorted in the common Sea-charts.

# An Appendix concerning

## *The description and vse of an instrument, made in forme of a* Crosse-bow, *for the more easie finding of the latitude at Sea.*

THe former *Prop.* suppose the latitnde to be knowne I will here shew how it may be easily obserued.

Vpon the center *A* and sem diameter *A B*, describe an ark of a circle *S B N*. The same semidiameter will set of 60 *gr.* from *B* unto *S* for the South end, and other 60 *gr.* from B vnto *N* for the North end of the Bow: so the whole Bow will containe 120 *gr.* the third part of a circle. Let it therefore be diuided into so many degrees, and each degree subdiuided into six parts, that each part may be ten minutes: but let the numbers set to it be 5. 10. 15 vnto 90 *gr.* and then againe 5. 10. 15, vnto 25, that 55 may fall in the middle, as in this figure.




The Bow being thus diuided and numbred, you may set the

the

the moneths and dayes of each moneth upon the backe, and such starres as are fit for obseruation vpon the side of the Bow.

If you desire to make vse of it in North latitude, you may number 23 gr. 30 *m.* from 90 towards the end of the Bow at N, and there place the tenth day of Iune. And 23 *gr.*30 *m.* from 90 towards *S*; and there at *66 gr.* 30 *m* place the tenth day of December. And to the rest of the dayes of the yeare, according to the declination of the Sunne at the same dayes.

The starres may be placed in like maner according to their declinations.

| | | |
|---|---|---|
| Arcturus | 21 *gr.* | 10 *m.* |
| The Buls eye | 15 | 42 |
| The Lions heart | 13 | 45 |
| The Vultures heart | 7 | 58 |
| The little dog | 6 | 9 |

from 90 toward the North end of the Bow at N. Then for Southerne starres, you may number their declination from 90 toward the South end of the Bow at S. As first the three starres in *Orions* girdle,

| | | |
|---|---|---|
| In *Orions* girdle the first at | 0 *gr.* | 27 *m.* |
| second | 1 | 28 |
| third | 2 | 11 |
| The Hydra's heart | 7 | 5 |
| The virgins spike | 9 | 10 |
| The great dog | 16 | 12 |
| Aquaries leg | 20 | |
| The Whales taile | 18 | |
| The Scorpions heart | 25 | 30 |
| Fomahant | 31 | 30 |

And so the South crowne, the triangle, the clouds, the crosiers, or what other starres you think fit for obseruation. This I call the fore side of the Bow.

If you desire to make vse of it in South latitude, you may turne the Bow, and divide the backe side of it, and number it in like maner; and then put on the months and dayes of the yeare, placing the tenth of December at the *South* end, and the tenth of Iune toward the middle of the Bow, and the reſt of the dayes according to the Sunnes declination as before.

The chiefeſt of the Northerne ſtarres may here be placed in like maner according to their declination, Anno 1625.

| | | |
|---|---|---|
| The pole ſtarre at | 87 *gr.* | 20 *m.* |
| The firſt guard | 75 | 45 |
| The ſecond guard | 73 | 25 |
| The great Beares backe | 63 | 45 |
| In the great Beares taile — firſt | 58 | 2 |
| In the great Beares taile — ſecond | 57 | 55 |
| In the great Beares taile — third | 51 | 15 |
| The ſide of Perſeus | 48 | 28 |
| The goate | 45 | 33 |
| The taile of the ſwan | 44 | 0 |
| The head of Meduſa | 39 | 30 |
| The harp | 38 | 30 |
| Caſtor | 32 | 38 |
| Pollux | 28 | 52 |
| The North crowne | 28 | 0 |
| The Rams head | 21 | 40 |
| Arcturus | 21 | 10 |
| The Buls eye | 15 | 42 |
| The Lions heart | 13 | 45 |
| The Vultures heart | 7 | 58 |
| Orions right ſhoulder | 7 | 17 |
| Orions left ſhoulder | 5 | 57 |

And ſo any other ſtarre, whoſe declination is knowne vnto you, which being done. The vſe of this Bow may be.

1 *The*

## 1 *The day of the moneth being knowne, to finde the declination of the Sunne.*

## 2 *The declination being giuen, to finde the day of the moneth.*

These two *Prop.* depend on the making of the Bow. If the day be knowne, looke it out in the backe of the Bow: so the declination will appeare in the side. Or if the declination be knowne, the day of the moneth is set ouer against it. As if the day of the moneth were the 14 of Iuly: looke for this day in the backe of the Bow, and you shall find it ouer against 20 *gr.* of North declination. If the declination giuen be 20 *gr.* to the Southward, you shall find the day to be either the eleuenth of November, or the eleuenth of Ianuary.

## 3 *To find the altitude of the Sunne or starres.*

Here it is fit to haue two running sights, which may be easily moued on the backe of the Bow. The vpper sight may be set either to 60 *gr.* or to 70 *gr.* or to 80 *gr.* as you shall find to be most conuenient: the other sight may be set on, to any place betweene the midle and the other end of the Bow. Then with the one hand hold the center of the Bow to your eye, so as you may see the Sunne or starre by the vpper sight, and with the other hand moue the lower sight vp or downe vntill haue you brought one of the edges of it to be euen with the horizon (as when you obserue with the Crosse-staffe:) so the degrees contained betweene that edge and the vpper sight, shall shew the altitude required.

Thus

Thus if the vpper sight shall be at 80 *gr.* and the lower sight at 50 *gr.* the altitude required is 30 *gr.*

### 6 *To find any North latitude, by the meridian altitude of the Sun at a forward observation knowing either the day of the moneth, or the declination of the Sunne.*

As oft as you are to obserue in North latitude, place both the sights on the fore side of the Bow, the vpper sight to the declination of the Sunne, or the day of the moneth at the North end, and the lower sight toward the South end. Then when the Sunne cometh to the meridian, turne your face to the South, and with the one hand hold the center of the Bow to your eye, so as you may see the Sunne by the vpper sight; with the other hand moue the lower sight, vntill you haue brought one of the edges of it to be euen with the horizon: so that edge of the lower sight shall shew the latitude of the place in the fore side of the Bow.

Thus being in North latitude vpon the ninth of October: if I set the vpper sight to this day, at the fore side and North end of the Bow, I shall find it to fall to the Southward of 90 vpon 80 *gr.* and therefore at 10 *gr.* of South declination. Then the Sunne coming to the meridian, I may set the center of the Bow to mine eye, as if I went to find the altitude of the Sunne, holding the North end of the Bow vpward, with the vpper sight betweene mine eye and the Sunne, and mouing the lower sight, vntill it come to be euen with the horizon. If here the lower sight shall stay at 50 *gr.* I may well say, that the latitude is 90 *gr.* For the meridian altitude of the Sunne is 30 *gr.* by the third *Prop.* and the Sunne hauing 10 *gr.* of South declination, the meridian altitude of the æquator would be 40 *gr.* and therefore the obseruation was made in 50 *gr.* of North latitude.

By the same reason, if the lower side had stayed at 51 *gr.* 30 *m.* the latitude must have been 51 *gr.* 30 *m.* and so in the rest.

### 5 *To find any North latitude, by the meridian altitude of the starres to the Southward.*

Let the vpper sight be set to the starre, which you intend to obserue, here placed in the fore side of the Bow. Then hold the North end of the Bow vpward, and turning your face to the *S*outh, obserue the meridian altitude as before: so the lower sight shall shew the latitude of the place in the fore side of the Bow.

Thus if in obseruing the meridian altitude of the great Dog-starre, the lower sight shall stay at 50 *gr*. it would shew the latitude to be 50 *gr*. For this starre being here placed at 73 *gr*. 48 *m*. if we take thence 50 *gr*. his meridian altitude would be 23 *gr*. 48 *m*. to this if we adde 16 *gr*. 12 *m*. for the South declination of this starre, it would shew the meridian altitude of the equator to be 40 *gr*. and therefore the latitude to be 50 *gr*.

### 6 *To find any North latitude, by the meridian altitude of the starres to the Northward.*

If the Bow be intended onely for north latitude it may suffice to haue the degrees diuided onely on the foreside, and then the starres to the northward may be placed either on the backside or the inside of the Bow by these degrees: the pole starre at 87 *gr*. 20 *m*. neere the 20 day of *September*, the formost guard at 75 *gr*. 45 *m*. the hindmost guard at 73 *gr*. 25 *m*. and the rest according to their declinations before mentioned so the 90 *degree* shall represent the north pole of the world.

When any of these starres come to be in the meridian and vnder the pole set the vpper sight to that starre, hold the north end of the Bow vpward and turning your face to the north obserue his altitude as before so the degrees contained between the 90 degree and the lower sight shall shew the altitude of the pole.

Thus the former guard coming to be in the meridian vnder the pole if you obserue and find the lower sight to stay at 40 *gr.* the eleuation of the pole is 50 *gr.* according to the distance betweene 40 and 90.

If you would obserue any of these starres at such time as they come to be in the meridian and aboue the pole, you may place these starres in the Bow aboue 90 *gr.* the north starre at 2 *gr.* 40 *m.* neere the fourth day of *September* the formost guard at 14 *gr.* 15 *m.* the hindmost guard at 16 *gr.* 35 *m.* and such others as you thinke fittest according to their distance from the pole: then setting the vpper sight to the place of the starre aboue the pole, the rest of the obseruation will be the same as before.

But if the Bow be made to serue at large both in South and north latitude then these northerne starres would be let placed on the backside of the Bow by the degrees on that side according to the complement of their declinations, that the north starres may answer to the north sun in south latitude in such sort as the southerne starres did to the south sun in north latitude in the former *Prop.* This being done let the vpper sight be set to the stare which you intend to obserue, here placed on the backe side of the Bow. Then hold the North end of the Bow vpward. and turning your face to the North, obserue the altitude of the starre when he cometh to be in the meridian and vnder the pole: so the lower sight shall shew the altitude of the pole in the back side of the Bow.

Thus the former guard coming to be in the meridian vnder the pole, if you obserue and find the lower sight to stay at 50 *gr.* such is the eleuation of the pole, and the latitude of the place to the Northward. For the distance betweene the two sights will shew the altitude to be 35 *gr.* 45 *m.* & the star is 14 *gr.* 15 *m.* distant from the North pole. These two do make vp 50 *gr.* for the eleuation of the North pole, and therefore such is the North latitude.

### 7 *To find any South latitude, by the meridian altitude of the sun at a forward obseruation, knowing either the day of the moneth, or the declination of the Sunne.*

When you are come into South latitude, turne both your sights to the backside of the Bow; the vpper sight to the declination of the Sun, or the day of the moneth at the *South* end, and the lower sight toward the North end of the Bow. Then the Sun coming to the meridian, turne your face to the north, and holding the South end of the Bow vpward, obserue the meridian altitude as before: so the lower sight shall shew the latitude of the place in the backe side of the Bow.

Thus being in South latitude, vpon the tenth of May if you obserue and find the lower sight to stay at 30 *gr.* on the back side of the Bow, such is the latitude. For the declination is 20 *gr.* northward, the altitude of the *Sunne* betweene the two sights 40 *gr.* the altitude of the equator 60 *gr.* and therefore the latitude 30 *gr.*

### 8 *To find any South latitude, by the meridian altitude of the Starres to the Northward.*

Let the vpper sight be set to the starre which you intend to obserue, here placed on the backe side of the Bow. Then hold the *South* end of the Bow vpward, and turning your face to the north, obserue the meridian altitude as before: so the lower sight shall shew the latitude of the place in the back side of the Bow.

Thus being in South latitude, and the former guard comming to be in the meridian ouer the pole. If you obserue and finde the lower sight to stay at 5 *gr.* such is the latitude. For this starre is 14 *gr.* 15 *m.* from the north pole, the altitude of the starre betweene the two sights 9 *gr.* 15 *m.* the north pole depressed 5 *gr.* and therefore the latitude 5 *gr.* to the Southward.

## 9 *To obserue the altitude of the Sunne by the Bow or with an Astrolabe.*

Here it is fit to haue a third sight (like to the horizontall sight belonging to the staffe) which may be set to the center of the Bow.

If the sun be neere to the zenith, hold the Bow as when you obserue with the *Astrolabe*, so as the center being downward the line *A B* may be verticall and the line S *N* parallel to the horizon, then turning one end of the Bow toward the sun you may moue one of the sights on the back of the Bow, vntill the shadow thereof fall on the middle of the horizontall sight so the degrees contained betweene the verticall line *A* B and that vpper sight shall shew the distance of the Sunne from the zenith.

If the sunne be neerer to the horizon, you may hold the Bow so as the line S *N* may be verticall and the line *A*B parallell to the horizon, then obseruing as before the degrees contained between the line *A*B and the vpper sight shall shew the altitude of the sun aboue the horizon.

## 10 *To find a south latitude by the meridian altitude of the starres to the Southward.*

Let the vpper sight be set to the starre which you intend to obserue which might be here placed on the fore side of the Bow by the complement of their declinations if we knew the true place of such as neere to the south pole.

Then hold the south end of the Bow vpward and turning your face to the south, obserue the altitude when he cometh to be in the meridian and vnder the pole so the

lower

lower sight shall shew the altitude of the pole in the fore side of the Bow.

## 11 *To obserue the altitude of the Sunne backward.*

Set the vpper sight either to 60, or 70, or 80 *gr.* as you shall find it to be most conuenient, the lower sight on any place betweene the middle and the other end of the Bow, and haue an horizontall sight to be set to the center. Then may you turne your backe to the Sunne, and the back of the Bow toward your selfe, looking by the lower sight through the horizontall sight, and mouing the lower sight vp & downe, vntill the vpper sight doe cast a shadow vpon the middle of the horizontall sight: the degrees contained betweene the two sights on the Bow, shall giue the altitude requi-rd.

Thus if the vpper sight shall be at 80 *gr.* and the lower sight at 50 *gr.* the altitude required is 30 *gr.* as in the third *Prop.*

Or if you tourne the other end of the bowe vpward and set the vpper sight to the beginning of the quadrant and then obserue as before, the lower sight will shew the altitude.

## 12 *To find any North latitude by the meridian altitude of the sun at a backe obseruation, knowing either the day of the moneth, or the declination of the Sunne.*

Place your three sights as before on the fore side of the Bow: the vpper sight to the declination of the *Sun*, or to day of the moneth, at the North end; the lower sight toward the South end of the Bow; and the horizontall sight to the center. Then the Sunne coming to the meridian, turne your face to the North, & holding the North end of the Bow vpward, the South end downeward, with the back of it toward your selfe, obserue the shadow of the vpper sight as in the former part of the, 5 *Prop.* so the lower sight shall shew the latitude of the place in the fore side of the Bow.

Thus being in North latitude vpon the ninth of October, if you obserue and find the lower sight to stay at 50 *gr.* on the fore side of the Bow, such is the latitude. For the declination is 10 *gr.* Southward, and the altitude of the Sunne betweene the two sights 30 *gr.* the altitude of the equator 40 *gr.* and therefore the latitude 50 *gr.* as in the sixth *Prop.*

13 *To find any South latitude by the meridian altitude of the sun at a back obseruation, knowing either the day of the moneth, or the declination of the Sunne.*

When you obserue in South latitude, place your three sights on the backe side of the Bow: the vpper sight to the declination of the Sunne, or the day of the moneth at the South end; the lower sight toward the North end of the Bow, and the horizontall sight to the center. Then the Sun coming to the meridian, turne your face to the South, and holding the South end of the Bow vpward, with the backe of it toward your selfe, obserue the shadow of the vpper sight as before: so the lower sight shall shew the latitude of the place in the back side of the Bow.

Thus being in the South latitude vpon the tenth of May, if you obserue and find the lower sight to stay at 30 *gr.* on the backe of the Bow, such is the latitude of the Sunne betweene the

the two sights 40 *gr.* the altitude of the equator 60 *gr.* and therefore the latitude 30 *gr.* as in the seuenth *Prop.*

### 14 *To find the day of the moneth, by knowing the latitude of the place, and obseruing the meridian altitude of the Sunne.*

Place your three sights according to your latitude; the horizontall sight to the center, the lower sight to the latitude, and the vpper sight among the moneths. Then when the Sunne cometh to the meridian, obserue the altitude, looking by the lower sight through the horizontall, and keeping the lower sight still at the latitude, but mouing the vpper sight vntil it giue shadow vpon the middle of the horizontal sight: so the vpper sight shall shew the day of the moneth required.

Thus in our latitude if you set the lower sight to 51 *gr.* 30 *m.* and obseruing finde the altitude of the Sunne betweene that and the vpper sight to be 28 *gr.* 30 *m.* this vpper sight will fall vpon the ninth of October, and the twelfth of Februarie. And if yet you doubt which of them two is the day, you may expect another meridian altitude; and then if you find the vpper sight vpon the tenth of October, and the eleuenth of Februarie, the question will be soone resolued.

### 15 *To find the declination of any vnknowne starre, and so to place it on the* Bow, *knowing the latitude of the place, and obseruing the Meridian altitude of the Starre.*

☞ When you find a starre in the Meridian that is fit for obseruation. Set the center of the Bow to your eye, the lower sight

sight to the latitude, and moue the vpper sight vp or downe vntill you see the horizon by the lower sight, and the starre by the vpper sight, then will the vpper sight stay at the declination and place of the starre.

Thus being in 20 *gr.* of North latitude, if you obserue and find the meridian altitude of the head of the Crosier to be 14 *gr.* 50 *m.* The vpper sight will stay at 34 *gr.* 50 *m.* and there may you place this starre. For by this obseruation the distance of this starre from the South pole should be 34 *gr.* 50 *m.* and the declination from the equator 55 *gr.* 10 *m.* And so for the rest:

The starres which I mentioned before, do come to the meridian in this order, after the first point of *Aries.*

### 16 *To find any north latitude on land by obseruation with thread and plummet.*

Set the sight to the day of the moneth at the fore side and south end of the Bow: then when the sun cometh to the meridian turning the north end in your left hand toward the south, so as the sight at the center may shadow the sight at the day, obserue where the thread falleth and abate 20 *gr.* If it fall on 70 *gr.* the latitude is 50 *gr.* If on 71 *gr.* 30 *m.* in the latitude is 51 *gr.* 30 in. And so in the rest

If the Bow had ben made onely for finding the latitude on land I might then haue set such numbers to it as needed no allowance.

### 17 *To find any south latitude on land by obseruation with thread and plummett.*

Set the sight to the day of the moneth at the back side and north end of the Bow, and when the sun cometh to the meridian turning the south en di your left hand toward the north obserue as before, and abate 20 degrees.

Or

¶ Or you may set the sight to the day of the moneth at the fore side and north end of the Bow, and so obseruing as before, the thread will fall on the complement of the latitude.

| | Ho. | Mi. | | Ho. | Mi. |
|---|---|---|---|---|---|
| The pole starre at | 0 | 29 | The lions hart | 9 | 48 |
| The rams head | 1 | 46 | The great bearesbacke | 10 | 40 |
| The head of Medusa | 2 | 44 | First in gr beares taile | 12 | 27 |
| The side of Perseus | 2 | 58 | The Virgins spike | 13 | 5 |
| The Buls eye. | 4 | 15 | Second in gi beares taile | 13 | 9 |
| The goate | 4 | 49 | Third iu gr. beares taile | 13 | 33 |
| Orions left shoulder | 5 | 5 | Arcturus | 13 | 58 |
| Orions girdle, the first | 5 | 13 | The formost guard | 14 | 52 |
| Orions girdle, the second | 5 | 17 | The North crowne | 15 | 19 |
| Orions girdle, the third. | 5 | 22 | The hindmost guard | 15 | 25 |
| Orions right shoulder | 5 | 35 | Scorpions hart | 16 | 7 |
| The great dog | 6 | 29 | The harpe | 18 | 24 |
| Castor | 7 | 10 | Vulturs hart | 19 | 33 |
| The little dog | 7 | 20 | Swans taile | 20 | 29 |
| Pollux | 7 | 22 | Fomahant | 22 | 36 |
| The Hydra's hart | 9 | 9 | | | |

| Anno 1624 | R. Ascen. | | Declin: | | M. |
|---|---|---|---|---|---|
| Pole starre | 6 | 28 | 87 | 20 | 2 |
| | 294 | 28 | 86 | 35 | 4 |
| Little beare | 261 | 56 | 82 | 33 | 4 |
| | 239 | 54 | 79 | 0 | 4 |
| | 246 | 44 | 76 | 38 | 5 |
| First guard | 222 | 57 | 75 | 45 | 2 |
| Second guard | 231 | 18 | 73 | 25 | 3 |
| Gr. beare | | | | | |
| Snout | 117 | 48 | 51 | 40 | 4 |
| eye | 120 | 30 | 64 | 30 | 4 |
| Forehead | 124 | 15 | 68 | 30 | |
| | 126 | 40 | 68 | 0 | |
| Eare | 131 | 15 | 71 | 15 | 5 |
| Necke | 131 | 30 | 63 | 50 | |
| | 142 | 10 | 62 | 15 | |
| brest | 143 | 50 | 61 | 25 | |
| | 140 | 40 | 60 | 0 | |
| Knee | 135 | 30 | 53 | 40 | 3 |
| Right foot | 129 | 00 | 48 | 50 | 3 |
| | 127 | 00 | 48 | 40 | 3 |
| In the square | 160 | 3 | 63 | 46 | 2 |
| | 159 | 38 | 58 | 22 | 2 |
| | 173 | 24 | 55 | 48 | 2 |
| | 179 | 10 | 59 | 6 | 2 |
| In the taile | 189 | 20 | 58 | 2 | 2 |
| | 197 | 10 | 56 | 55 | 2 |
| | 203 | 2 | 51 | 16 | 2 |
| Casiopea | | | | | |
| Head | 4 | 10 | 51 | 50 | 4 |
| Brest | 4 | 57 | 54 | 30 | 3 |
| Waste | 6 | 45 | 55 | 50 | 4 |
| Belly | 8 | 44 | 58 | 40 | 3 |
| Knee | 15 | 50 | 58 | 15 | 3 |
| Thygh | 22 | 15 | 61 | 58 | 3 |
| Foot | 29 | 45 | 65 | 40 | 4 |
| Chaire | 3 | 10 | 60 | 50 | 4 |
| | 357 | 25 | 57 | 0 | 3 |
| Auriga | | | | | |
| Head | 81 | 0 | 0 | 0 | |
| Left. sh. Hircus | 72 | 16 | 45 | 32 | 1 |
| Right should | 83 | 8 | 44 | 51 | 2 |

| Cepheus | R. Ascen | | Decli. | | M. |
|---|---|---|---|---|---|
| Girdle | 320 | 52 | 68 | 56 | 3 |
| lower | | | | | |
| R. should | | | | | |
| Left. should | | | | | |
| Head | | | | | |
| Thighe | | | | | |
| Right foot | | | | | |
| Left foot | | | | | |
| Draco | 454 | | 55 | | . |
| Tongue | | | | | |
| Mouth | | | | | |
| Eye | | | | | |
| Cheeke | | | | | |
| Head | 267 | 0 | 51 | 36 | 3 |
| In the 1 winding | 2 | | | | |
| | 2 | | | | |
| | 2 | | | | |
| | 2 | | | | |
| Vnd. that w | 2 | | | | |
| In the □ of the 2 winding | 2 | | | | |
| | . | | | | |
| | . | | | | |
| | . | | | | |
| In the first △ | . | | | | |
| | . | | | | |
| | . | | | | |
| In the second △ | . | | | | |
| | . | | | | |
| | . | | | | |
| In the 3 winding nere the pole of the zodiac. | . | | | | |
| | . | | | | |
| | . | | | | |
| | . | | | | |
| Before the fourth winding | | | | | |
| After the winding in the taile | | | | | |

The end of the second booke of the crosstaffe.

# THE THIRD BOOKE.

## of the vse of the lines of Numbers, *Sines and Tangents for the drawing of Houre-lines on all sorts of Planes.*

THERE are ten seuerall sorts of Planes, which take their denomination from those great circles to which they are parallels, and may sufficiently for our vse be represented in this one fundamentall Diagram and be knowne by their horizontall and perpendicular lines, of such as know the latitude of the place, and the circles of the sphære.

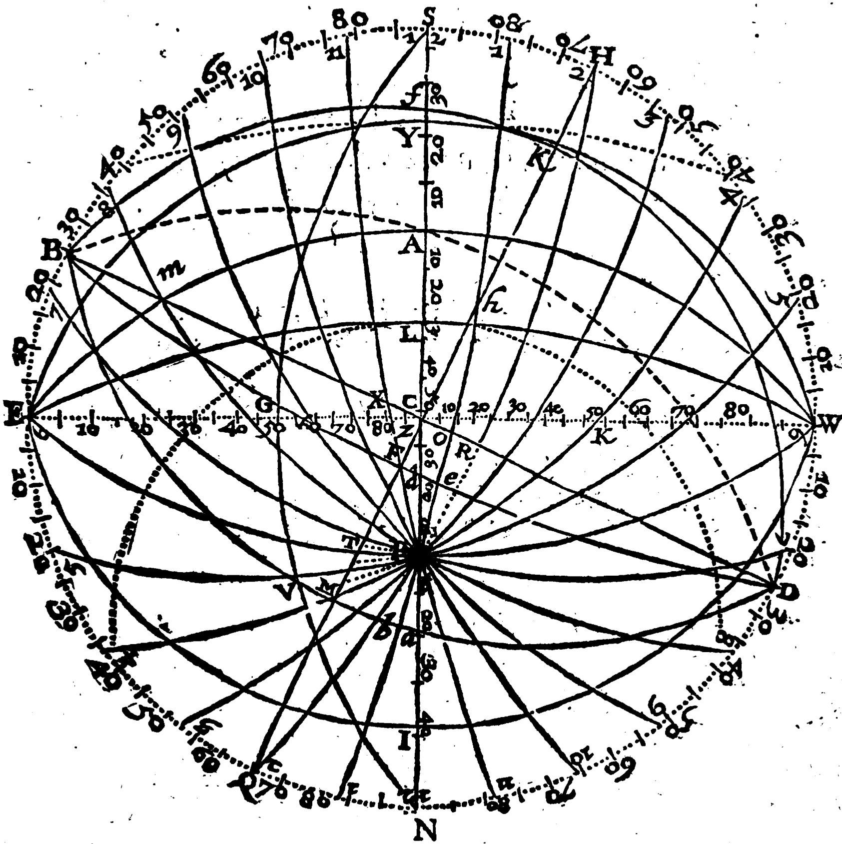
1 An horizontall plane parallell to the horizon, here represented by the outward circle *E S W N*.

2 A verticall plane parallell to the prime verticall circle which passeth through the zenith and the points of East and West in the horizon, and is right to the horizon and the meridian; that is, maketh right angles with them both. This is represented by *E Z W*.

3 A polar plane parallell to the circle of the houre of 6, which passeth through the pole and the points of East and West, being right to the Equinoctiall and the Meridian, but inclining to the horizon, with an angle equall to the latitude. This is here represented by *E P W*.

4 An æquinoctiall plane parallell to the Equinoctiall, which passeth through the points of East and West, being right to the Meridian, but inclining to the Horizon, with an angle equall to the complement of the latitude. This is here represented by *E A W*.

5 A verticall plane inclining to the horizon, parallell to any great circle, which passeth through the points of East and West, being right to the meridian, but inclining to the horizon, and yet not passing through the pole, nor parallell

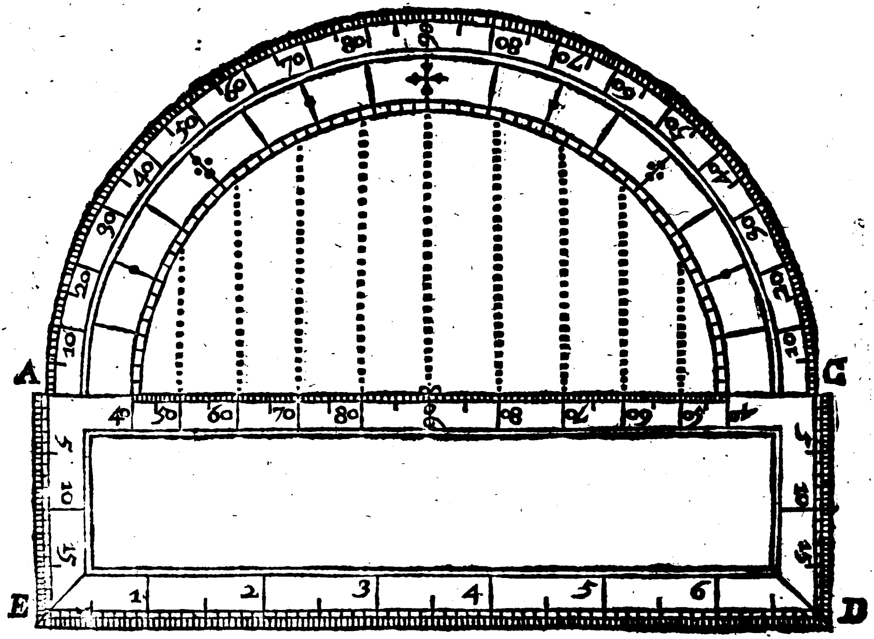


to the æquinoctiall. This is here represented either by *E I W*, or *E Y W*, or *E L W*.

6 A meridian plane parallell to the meridian, the circle of the houre of 12, which passeth through the zenith, the pole, and the points of South and North, being right to the horizon, and the prime verticall. This is here represented by *S Z N*.

7 A meridian plane inclining to the horizon, parallell to any great circle, which passeth through the points of South and North, being right to the prime verticall, but inclining

## The Protractor.




Place the figure page 116 of the *Sector.*

17.

clining to to the horizon. This is here represented by *SGN*.

8 A verticall declining plane, parallell to any great circle, which passeth through the zenith, being right to the horizon, but inclining to the meridian. This is represented by *BZD*.

9 A polar declining plane, parallell to any great circle, which passeth through the pole, being right to the equinoctiall, but inclining to the meridian. This is here represented by *HPQ*.

10 A declining inclining plane, parallell to any great circle, which is right to none of the former circles, but declining from the prime verticall, and inclining both to the horizon and the meridian, and all the houre circles. This may be here represented either by *BMD*, or *BFD*, or *BKD*, or any such great circle, which passeth neither through the South and North, nor East and West points, nor through the zenith nor the pole.

Each of these planes (except the horizontall) hath two faces whereon houre-lines may be drawne; and so there are 19 planer in all. The meridian plane hath one face to the East, and another to the West: the other verticall planes haue one to the South, and another to the North, and the rest one to the zenith, and another to the nadir: but what is said of the one, may be vnderstood of the other.

## *To describe the fundamentall Diagram.*

The description of this *diagram* is set downe at large in the vse of the *Sector* Pag. 65. but for this purpose it may suffice if it haue the verticall circle, the houre circles, the equator and the tropiques first drawne in it, other circles may be supplyed afterward as we shall haue vse of them. And those may be readily drawne in this maner.

Let the outward circle representing the horizon be drawne and diuided into foure equall parts with *SN* the meridian & *EW* the verticall and each fourth part into 90 *gr.* That done lay a ruler to the poynt S, and each degree in the quadrant *E N* and note the interſections where the ruler croſſeth the verticall, ſo ſhall the ſemidiameter *EC* be diuided into other 90 *gr.* and from thence the other ſemidiameters may be diuided in the ſame ſort. Theſe may be numbered with 10. 20 30. &c. from *E* toward *C*, and for varietie with 10. 20. 30. &c. from *C* toward *W*. But for the meridian the *S*outh part would be beſt numbered according to the declination from the equator and the North part according to the diſtance from the pole.

Then with reſpect vnto the latitude which here we ſuppoſe to be 51 *gr.* 30 *m.* Open the compaſſes vnto 38 *gr.* 30 *m.* from *C* toward *W*, and prick them downe in the meridian from *C* vnto *P* ſo this point *P* ſhall repreſent the pole of the world, and through it muſt be drawne all the houre circles.

Hauing three points *E*, *P*, *W*, finde their center which will fall in the meridian a little without the point *S*, and draw them into a circle *EPW*, which will be the circle of the houre of 6.

Through this center of the houre of 6, draw an occult line at length parallell to *EW*, ſo this line ſhall containe the centers of all the other houre circles. Where the circle of the houre of 6 croſſeth this occult line, there will be the centers of the houre circles of 9 and 3. The diſtance between theſe centers of 9 and 3, will be equall to the ſemidiameters of the houre circles of 10 and 2. And where theſe two circles of 10 and 2 ſhall croſſe this occult line there will be the centers for the houre circles of 11 & 7 & 5 and 1. Againe diuide the diſtance between the centers of 10 and 2, into three equall parts, ſo the feet of the compaſſes will reſt in two points: the one is the center of the houre circle of 8, and the other the center of the houre circle of 4. & the extent of the compaſſes to one of theſe third parts ſhall be the true ſemidiameter of theſe circles if there be no error committed in the finding of the other centers.

The

The houre circles being thus drawne, take 51 *gr.* 30 *m.* from *C* toward *W* and prick them downe in the South part of the meridian from *C* vnto *A*, and bring the third point *E*, *A*, *W*, into a circle this circle so drawne shall represent the equator.

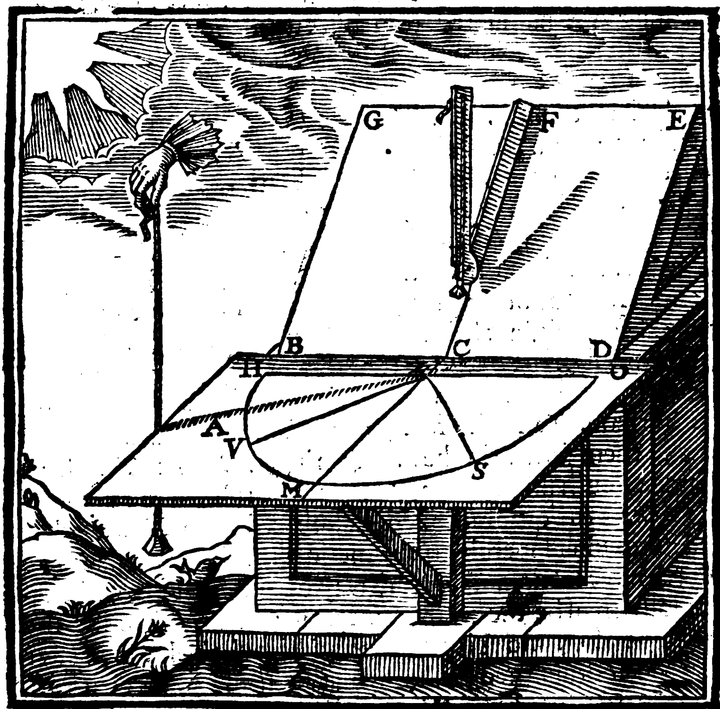
The tropique of ♋ is 23 *gr.* 30 *m.* aboue the equator, and 66 *gr.* 30 *m.* distant from the pole, and so in this latitude it will crosse the South part of the meridian at 28 *gr.* from the zenith, and the North part of the meridian at 15 *gr.* below the horizon. Take therfore 28 *gr.* frō *C* toward *W* & princk them downe in the meridian from *C* vnto *L*, so haue you the South intersection. Then lay the ruler to the point *E* & 15 *gr.* in the quadrant *NE* numbered from *N* toward *E*, and note where it crosseth the meridian, so shall you haue the North intersection. The halfe way between these two intersections will fall in the meridian at the point a a a a, & the circle drawne on the center a, and semidiameter a *L*, shall represent the tropique of ♋, and here crosse the horizon before 4 in the morning & after 8 in the euening, about 40 *gr.* nortwhard from *E* and *W.* according to the rising and setting of the sun at his entrance into ♋.

The tropique of ♑ is 23 *gr.* 30 *m.* below the equator, & 113 *gr.* 30 *m.* distant from the north pole, so that in this latitude it crosseth the South part of the meridian at 75 *gr.* from the zenith, and the north part of the meridian at 62 *gr.* below the horizon. Take therfore 75 *gr.* from *C* toward W, and pricke them downe in the meridian from *C* vnto *T* so haue you the South intersection, then lay the ruler to the point *E* & 62 *gr.* in the quadrant *NE* numbered from *N* toward *E* and note where it crosseth the meridian, so shall you haue the North niter section. The halfe way between these two intersections shall be the center whereon you may describe the tropique of ♑. and this tropique will crosse the horizon after 8 in the morning and before 4 in the euening, about 40 *gr.* southward from *E* and W. according to the rising and setting of the sun at his entrance into ♑.

## To find the inclination of any Plane.

For the diſtinguiſhing of theſe Planes we may finde whether they be horizontall, or verticall, or inclining to the horizon, and how much they incline, either by the vſuall inclinatorie quadrant, or by fitting a thread and plummet vnto the *Sector*.

For let the *Sector* be opened to a right angle, the lines of *Sines* to an angle of 92 *gr.* the inward edges of the *Sector* to 90 *gr.* and let a thread and plummet be hanged vpon a line




parallell to the edges of one of the legs, ſo that leg ſhall be verticall, and the other leg parallell to the horizon.

If

If the plane seeme to be verticall (like the wall of an vpright building) you may trie it by holding the *Sector*, so that the thread may fall vpon his plumet line. For then if the verticall edge of the *Sector* shall lie close to the plane, the plane is erect, and therefore said to be verticall; and if you draw a line by that edge of the *Sector*, it shall be a verticall line.

If the plane seeme to be leuell with the horizon, you may trie it by setting the horizontall leg of the Sector to the plane, and holding the other leg vpright: for then if the thread shall fall on his plummet line, which way soeuer you turne the *Sector*, it is an horizontall plane.

If the one end of the plane be higher then the other, and yet not verticall, it is an inclining plane, and you may find the inclination in this manner.

First hold the verticall leg of the Sector vpright, and turne the horizontall leg about, vntill it lie close with the plane, and the thread fall on his plummet line so the line drawne by the edge of that horizontall leg, shall be an horizontall line.

Suppose the plane to be B *G E D*, and that B *D* were thus found to be the horizontall line vpon the plane then may you crosse the horizontall line at right angles with a perpendicular *C F*: that done, if you set one of the legs of the *Sector* vpon the perpendicular line *C F*, and make the other leg with a thread and plummet to become verticall, you shall haue the angle betweene the verticall line and the perpendicular on the Plane, as before in the vse of the *Sector*, pag. 50. and the complement of this angle is the inclination of the plane to the horizon.

## *To find the declination of a Plane.*

The declination of a Plane is alwayes reckoned in the horizon betweene the line of East and West, and the horizontall line vpon the plane. As in the fundamentall Diagram, the prime verticall line (which is the line of East and West) is *E C W*; if the horizontall line of the plane proposed shal be B *C D*. the angle of declination is *E C* B.

But because a Plane may decline diuers wayes, that we may the better distinguish them, we consider three lines belonging to euery Plane: the first is the horizontall line; the second the perpendicular line, crossing the horizontall at right angles; the third the axis of the plane, crossing both the horizontall line, and his perpendicular, and the plane it selfe at right angles.

The perpendicular line doth help to find the inclination of the plane as before, the horizontall to finde the declination, the axis to giue denomination vnto the plane.

For example, in a verticall plane in the fundamentall diagram represented by *EZW*, the horizontall line is *ECW*, the same with the line of East & West, & therefore no declination; the perpendicular crossing it is *CZ*, the same with the verticall line, drawne from the center to the zenith, right vnto the horizon, and therefore no inclination. The axis of the plane is *S C* N, the same with the meridian line, drawne from the South to the North, and accordingly giues the denomination to the plane. For the plane hauing two faces, and the axis two poles, S and N; the pole *S* falling directly into the South, doth cause that face to which it is next to be called the South face; and the other pole at N, pointing into the North, doth giue the denomination to the other face, and make it to be called the North face of this plane.

In like manner in the declining inclining plane in the fundamentall diagram represented by B F D, the horizontall line is B C D, which crosseth the prime verticall line *E C W*, & therefore it is called a declining plane, according to the angle of declination *E C* B or *W C D*. The perpendicular to this horizontall line is *C F*, where the point *F* falleth in the plane *Q Z H* perpendicular to the plane proposed, betweene the zenith and the North part of the horizon, and therefore it is called a plane inclining to the Northward, according to the arke *F Q*, or the angle *F C Q*. The axis of the plane is here represented by the line C *K*, where the pole *K* is 90 *gr*. distant

from

from the plane, and so is as much aboue the horizon at H, and the other pole as much below the horizon at Q, as the plane at F is distant from the zenith: and this pole K here falling betweene the meridian and the prime verticall circle into the Southwest part of the world, this vpper face of the plane is therefore called the Southwest face, and the lower the Northeast face of the plane.

The declination from the prime verticall may be found by the needle in the vsuall inclinatorie Quadrant, or rather by comparing the horizontall line drawne vpon the plane with the azimuth of the Sunne and the meridian line, in such sort as before we found the variation of the magneticall needle. For take any boord that hath one side straight, and draw as in the last diagram the line HO parallel to that side, & the line *Z M* perpendicular vnto it, and on the center Z make a semicircle H M O: this done, hold the boord to the plane, so as H O may be parallel to B D the horizontall line on the plane & the boord parallel to the horizon; then the Sun shining vpon it, hold out a thread and plummet, so as the thread being verticall, the shadow of the Sunne may fall on the center *Z*, and draw the line of shadow *A* Z representing the common section, which the Azimuth of the Sunne makes with the plane of the horizon, and let another take the altitude of the Sunne at the same instant: so by resoluing a triangle, as I shewed before pag. 65 you may find what Azimuth the Sun was in when he gaue shadow vpon *A* Z.

Suppose the azimuth to be (as before pag. 64:) 72 *gr.* 52 *m.* from the North to the Westward, and therefore 17 *gr.* 8 *m.* from the West, we may allow these 17 *gr.* 8 *m.* from *A* vnto *V*, and draw the line *ZV*, and so we haue the true West point of the prime verticall line: then allowing 90 *gr.* from *V* vnto *S*, we haue the South point of the meridian line *ZS*, and the angle H Z V shall giue the declination of the plane from the verticall, and the angle O Z S the declination of the plane from the meridian.

Or we may take out onely the angle A Z H, which the line of shadow makes with the horizantall line of the plane, and compare it with the angle *AZV*, which the line of shadow makes with the prime verticall. And so here if *AZV* the Sunnes Azimuth shall be 17 *gr*. 8 *m* past the West, and yet the line of shadow *AZ* 7 *gr*. 12 *m*. short of the plane, the declination of the plane shall be 24 *gr*. 20 *m*. as may appeare by the site of the plane and the circles.

If the altitude of the Sunne be taken at such time as the shadow of the thread falleth on B D or H O, and then a triangle resolued, the declination of the plane will be such as the Azimuth of the Sunne from the prime verticall.

If at such a time as the shadow falleth on *MZ*, the declination will be such as the Azimuth of the Sunne from the meridian.

If it be a faire Summers day you may first finde what altitude the Sunne will haue when he cometh to be due East or West, and then expect vntill he come to that altitude; so the declination of the plane shall be such as the angle contained betweene the line H O and the line of the shadow.

Hauing distinguished the Planes, the next care will be for the placing of the style and the drawing of the houre-lines.

The style will be as the axis of the world, sometimes parallel to the plane, sometimes perpendicular, sometimes cut the plane with oblique angles.

The houre-lines will be either parallell one to the other, or meete in a center with equall angles, or meete with vnequall angles. If the style be perpendicular to the plane, the angles at the center will be equall; and this falls out onely in the South and North face of an equinoctiall plane: if the style be parallel to the plane, the houre-lines will be also parallell one to another; and this falls out in all polar planes, as in the East and West meridian planes parallel to the circle of the houre of 12, in the vpper and lower direct polars parallell to the circles of the houre of 6, and in the vpper and lower declining polars which are parallel to any of the other houre circles.

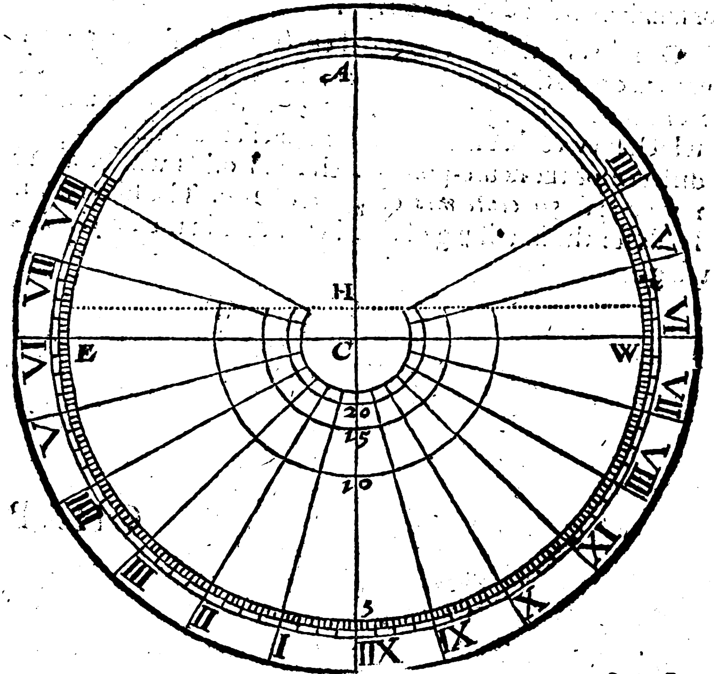
But

But in the horizontall and all other planes, the style will cut the plane with an acute angle, and the houre lines will meet at the root of the style, and there make vnequall angles.

## CHAP. I.

### *To draw the houre-lines in an equinoctiall Plane.*

AN equinoctiall plane is that which is parallell to the equinoctiall circle here represented by *E A V*, wherein the

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spaces betweene the houre circles being equall, there is no need of further precept, but onely to draw a circle and to diuide it into 24 equall parts for the 24 houres, and subdiuide each houre into halues and quarters, and then to set vp the style perpendicular to the plane in the center of the circle. The help which these lines of proportion doe here affoord vs, is onely in the diuision of the circle, which may be done readily by that which I shewed before, *Pag.* 29.

For example, suppose the semidiameter of the equinoctiall circle to be six inches, and that it were required to know the distance of the houre-points each from other: here each houre being 15 *gr.* distant from other, I extend the compasses from the sine of 30 *gr.* vnto the sine of 7 *gr.* 30 *m.* the halfe of 15 *gr.* and I find the same extent to reach in the line of numbers from 6.00 vnto 1.56.

Or in crosse worke I extend them from the sine of 30 *gr.* vnto 6.00 in the line of numbers, the same extent will reach from the sine of 7 *gr.* 30 *m.* vnto 1.56 in the line of numbers; which shewes that in a circle of six inches semidiameter, the distance of the houre-points each from other will be about 1 inch and 56 *centesmes* or parts of 100. The like reason holds for the inscribing of all other chords in the *Prop.* following.

CHAP

## CHAP. II.

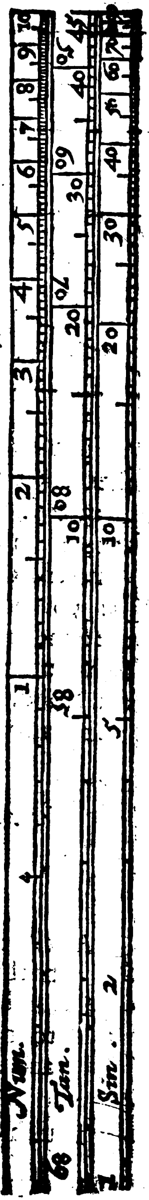
### *To draw the houre-lines in a direct polar plane.*

A Direct polar plane is that which is parallell to the houre of 6, here represented by *E P W*, wherein the style will be parallell to the plane, and the houre-lines parallell one to the other, and therefore may be best drawne by that which I haue shewed in the vse of the *Sector*. They may be allso drawne by the helpe of these lines of proportion, in this maner.

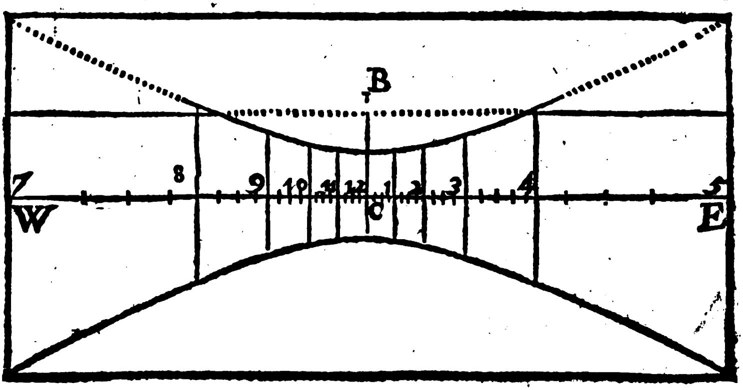
First draw a right line W E for the horizon and the æquator, and crosse it at the point C, about the midle of the line with C B another right line, which may serue for the meridian and the houre of 12, and must also be the substylar line wherein the style shall stand. Then, to proportion the style vnto the plane, consider the length of the horizontall line, and what houre-lines you would haue to fall on your plane.

For the distance of any one houre-line from the meridian being knowne, we may finde both the length of the style and the distance of the rest: because.

As the tangent of the houre giuen,
is to the distance from the meridian:
So the tangent of 45 *gr.*
to the height of the style.




Suppose




Suppose the length of the horizontall line to be 12 inches, and that it were required to put on all the houre-lines from 7 in the morning vnto 5 in the euening. Here we haue 5 houres and 6 inches on either side the meridian. Wherefore I allow 15 *gr.* for an houre, and extending the compasses from the tangent of 75 *degrees* I find the same extent to reach in the line of numbers from 6. 00 to about 1. 61. This shewes both the height of the style, and the distance of the houre-points of 9 and 3 from the meridian to be 1 inch, 61 parts.

## *To find the length of the Tangent betweene the substylar and the houre-points.*

As the tangent of 45 *gr.*
to the tangent of the houre:
So the height of the style
to the length of the tangent line betweene the substylar and the houre-points.

Thus hauing found the length of the style in our example

ple to be 1. 61, if I extend the compaſſes from the tangent of 45 *gr.* vnto the tangent of 15 *gr.* the meaſure of the firſt houre from the ſubſtylar, I ſhall find the ſame extent to reach in the line of numbers from 1.61 vnto 0.43, for the length of the tangent betweene the ſubſtylar and the houre-points of 11 and 1. If I extend them from the tangent of 45 *gr.* vnto the tangent of 75 *gr.* the meaſure of the fift houre, I ſhall finde them to reach in the line of numbers from 1.61 vnto 6.00. for the length of the tangent from the ſubſtylar to the houre-points of 7 and 5. For howſoever it be the ſame diſtant in the line of tangents from 45 vnto 75, as from 45 vnto 15; yet becauſe 75 are more, and 15 leſſe then 45, the tangent lines that anſwer to them wil be accordingly more or leſſe then the length of the ſtyle.

| Ho. | An.Po | | Tang. | |
|---|---|---|---|---|
| | Gr. | M. | In | Pa. |
| 12 | 0 | 0 | 0 | 0 |
| 11. 1 | 15 | 0 | 0 | 43 |
| 10. 2 | 30 | 0 | 0 | 93 |
| 9. 3 | 45 | 0 | 1 | 61 |
| 8. 4 | 60 | 0 | 2 | 79 |
| 7. 5 | 75 | 0 | 6 | 00 |
| 6. 6 | 90 | 0 | infin. | |

Againe, if I extend them from 45 *gr.* in the tangents vnto 30 *gr.* the meaſure of the ſecond houre, I ſhall finde them to reach in the line of numbers from 1. 61 vnto 0. 93 for the houre of 10 and 2; if I extend them from the tangent of 45 *gr.* vnto the tangent of 60 *gr.* for the fourth houre, I ſhall find them to reach in the line of numbers from 1.61 vnto 2 79, and ſuch is the length of the tangent line from the ſubſtylar vnto the houre of 8 and 4. And the like reaſon holdeth for the inſcribing of all other tangent lines in the propoſitions following.

But for ſuch tangents as fall vnder 45 *gr.* I may better vſe croſſe worke, and extend the compaſſes from the tangent of 45 *gr.* vnto 1.61 in the line of numbers, ſo ſhall I finde the ſame extent to reach from 30 *gr.* in the tangents, to 93 parts in the line of numbers, for the diſtance of the ſecond houre, and from 15 *gr.* in the tangents to 43 parts for the diſtance of the firſt houre from the meridian.

Or if this extent from 45 *gr.* backward to 1.61 be too large for the compasses, I may extend them forward from the tangent of 5 *gr.* 43 *m* to 1 61 parts in the line of numbers, & the same extent shall reach from 15 *gr.* in the tangents, to 43 parts in the line of numbers, for the distance of the first houre; and from 30 *gr.* to 93 parts, for the distance of the second houre, as before.

Hauing found the length of the tangent lines in inches and parts of inches, and pricked them in the æquator on both sides of the meridian, from the center C; if we draw right lines through each of those points, crossing the æquator at right angles, they shall be the houre-lines required; and if we set a style ouer the meridian, so as the edge of it be parallel to the plane, and the height of it be as much aboue the meridian as the distance between the meridian and the houre-points of 3 or 9, it shall represent the axis of the world, and be truly placed for the casting of the shadow vpon the houre-lines in a polar plane.

| Hora | Ang Po | | Tang. | |
|---|---|---|---|---|
| | Gr. | M | In. | Pa. |
| 6 | | 0 | | 0 |
| | 3 | 45 | | 165 |
| | 7 | 30 | 1 | 32 |
| | 11 | 15 | 1 | 99 |
| 7 | 15 | 0 | 2 | 68 |
| | 18 | 45 | 3 | 39 |
| | 22 | 30 | 4 | 14 |
| | 26 | 15 | 4 | 93 |
| 8 | 30 | 0 | 5 | 77 |
| | 33 | 45 | 6 | 68 |
| | 37 | 30 | 7 | 67 |
| | 41 | 15 | 8 | 77 |
| 9 | 45 | 0 | 10 | 00 |
| | 48 | 45 | 11 | 40 |
| | 52 | 30 | 3 | 03 |
| | 56 | 15 | 14 | 97 |
| 10 | 60 | 0 | 17 | 32 |
| | 63 | 45 | 20 | 28 |
| | 67 | 30 | 24 | 14 |
| | 71 | 15 | 29 | 46 |
| 11 | 75 | 0 | 37 | 32 |
| | 78 | 45 | 50 | 27 |
| | 82 | 30 | 75 | 96 |
| | 86 | 15 | 152 | 57 |
| 12 | 90 | 0 | Infin. | |

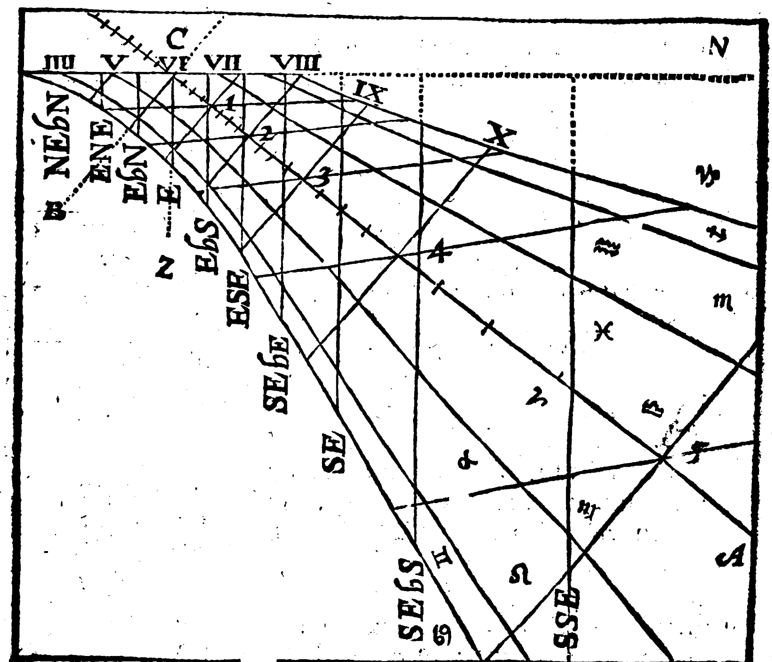
## CHAP. III.

### *To draw the houre-lines in a meridian plane.*

A Meridian plane is that which is parallell to the meridian circle in the fundamentall diagram represented by *S Z N*; it hath two faces, one to the East, and the other to the West; in each of them the style will be parallell to the plane

plane, and the houre-line parallell one to the other, as in a poler plane, the difference being onely in the placing of the æquator and in numbring of the houres.

For in these meridian planes hauing drawne on occult verticall line C Z, and an occult horizontall line C N, crossing one the other at right angles in the point C, the æquator A C will cut the verticall with an angle Z C A, equall to the latitude of the place: then may we crosse the æquator at right angles with the line C B for the houre of 6, and from this set off the houre-points in the æquator as in the former *Prop.*




For supposing the length of the style C B to be ten inches, the length of the tangent line belonging to the first houre wil be 2 *in.* 68 *p.* the length of the second 5 *in* 77 *p.* as in the Table. Then the tangent of 15 *gr.* being prickt downe in the æquator on both sides from 6, shal serue for the houres of 5 and 7, and the tangent of 30 *gr.* for the houres of 4 and 8, and so in the rest. This done, if we draw right lines through each of these points, crossing the æquator at right angles, they shal be the houre lines required: and if we set a style ouer the houre of 6, so as the edge of it may be parallell to the plane, and the height of it may be equall to the distance betweene the houres of 6 and 9 in the æquator, it shall represent the axis of the world, and be truly placed for the casting of the shadow vpon the houre-lines in a meridian plane.

| Latitud | 51 | 30 | | |
|---|---|---|---|---|
| Hou. | Ang.Po | | Arc.Pla. | |
| | Gr. | M. | Gr. | M. |
| 12 | 0 | 0 | 0 | 0 |
| | 3 | 45 | 2 | 56 |
| | 7 | 30 | 5 | 52 |
| | 11 | 15 | 8 | 51 |
| 1 | 15 | 0 | 11 | 50 |
| | 18 | 45 | 14 | 52 |
| | 22 | 30 | 17 | 57 |
| | 26 | 15 | 21 | 6 |
| 2 | 30 | 0 | 24 | 20 |
| | 33 | 45 | 27 | 36 |
| | 37 | 30 | 31 | 0 |
| | 41 | 15 | 34 | 28 |
| 3 | 45 | 0 | 38 | 3 |
| | 48 | 45 | 41 | 41 |
| | 52 | 30 | 45 | 34 |
| | 56 | 15 | 49 | 39 |
| 4 | 60 | 0 | 53 | 35 |
| | 63 | 45 | 57 | 47 |
| | 67 | 30 | 62 | 6 |
| | 71 | 15 | 66 | 33 |
| 5 | 75 | 0 | 71 | 6 |
| | 78 | 45 | 75 | 41 |
| | 82 | 30 | 80 | 21 |
| | 86 | 15 | 85 | 13 |
| 6 | 90 | 0 | 90 | 0 |

## CHAP. III.

### *To draw the houre-lines in an horizontall plane.*

AN horizontall plane is that which is parallell to the horizon, represented in the fundamentall diagram by the outward circle *E S W N*, in which the diameter *S N* drawne from the South to the North, may go both for the meridian line and the meridian circle, Z for the zenith, *P* for the pole of the world, and the circles drawne through *P* for the houre-circles of 1. 2. 3. 4. &c. as they are numbred from the meridian.

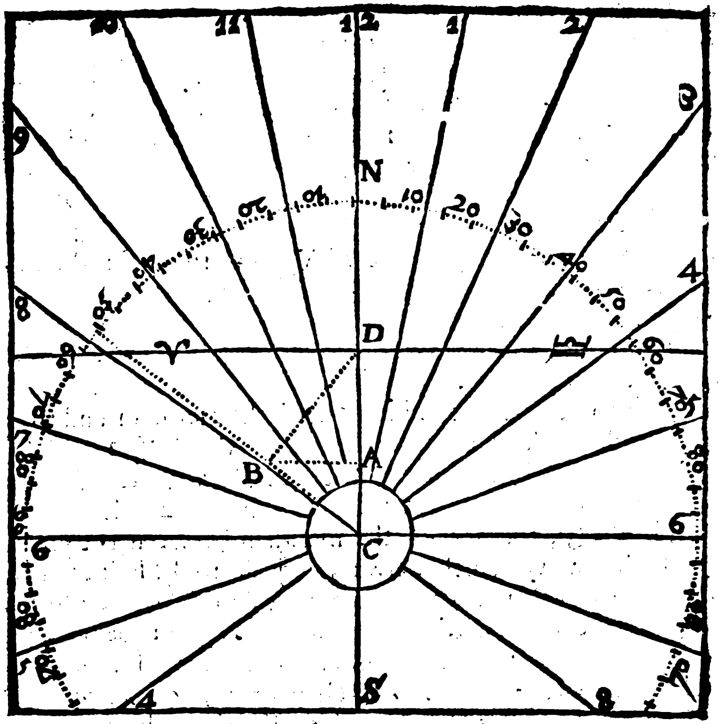
These

These are equall at the pole and at the æquator but vnequally distant at the horizon: the distance between the meridian and the first houre being not full 12 gr. the distance between the fift and sixth houre aboue 18 gr. which inequality being obserued, if you suppose right lines drawne from the center C to the intersections of these houre-circles with the horizon, the lines so drawne shall be the houre-lines here inquired. And then if you can imagin a line drawne from the center C, toward P the pole of the world and raised aboue the meridian line CN, so as the angle PCN may be equall to the latitude of the place, this right line CP shall be the axis of the style. And so you haue both style and houre-lines ready drawne to your hand. But more particularly to our purpose.

These houre-circles considered with the meridian and the horizon, doe make diuers triangles, PN 1, PN 2, PN 3, in which we haue knowne first the right angle at N, the North intersection of the meridian and the horizon; secondly the side PN, the arke of the meridian between the pole and the horizon, which is alwayes equall to the latitude of the place; thirdly the angles at the pole, made by the meridian and the houre-circles, the angle NP 1 being 15 gr. NP 2 30 gr. each houre 15 gr. more then other, each halfe houre 7 gr. 30 m. each quarter 3. gr. 45 m. as in the second columne of this table. And these three being known. we may finde the arks of the horizon between the meridian and the houre-circles N 1, N 2, N 3, &c. For.

As the sine of 90 gr.
is to the sine of the latitude:
So the tangent of the houre
to the tangent of the houre line
from the meridian.

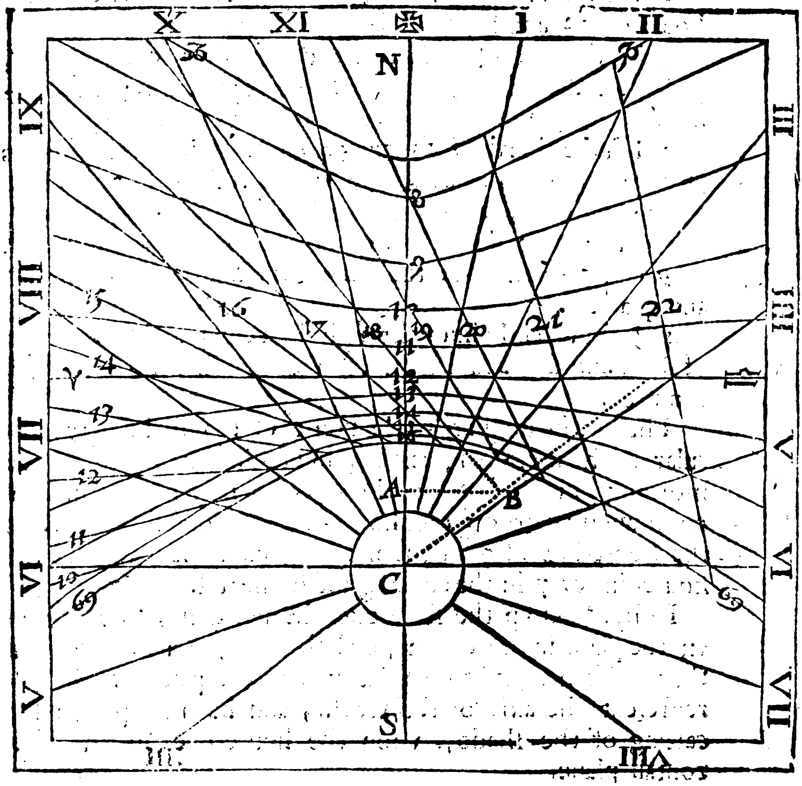
Extend the compasses from the sine of 90 gr. to the sine of the latitude, so the same extent shall reach from the tangent of the houre, to the tangent of the houre-line from the meridian.




meridian. Thus the latitude being 51 *gr.* 30 *m.* I extend the compasses from the sine of 90 *gr.* to the sine of 51 *gr.* 30 *m,* & find the same extent to reach from the tangent of 3 *gr.* 45 *m.* vnto the tangent of 2 *gr.* 56 *m.* for the distance of the first quarter from the meridian; and from the tangent of 7 *gr.* 30 *m.* vnto the tangent of 5 *gr.* 52 *m.* for the halfe houre; and from the tangent of 11 *gr.* 15 *m.* to the tangent of 8 *gr.* 51 *m.* for the third quarter; and from the tangent of 15 *gr.* 0 *m.* vnto 11 *gr.* 50 *m.* for the first houre: and so the rest, as in the third columne of this table vnder the title of the arks of the plane.

Only when I come to set one foote of the compasses to

48 *gr.*




43 *gr.* 45 *m.* for the finding of a quarter past 3, the other foote will fall out of the line, and then I may either take out so much as is out of the line beyond 45 *gr.* and turne it backe into the line, and it will reach from 45 *gr.* to 41 *gr.* 45 *m.* or I may vse crosse worke, extending the compasses from the sine of 90 *gr.* to the tangent of 48 *gr.* 45 *m.* so the same extent wil reach from the sine of 51 *gr.* 30 m. to the tangent of 41 *gr.* 45 *m.* And such is the distance of the line of 3 houre $\frac{1}{4}$ from the meridian.

This done, I come to the Plane, and there according as the lines do fall in the fundamentall diagram, 1 I draw a right line *S N* seruing for the meridian, the houre of 12 and the substylar.

2 In this meridian I make choice of a center at *C*, and there describe an occult circle representing the horizon.

3 I find a chord of 11 *gr.* 50 *m.* and inscribe it into this circle on either side of the meridian for the houres of 11 and 1; in like maner, a chord of 24 *gr.* 20 *m.* for the houres of 10 and 2; and a chord of 38 *gr.* 3. *m.* for the houres of 9 and 3; and so for the rest of the houres, their halues and quarters.

4 I draw right lines through the center and the termes of these chords, and these lines so drawne are the houre-line required.

The line be-longing to the houre of 6 will be perpendicular to the meridian, and the houre-lines before 6 in the morning, or after 6 in the evening may be supplied by continuing their opposet houre-lines beyond the center. As the houre-line of 7 in the morning continued will be the houre-line of 7 in the euening and so the rest.

Lastly, I set vp the style ouer the meridian, so as it may cut the plane in the center, and there make an angle with the meridian equall to the latitude of the place, so it shall represent the axis of the world, and be truly placed for casting of the shadow vpon the houre-lines in an horizontall plane.

CHAP.

## CHAP. V.

### *To draw the houre-lines in a verticall plane.*

A Verticall plane is that which is parallel to the prime verticall circle in the fundamentall diagram represented by *EZW*. It hath two faces, one to the North, the other to the South; in each of them the substylar will be the same with the meridian line, and the angle of the style aboue the plane will be equall to *ZP* the complement of the latitude and the houre-lines here inquired may be supplied by imagining right lines drawne from the center *C* to the intersections of the houre-circles with *EZW*.

The triangles here considered are made by the verticall, the meridian, and the houre-circles, in which we know the side *ZP*, the angles at the pole, and the right angle at the zenith, and therefore may find the arks of the verticall, between the meridian and the houre-circles after this maner:

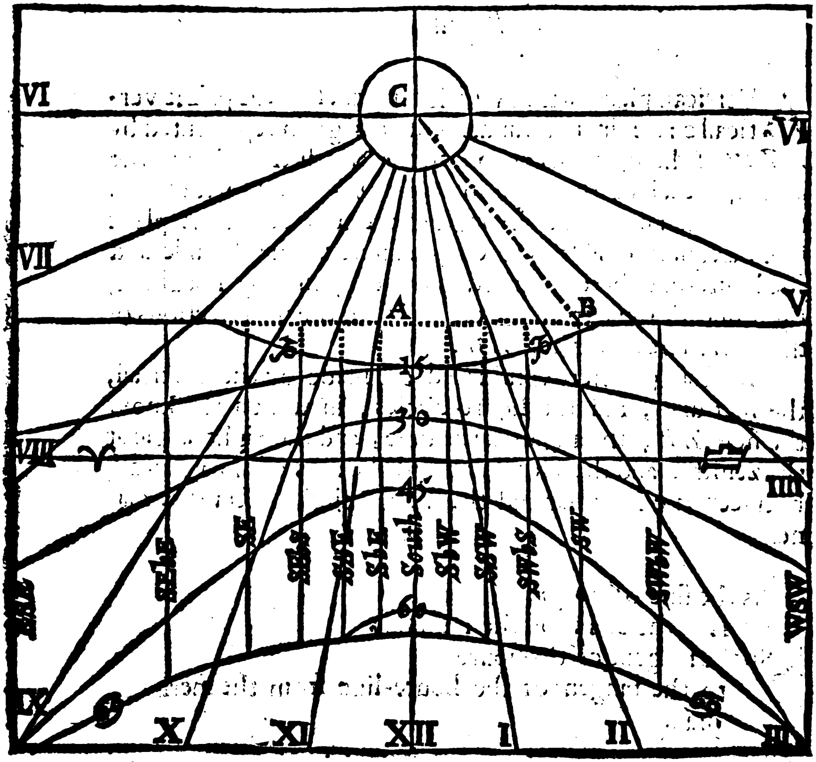
As the sine of 90 *gr*:
  is to the cosine of the latitude:
So the tangent of the houre
  to the tangent of the houre-line from the meridian.

Extend the compasses from the sine of 90 *gr*. to the sine of the complement of the latitude, so the same extent shal reach from the tangent of the houre, to the tangent of the houre-line from the meridian.

Thus in the latitude of 51 *gr*. 30 *m*. I extend the compasses from the sine of 90 *gr*. to the sine of 38 *gr*. 30 *m*. and

 find

find the same extent to reach from the tangent of 15 *gr.* to the tangent of 9 *gr.* 28 *m.* for the distance of the first houre from the meridian: and from the tangent of 75 *gr.* vnto the tangent of 66 *gr.* 42 *m.* for the fift houre: and so in the rest as in the Table following.




These arks being knowne, I may come to the plane, and there by help of a thread and plummet draw a verticall line seruing both for the meridian and the houre of 12, and the substylar; then may I draw an occult verticall circle, and there in inscribe the chords of those former arks, and draw the

the houre-lines, and set vp the style, as before in the horizontall plane.

If it be the South face of the plane, the center will be vpward, and the style must point downward; if the North face, the center must be in the lower part of the meridian-line, and the style-point vpward in all such places as are to the Northward of the equinoctiall line, as it may appeare by considering how the lines do fall in the fundamentall Diagram.

| Latitud | 51 | | 30 | |
|---|---|---|---|---|
| Ho. | Ang.Po | | Arc.Pla. | |
| | Gr. | M. | Gr. | M. |
| 12 | 0 | 0 | 0 | 0 |
| | 3 | 45 | 2 | 20 |
| | 7 | 30 | 4 | 41 |
| | 11 | 15 | 7 | 3 |
| 1 | 15 | 0 | 9 | 28 |
| | 18 | 45 | 11 | 56 |
| | 22 | 30 | 14 | 27 |
| | 26 | 15 | 17 | 4 |
| 2 | 30 | 0 | 19 | 54 |
| | 33 | 45 | 22 | 35 |
| | 37 | 30 | 25 | 32 |
| | 41 | 15 | 28 | 38 |
| 3 | 45 | 0 | 31 | 54 |
| | 48 | 45 | 35 | 22 |
| | 52 | 30 | 39 | 3 |
| | 56 | 15 | 42 | 58 |
| 4 | 60 | 0 | 47 | 9 |
| | 63 | 45 | 51 | 36 |
| | 67 | 30 | 56 | 20 |
| | 71 | 15 | 61 | 23 |
| 5 | 75 | 0 | 66 | 42 |
| | 78 | 45 | 72 | 17 |
| | 82 | 30 | 78 | 3 |
| | 86 | 15 | 84 | 0 |
| 6 | 90 | 0 | 90 | 0 |

## CHAP. VI.

### *To draw the houre-lines in a verticall inclining plane.*

All those Planes that haue their horizontall line lying East and West, are in that respect said to be verticall; if they be also vpright and passe through the zenith, they are direct verticals; if they incline to the pole they are direct polars: if to the equinoctiall, they are properly called equinoctiall planes, and are described before: if to none of these three points, they are then called by the generall name of inclining verticals.

These may incline either to the North part of the horizon, or to the South; and each of them hath two faces,

 one

one to the zenith, the other to the nadir, in which we are first to consider the height of the pole aboue the plane, by comparing the inclination of the plane to the horizon, with the latitude of the place.

As in our latitude of 51 *gr.* 30 *m.* if the inclination of the plane *E I W* in the fundamentall diagram shall be 13 *gr.* Northward, that is, if *I N* the ark of the meridian betweene the plane and the North part of the horizon shall be 13 *gr.* we may take these 13 *gr.* out of *P N* 51 *gr.* 30 *m.* the eleuation of the pole aboue the horizon, and there wil remain *P I* 38 *gr.* 30 *m.* for the eleuation of the North pole aboue the vpper face of the plane, and therefore 38 *gr.* 30 *m.* for the height of the South pole aboue the lower face of the plane.

Or if the inclination of the plane shall be found to be 62 *gr.* to the Southward, we may number them in the meridian from *S* the South part of the horizon vnto *L*, and there draw the arke *E L W* representing this plaine; so the arke of the meridian *P L* shall giue the height of the North pole aboue the vpper face of this plane to be 66 *gr.* 30 *m.* and therefore the height of the South pole aboue the lower face of the plane is also 66 *gr.* 30 *m.*

In like maner if the inclination of the plane *E Y W* shall be 15 *gr.* Southward, that is, if *S Y* the arke of the meridian between the South part of the horizon and the plane, shall be 15. *gr.* The height of the North pole aboue the vpper face of the plane, and the height of the South pole aboue the lower face of the plane, will be also found to be 66 *gr.* 30. *m.*

But if the plane shall fall betweene the zenith and the North pole, then will the North pole bee eleuated aboue the lower face, and the South pole aboue the vpward face of the plane, as may appeare by the proiection of the spheare in the fundamentall Diagram.

Then in the triangles made by the plane, the meridian, and the houre-circles, we haue the side which is the height of the pole aboue the plane, together with the angles at the pole,

pole, and the right angle at the intersection of the meridian with the plane, by which we may find the arks of the plane betweene the meridian and the houre-circles, after this maner.

As the sine of 90 *gr.*
is to the sine of the pole aboue the plane:
So the tangent of the houre
to the tangent of the houre-line from the meridian.

Thus in the former example, where *P I* the height of the pole aboue the plane was found to be 38 *gr.* 30 *m.* if you shall extend the compasses from the sine of 90 *gr.* to the sine of 38 *gr.* 30 *m.* the same extent will reach from the tangent of 15 *gr.* vnto the tangent of 9 *gr.* 28 *m.* for the distance of the first houre from the meridian, and from 30 *gr.* vnto 19 *gr.* 46 *m.* for the second houre, and so forward as in the direct verticall.

And for the two last examples, you may extend the compasses from the sine of 90 *gr.* vnto the sine of 66 *gr.* 30 *m.* so the same extent shall reach in the line of tangents from 15 *gr.* vnto 13 *gr.* 48 *m.* for the first houre, from 75 *gr.* vnto 73 *gr.* 43 *m.* for the fift houre, from 30 *gr.* vnto 27 *gr.* 54 *m.* for the second houre, from 60 *gr.* vnto 57 *gr.* 48 *m.* for the fourth houre, and from 45 *gr.* vnto 42 *gr.* 31. *m.* for the third houre from the meridian.

These arkes being knowne, you may first draw the horizontall line, and crosse it in the middle with a perpendicular that may serue both for the meridian and the houre of 12, and the substylar; then knowing which pole is eleuated aboue the plane, you may accordingly make choice of a fit point in the meridian for the center of your houre-lines, and thence describe an occult arke of a circle, inscribe the chords of those former arkes, and draw the houre lines, and set vp the style, as I shewed before in the horizontall plane.

# CHAP. VII.

## *To draw the houre-lines in an verticall declining Plane.*

ALl vpright planes whereon a man may draw a verticall line, are in this respect said to be verticall; if they shall also stand directly East and West, they are direct verticals; if directly North and South, they are properly called meridian planes, and are described before: if they behold none of these foure principall parts of the world, but shall stand between the prime verticall and the meridian, they are then called by the generall name of declining verticals.

These haue two faces, one to the South, the other to the Northward, which may be distinguished in these Northerne parts of the world after this manner. If the Sunne coming to the meridian shall shine vpon the plane, it is the South face; if not, it is the North face of that plane. Againe, if the Sunne shall shine vpon the plane at high noone, and yet longer in the forenone then in the afternoon, it is the Southeast face; if longer in the afternoone then in the forenoone, it is the Southwest face of the plane. But how much the declination commeth to, is best found as before.

When the declination is found, there be foure things more to be considered before we can come to the drawing of the houre-lines.

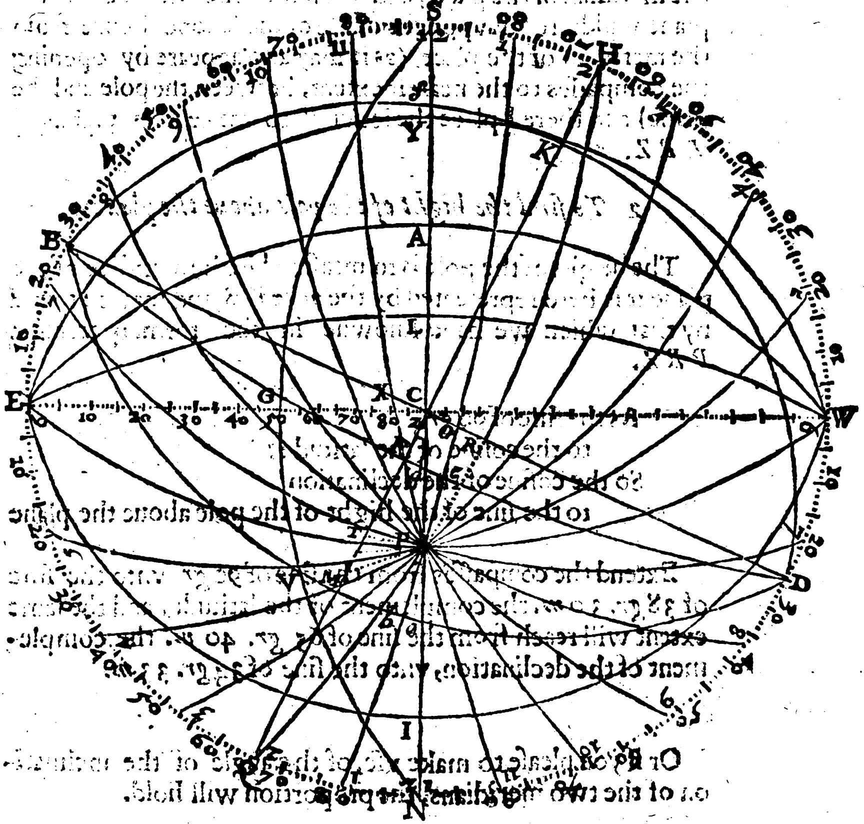
1. The meridian of the plane and his inclination to the meridian of the place.
2. The hight of the pole aboue the plane.
3. The distance of the substylar from the meridian line.
4. The distance of each houre-line from the substylar.

And these foure may all be represented in the fundamentall *Diagram*, as in this example.

Suppose that in our latitude of 51 *gr.* 30 *m.* northward the declination

declination of an vpright plane *vide Pag. 114. lin. 28.*

In the triangle P R Z we know the angle at R to be a right angle, and the angle at Z, for it is the complement of the declination, and the base P Z, for it is the complement of the latitude. And these three being knowne we may finde the other angle R P Z, which is the angle of inclination betweene both meridians.




As the sine of the latitude
is to the sine of 90 gr.

So the tangent of the declination
to the tangent of inclination of meridian.

Thus in our former example I extend the compasses from the sine of the latitude 51 *gr.* 30 *m.* vnto the sine of 90 *gr.* the same extent will reach in the line of tangents from 24 *gr.* 20 *m.* the declination giuen, to about 30 *gr.* and such is *Z P R* the angle of inclination between the meridian of the place and the meridian of the plane; and therefore the meridian of the plane will here fall vpon the circle of the second houre from the meridian of the place, (as it may also appeare by opening the compasses to the nearest extent, between the pole and the plane) and there I place the letter *R* to make this rectangle *P R Z.*

2 *To find the hight of the pole aboue the plane.*

The height of the pole is to measured in the meridian of the plane it is here represented by the arke *P* R, and may be found by that which we haue knowne in the former triangle *P R Z.*

As the sine of 90 *gr.*
to the cosine of the latitude:
So the cosine of the declination
to the sine of the hight of the pole aboue the plane

Extend the compasses from the sine of 90 *gr.* vnto the sine of 38 *gr.* 30 *m.* the complement of the latitude, and the same extent will reach from the sine of 65 *gr.* 40 *m.* the complement of the declination, vnto the sine of 34 *gr.* 33 *m.*

Or if you please to make vse, of the angle of the inclination of the two meridians, the proportion will hold.

As the sine of 90 *gr.*
to the cosine of the inclination of meridians:

So

So the cotangent of the latitude
to the tangent of the height of the pole aboue the plane.

And then you may extend the compasses from the sine of 90 *gr.* vnto the sine of 60 *gr.* the complement of the inclination of the meridians, and the same extent will reach from the tangent of 38 *gr.* 30 *m.* the complement of the latitude, vnto the tangent of 34 *gr.* 33 *m.* and such is the arke *P R*, the hight of the pole aboue the plane.

3 *To find the distance of the substylar from the meridian.*

This is here represented by the arke Z R, and may be found by that which we haue knowne in the former triangle *P R Z*.

As the sine of 90 *gr.*
to the sine of the declination:
So the cotangent of the latitude
to the tangent of the substylar from the meridian.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 24 *gr.* 20 *m.* the declination giuen, and the same extent will reach from the tangent of 38 *gr.* 30 *m.* the complement of the latitude, vnto the tangent of 18 *gr.* 8 *m.* and such is the arke Z *R*, the distance of the substylar from the meridian.

4 *To find the distance of each houre-line from the substylar.*

The distances of the houre-lines from the substylar, are here represented by those arks of the declining verticall belonging to the plane, which are intercepted betweene the proper meridian of the plane and the houre-circles.

To this purpose we haue diuers triangles made by the declining plane, together with his proper meridian, and the houre-circles. In these we haue knowne, first the right angle at the intersection of the proper meridian with the plane, then the side which is the hight of the pole aboue the plane; and thirdly the angles at the pole. For knowing the angle of inclination betweene the meridian of the plane and the meridian of the place, which is alwayes the houre of 12, we may finde the angle betweene the meridian of the plane and the houre of 1, by allowing in 15 *gr.* and the angle betweene the meridian of the plane and the houre of 2 by allowing in 30 *gr.* and so for the rest, which being knowne and set down in a table we may find the arks of the plane from the substylar to the houre-circles, in this maner.

As the sine of 90 *gr.*
to the sine of the hight of the pole aboue the plane:
So the tangent of the houre from the proper meridian,
to the tangent of the houre-line from the substylar.

Thus in our latitude of 51 *degrees* 30 *minutes*, if the declination of an vpright plane shall be found to be 24 *gr.* 20 *m.* from the prime verticall, the one face open to the Southwest, the other to the Northeast, I may number these 24 *gr.* 20 *m.* in the horizon of the fundamentall Diagram, from *E* vnto *B*, according to the situation of the plane, and there draw the verticall *B Z D*, which shall represent the plane proposed.

The two poles of this plane will fall in the horizon at *H* and *Q* and therefore the proper meridian drawne through the poles of the plane, and the pole of the world must be the circle *H P Q* which here crosseth the plane at right angles in the point *R*, and inclineth to *P Z S* the meridian of the place, according to the angle *R P Z*.

The quantity of this inclination may be readily found by the houre circle where the proper meridian falleth. As here it falleth on the second houre circle, and so the inclination is 30 *gr.*

The height of the pole above the plane which giueth the height of the stile aboue the substylar is here represented by the arke *P R*. For as in the Horizontall, so in this and all o-

ther

ther planes the line *C P* the axis of the world is alwaies the axis of the stile, and the neerest line that can be drawne vpon the plane to the axis of the world is the fittest for the substylar, and that is the line *C R*, so the angle *P C R* is the angle betweene the axis and the plane, commonly called the height of the style and the measure of this angle is the arke *P R*, This arke is alwayes lesse then the complement of the latitude, and may be estimated by taking the distance *P R* with the compasses, and measuring it in the Meridian from *P* toward Z. So in this example it will appeare to be about 34 *gr.* ½.

The distance of the substylar from the meridian is here represented by the arke *Z* R. For the meridian line vpon the plane is *C Z*, the substylar line is *C R*, so the angle contained betweene them is *Z C R*, and the measure of this angle is the arke Z R, which taken with the compasses and measured in the semidiamiter *C W*, from *C* toward *W*, will be found about 18 *gr.*

The distances of each houre line from the substylar are here represented by the arks of the plane between the point R and the intersections of the houre circles. For the substylar line is C R, and the houre circle of 1 crossing the plane in the point *O*, the houre line of 1 vpon the plane, must be *C O*, So the angle betweene the substylar and the houre line of 1 is R *C O*, and the measure of this angle is the arke R*O*. In like manner the houre line of 12 will be *C* Z, and the distance from the substylar R *Z*. The houre line of 11, will be *C X* and the distance from the substylar R *X* and so the rest. These distances R *O*, R Z, R *X*, &c. may also be taken with the compasses, and measured as before.

Besides these foure representations the diagrame will shew what pole is elevated above the plane, and what time the Sun shineth vpon the plane. If it be the North-East face of this plane, you may thinke P to be the North-pole, and the houre circles to be drawne on a convex hemisphære, so C R the substylar, and C P the axis of the stile will both point vpward, and having drawne the tropique of ♋ you shall find by the meeting of the plane with the tropique, and the houre circles, that the Sun at the highest, may shine vpon the plane, from the time of the rising untill it be past 9 in the morning, and from 7 in the Evenning unto the time of his setting. But if it be the South-west face of the plane, then you may either suppose the substylar, and the axis to be continued downe belowe the center, like unto the houres before and after 6 in an horizontall plane, or else you may turne the diagrame and thinke *P* to be the South pole, and the houre circles to be drawne in an horizontall concave so C R the substylar, C P the axis of the stile will both point downward, and so also the houre lines from 8 to the morning untill after 7 in the Evening, as it doth appeare by the meeting of the plane with the horizon, and the houre circles.

Thus with the drawing of one line in the diagram to represent the plane according to his declination, you may have the houre lines fitted to any declining verticall with the style and substilar in their due place, which may suffice to free you from grosse error, but for more exactnesse; wee consider three triangles.

## 1. *To find the inclination of Meridians.*

The meridian of the place is a circle passing through the poles of the world, the Zenith and the nadir. The proper meridian of the plane is a circle passing through the poles of the world and the poles of the plane. The circle of the plane, and these two meridians doe make a triangle, such as P R Z, wherein we know the angle at R.

I consider the angle of inclination of the meridians R P Z, and there see how that P Z the meridian of the place, which is the houre of 12, being 30 *gr*. distant frō *P* R the meridian of

the

the plane, and that one face of the plane being open to the Southwest, and the other to the Northeast, this meridian of the plane falleth to be the same with the houre of 2, (otherwise with the houre of 10.) therefore allowing 15 *gr.* for an houre, the houre of 1, *R P O* will be 15 *gr.* and *R P X* the houre of 11 will be 45 *gr.* distant from *P R* the proper meridian of the plane: and so I gather the incliation of the rest of the hourecircles towards this meridian, according to their angles at the pole, as in the second colume of this Table.

| | |
|---|---|
| Latitude N. | 51 30. |
| Declinatio: | 24 20. |
| Diff. merid: | 30 0. |
| Alt. Styl: | 34 33. |
| Dist. subst. | 18 8. |

| Houre | | Ang. Po. | | An. Pla. | |
|---|---|---|---|---|---|
| M. | E. | Gr. | M. | Gr. | M. |
| 4 | 8 | 90 | 0 | 90 | 0 |
| 5 | 7 | 75 | 0 | 64 | 42 |
| 6 | 6 | 60 | 0 | 44 | 30 |
| 7 | 5 | 45 | 0 | 29 | 33 |
| 8 | 4 | 30 | 0 | 18 | 8 |
| 9 | 3 | 15 | 0 | 8 | 38 |
| 10 | 2 | *Merid* | | *substyl* | |
| 11 | 1 | 15 | 0 | 8 | 38 |
| | 12 | 30 | 0 | 18 | 8 |
| 1 | 11 | 45 | 0 | 29 | 33 |
| 2 | 10 | 60 | 0 | 44 | 30 |
| 3 | 9 | 75 | 0 | 64 | 42 |
| 4 | 8 | 90 | 0 | 90 | 0 |

Then taking my compasses in my hand, I extend them from the sine of 90 *gr.* vnto the sine of 34 *gr.* 33 *m.* the hight of the pole aboue the plane, and find them to reach in the line of tangents from 15 *gr.* the inclination of the houre of 1, to 8 *gr.* 38 *m.* for the arke of 1, from the substylar, and from 30 *gr.* vnto 18 *gr.* 8 *m.* for the houre of 12, agreeable to the third *Prop.* & from 45 *gr.* vnto 29 *gr.* 33 *m.* for the houre of 11, and so the rest, which I also set downe in the third columne of the Table.

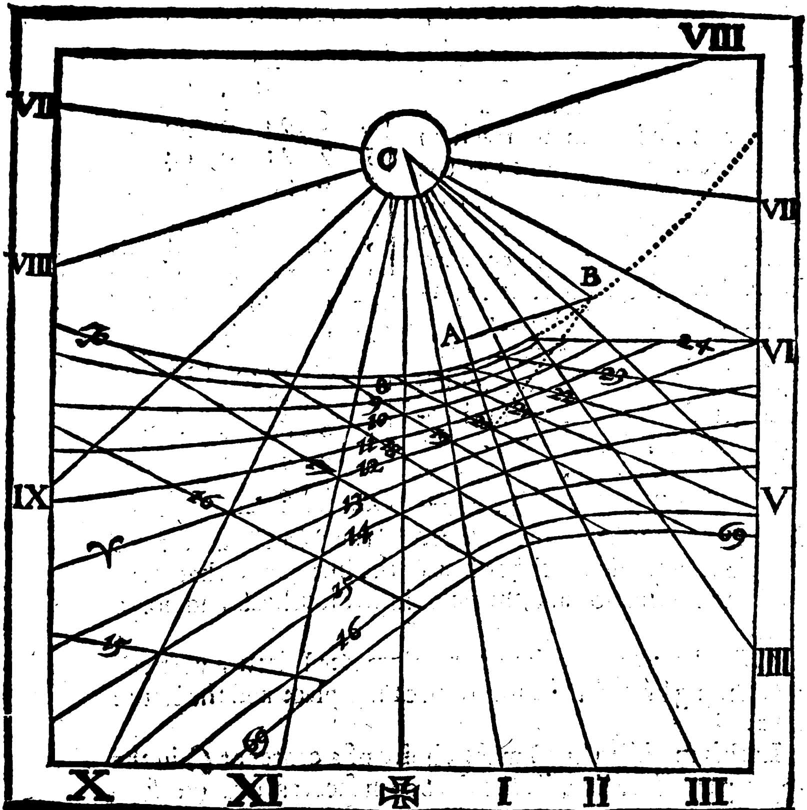
Thesearks being thus found, will serue for the drawing of the houre lines, both on the Southwest face, and the Northeast face of this plane, and also on either face of the like plane that hath the same declination and the poles in the southeast and north west.

1 By the helpe of a thread and plummet I draw a verticall line, seruing both for the meridian of the place and the houre of 12.

In this meridian line I make choice of a center at *C*, in the vpper part of the line, if it be the South face, as here we suppose

pose it, that the style may haue roome to point downward; but in the lower part of the line, if it be the North face of the plane; for there the style must point vpward: and vpon this center I describe an occult circle, representing the declining verticall belonging to the plane.

3° I find a chord of 18 gr. 8 m. the distance of the substylar from the meridian of the place, and inscribe it into this circle, from the meridian vnto A toward the right hand, because in this example the meridian of the plane falls among the houres after noone, (for otherwise it must have




been

been inscribed toward the left hand) and there I draw the line *C A* seruing for the substylar.

4 According to the Table of the arkes of the plane from the substylar, I find a chord of 8 *gr.* 38 *m.* and inscribe it into this circle, from the substylar toward the meridian, for the houre of 1. In like maner a chord of 29 *gr.* 23 *m.* for the houre of 11, and a chord of 44 *gr.* 30 *m.* for the houre of 10, and so for the rest of the houres, their halues and quarters.

5 I draw right lines through the center and the termes of these chords, and these lines so drawne are the houre-lines required.

Lastly, I set vp the style over the substylar, so as it may cut the plane in the center, and there make an angle with the substylar of 34 *gr.* 33 *m.* according to the height of the pole above the plane; so it shall represent the axis of the world, and be truely placed for casting of the shadow vpon the houre lines in this declining plane.

## *A second example.*

Suppose another vpright plane in the same latitude to decline from the verticall 65 *gr.* 44 *m.* with one face open to the South-East, the other to the North-west. These 65 *gr.* 40 *m.* would be numbred from E unto *Q*, and from *W* unto *H*, and the plane represented by *Q Z H*. For so the one pole will fall at *B* in the South-East, and the other at *D*, in the North-west according to the supposition. The proper meridian of this plane may be supplyed by the circle *B P D*, crossing the plane in the point *T*, betweene the houre of 7 and 8, and there is the place of the substylar. The South-East face will containe all the houres from Sun rising vnto two afternoone, and the Northwest face all the houres from one after noone vnto Sunne setting. Then working as before.

1 The angle Z P T the inclination of the two meridians

ridians will be found to be about 70 *degrees* 30 *minutes*.

2 The arke P T the measure of the angle P C T, the hight of the pole aboue the plane, and so the hight of the style aboue the substylar will be 14 *gr.* 51 *m.*

3 The arke Z T the measure of the angle Z C T, shewing the distance of the substylar from the meridian will be 35 *gr.* 56 *m.*

4 The arks of the plane betweene the substylar and the houre-lines depending on the difference of meridians which is here 70 *gr.* 30 *m.* or 4 *Ho.* 42 *m.* short of the meridian I first draw a table with three columnes, one for the morning and euening houres, another for the angles at the pole and the third for the arks of the plane and there write 70 *gr.* 30 *m.* by the houre of 12 and place the meridian and substylar betweene the houres of 7 and 8 according as the poles of the plane do fall in the Diagram.

Then will the angle at the pole betweene the proper meridian and the houre of 11 be 55 *gr.* 30 *m.* the houre of 10 will be 40 *gr.* 30 *m.* distant from that meridian and the rest in their order which being noted in the second columne, the arks of the plane will be found to be such as I haue noted in the third columne.

| | | | | | |
|---|---|---|---|---|---|
| Latitude N. | | | | 51 | 30 |
| Declination. | | | | 65 | 40 |
| Diff. merid. | | | | 70 | 30 |
| Altitude styl: | | | | 14 | 51 |
| Diff. substyl: | | | | 35 | 56 |
| Hours | | An.Po | | Ar. Pla. | |
| M. | E. | Gr. | M. | Gr. | M. |
| 2 | 10 | 79 | 30 | 54 | 12 |
| 3 | 9 | 64 | 30 | 28 | 16 |
| 4 | 8 | 49 | 30 | 16 | 42 |
| 5 | 7 | 34 | 30 | 10 | 0 |
| 6 | 6 | 19 | 30 | 5 | 11 |
| 7 | 5 | 4 | 30 | 1 | 9 |
| | | *Merid* | | *substy* | |
| 8 | 4 | 10 | 30 | 2 | 43 |
| 9 | 3 | 25 | 30 | 6 | 58 |
| 10 | 2 | 40 | 30 | 12 | 21 |
| 11 | 1 | 55 | 30 | 20 | 28 |
| | 12 | 70 | 30 | 35 | 56 |
| 1 | 11 | 85 | 30 | 72 | 56 |

With this table thus made, you may draw the houre-lines and set vp the style on either face of this or the like plane, the difference being onely in the placing of the substylar and that is resolued by the sight of the Diagram.

## *A third example of a Plane falling neere the Meridian.*

After the like manner if in our latitude an vpright plane shall decline 85. *gr.* from the prime verticall, the one face of it being open to the Northwest, and the other to the Southeast, we may in some sort represent it by the verticall *QZH*, and then working as before.

1 The angle *ZPT*, the inclination of the two meridians will be found to be 86 *gr.* 5 *m.* so that *PT* the meridian of this plane, will here fall betweene the houre-circles of 6 and 7 from the meridian.

2 The arke *PT* the measure of the angle *PCT*, the height of the pole aboue the plane will be onely 3 *gr.* 6 *m.*

3 The arke *ZT* the measure of the angle *ZCT*, the distance of the substylar from the meridian 38 *gr.* 23 *m.*

| | | |
|---|---|---|
| Latitude | 51 | 30 |
| Declination | 85 | 0 |
| Diff. Merid. | 86 | 5 |
| Altitude styl. | 3 | 6 |
| Dist. substy. | 38 | 23 |

4 The Table of the angles at the pole will be also gathered, by comparing the meridian of the plane with the rest of the houre-circles. For the angle *TPZ* betweene *PT* the meridian of the plane, *PZ* the meridian of the place, and the houre of 12. being 86 *gr.*

5 *m.* allowing 15 *gr.* for an houre, the houre of $11\frac{1}{2}$ will be 78 *gr.* 35 *m.* and the houre of 11 71 *gr.* 5 *m.* distant from the meridian of the plane; and so the rest of the houres. Or because the difference of meridians 86 *gr.* 5 *m.* resolved into time makes 5 houres, 44 *m.* and so the meridian of the plane falls betweene the houres of 6 and 7 from the meridian. I first place this meridian betweene these houres, and then taking 75 *gr.* the common measure for 5 houres out of 86 *gr.* 5 *m.* there remaine 11 *gr.* 5 *m.* for the angle at the pole betweene the meridian of the plane and the houre of 7. againe I take 86 *gr.* 5 *m.* out of 90 *gr.* the common measure for 6 houres, and there remaine 3 *gr.* 55 *m.* for the angle at the pole betweene the meridian of the plane and the houre of 6. To these angles so found I allow 15 *gr.* for euery houre, as in the second columne of this Table.

| Hor. | An. Po | | Ar. Pla. | | C F | | C G | |
|---|---|---|---|---|---|---|---|---|
| | Gr. | M. | Gr. | M. | In. | Par. | In. | Par |
| 12 | 86 | 5 | 38 | 23 | 91 | 08 | 79 | 21 |
| | 78 | 35 | 15 | 3 | 30 | 92 | 26 | 89 |
| 11 | 71 | 5 | 9 | 6 | 18 | 42 | 16 | 02 |
| | 63 | 35 | 6 | 13 | 12 | 52 | 10 | 89 |
| 10 | 56 | 5 | 4 | 36 | 9 | 25 | 8 | 05 |
| 9 | 41 | 5 | 2 | 42 | 5 | 43 | 4 | 72 |
| 8 | 26 | 5 | 1 | 31 | 3 | 05 | 2 | 65 |
| 7 | 11 | 5 | 0 | 36 | 1 | 20 | 1 | 05 |
| | *Merid Substy.* | | | | 0 | 0 | 0 | 0 |
| 6 | 3 | 55 | 0 | 13 | 0 | 44 | 0 | 38 |
| 5 | 18 | 55 | 1 | 4 | 2 | 15 | 1 | 86 |
| 4 | 33 | 55 | 2 | 5 | 4 | 18 | 3 | 64 |
| 3 | 48 | 55 | 3 | 33 | 7 | 13 | 6 | 20 |
| 2 | 63 | 55 | 6 | 20 | 12 | 77 | 11 | 10 |
| | 71 | 25 | 9 | 10 | 18 | 56 | 16 | 14 |
| 1 | 78 | 55 | 15 | 28 | 31 | 82 | 27 | 67 |
| | 86 | 25 | 40 | 55 | 79 | 67 | 86 | 68 |

Then hauing the height of the pole aboue the plane, and these angles at the pole; the arkes of the plane, betweene the substylar and the houre-circles, will bee found as in the third columne.

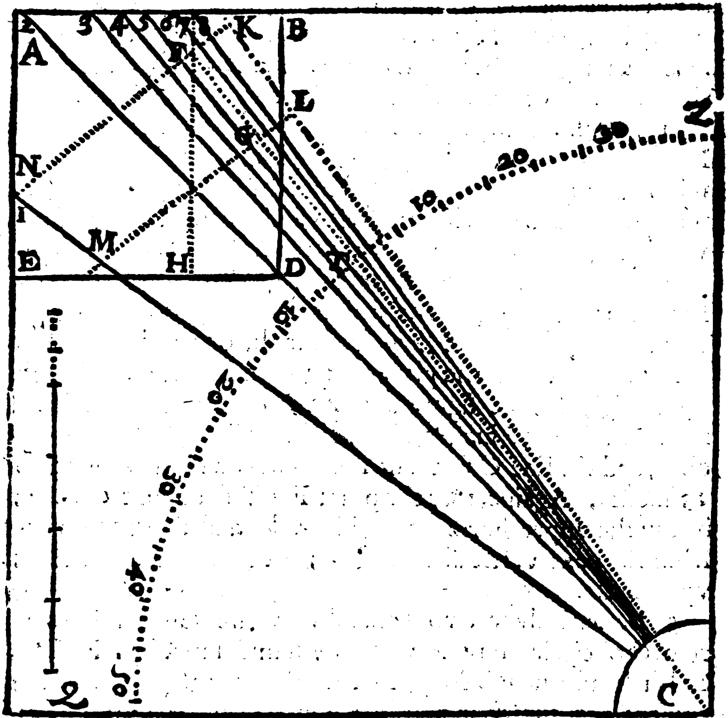
These arkes being found, will serue for the drawing of the houre-lines on either face of this or the like plane.

1 By the helpe of a thread and plummet I draw *Z C* a verticall line, seruing both for the meridian of the place and the houre of 12.

2 In this meridian line I make choice of a center in the vpper

vpper part of the line, if it had beene the Southerne face of the plane, but here in C the lower part of the line, because we supposed it to bee the Northwest face of the plane, and the style must point vpward; and vpon this center I describe an occult circle representing the declining verticall belonging to this plane.

¶ I finde a chord of 38 *gr.* 23 *m.* the distance of the sub-




stylar from the meridian of the place, and inscribe it into this circle, from Z in the meridian, vnto T toward the left hand, according as the proper meridian P T falls in the fundamentall Diagram; and here I draw the line C T seruing for the substylar.

4 The substylar being drawne, I may inscribe the chords of the arkes of the plane from the substylar, and draw the houre-lines, and set vp the style as in the former plane.

Or the arkes of the plane from the substylar being found as before, wee may draw the houre-lines vpon the plane otherwise then by chords. For hauing drawne the houre-lines, as in the last figure, vpon paper or paist boord, we shall finde the most part of them, in this and such like planes that haue greater declination, to fall so close together, that they can hardly be discerned: wherefore to draw them at large to the best aduantage of the plane, I leaue out the center, and draw them by tangents, as in the polar plane.

1. I consider the length and bredth of the plane whereon I am to draw the houre-lines, which I suppose to be a square, whose side is 36 inches, and find that the little square *ABDE* will containe both the substylar and all those houre-lines which are required in the great square AZCQ.

2 I draw two parallel lines FN, GM, crossing the substylar at right angles in the points F and G, so as they may best crosse all the houre-lines, and yet the one be distant from the other as farre as the plane will giue me leaue; and I finde by the sight of the figure that if *AB* the side of the lesser square sholl be 36 inches, the line CF will be about 115 inches, and the line CG about 100 inches, and therefore FG 15 inches. Againe, that the point F will fall about 6 inches below the vpper horizontall side *AB*, and about 12 inches from the next verticall side *BD*; for I need not here stand vpon parts.

3 Because these two parallel lines are tangent lines in respect of circles drawne vpon the semidiameters CF, CG, and such tangent as belong to the arkes of the plane, being tweene the substylar and the houre-lines, the proportion will hold.

As the tangent of 45 gr.
to the tangent of the arke of the plane,
So the length of the semidiameter
to the length of the tangent line.

As for example, the arke of the plane betweene the substylar and the houre of 1, is 15 *gr.* 28 *m.* in the former Table, the semidiameter *C* F 115 inches, and the semidiameter C G 100 inches: wherefore I extend the compasses from the tangent of 45 *gr.* vnto the tangent of 15 *gr.* 28 *m.* the same extent will reach from 115 in the line of numbers vnto 31, 82, which shewes the length of the tangent line betweene F in the substylar and the houre-line of 1, to be 31 inches, 82 *cent.* or parts of 100. Againe, the same extent will reach from 100 vnto 27, 67; and such is the length of the lesser tangent from *G* to the houre of 1.

The like reason holds for the length of the other tangents from the substylar to the rest of the houres, as in the Table; as also for the height of the style aboue these tangent lines; and so the angle of the style aboue the plane being 3 *gr.* 6 *m.* the height F K will be found to be 6 inches 23 *cent.* and the height G *L* 5 inches 42 *cent.*

Where the Reader may obserue, that if the extent from the tangent of 45 *gr.* to the tangent of 3 *gr.* 6 *m.* or to 115 in the line of numbers, be too large for his compasses, hee may vse the tangent of 5 *gr.* 43 *m.* in stead of the tangent of 45 *gr.* as I noted before *Pag.* 100.

4 Hauing found these lengths and heights, and set them downe in a Table, I come to the plane here resembled by the lesser square *A B D E*, where I begin with an occult verticall F *H*, about 12 inches from the side *B D*, and vpon the center F, abount 6 inches below the side *A B* describe an occult arke of a circle.

5 Into this arke I first inscribe a chord of 38 *gr.* 23 *m.* the distance of the substylar from the meridian, to make the angle *H* F G equall to the angle *Z C* T; so the line F G shall be the substylar: and then another chord of 51 *gr.* 37 *m.* the complement of this distance, to make vp the right angle G F N; so the line F N shall be the greater of the two tangent lines before mentioned.

6 I set off 15 inches from F vnto G, toward the center,

and through *G* draw the lesser tangent line *G M* parallel to the former.

7 These two occult tangent lines being thus drawne, I looke vnto the former Table for the houre of 1, and there finde the arke of the plane betweene the substylar and the houre of 1, to be 15 *gr.* 28 *m.* and the length belonging to it in the greater tangent line to bee 31 inches, 82 *cent.* in the lesser tangent line 27 inches, 67 *cent*: wherefore I take out 31 inches 82 parts, and pricke them downe in the greater tangent from *F* to *N*, and then 27 inches 67 parts, and prick them downe in the lesser tangent from *G* to *M*, and draw the line *M N* for the houre of 1, which if it were produced would crosse the substylar *F G* in the center *C*, and there make the angle F *C N* 15 *gr.* 28 *m.* The like reason holdeth for the drawing of all the rest of the houre-lines.

Lastly, I set vp the style right ouer the substylar, so as the height *F K* may be 6 inches 23 *cent.* and the height *G L* 5 inches 42 *cent.* then shall *K L* represent the axis of the world, and if it were produced would crose the substylar F G in the center C, and there make the angle F C K to bee 3 *gr.* 6 *m.* and so be truly placed for casting of the shadow vpon the houre-lines in this declining plane.

## CHAP. VIII.

### *To draw the houre-lines in a meridian inclining Plane.*

All those planes wherein the horizontall line is the same with the meridian line, are therefore called meridian planes: if they be right to the horizon, they are called by the generall name of meridian planes without farther addition, and are described before: if they leane to the horizon, they are then called meridian incliners.

These

These may incline either to the East part of the horizon, or to the West, and each of them hath two faces, the vpper toward the zenith, the lower toward the Nadir, wherein knowing the latitude of the place, and the inclination of the plane to the horizon, we are to consider.

1 The inclination of the meridian of the plane to the meridian of the place.
2 The height of the pole about the plane.
3 The distance of the substylar from the meridian.
4 The distance of each houre-line from the substylar.

And all these foure are represented in the fundamentall Diagram, as in this example.

In our latitude of 51 *gr.* 30 *m.* a meridian plane inclineth Eastward 50 *gr*; these 50 *gr.* I number in the verticall circle from *E* vnto *G*, according to the inclination of the plane, and there draw the arke *S G N* representing the plane proposed. Againe I number 50 from *Z* vnto *K*, so the point *K* (being 90 *gr.* from the plane at *G*) shall bee the pole of this plane and the proper meridian of this plane may bee supplied by a circle drawne through *K* and *P*. This meridian doth here fall betweene the houres of 4 and 5, and crossing the plane at right angles in the point *V*, in the right line C *V* shall be the substylar, and the angle *P* C *V* the height of the style aboue the plane and right lines drawne from the center C to the intersections of the houre-circles with *S G N* shall bee the houre-lines here inquired. The lower face of the plane will containe all the houre-lines from sunrising vnto 11 in the morning, and the vpper face the houres from 9 in the morning vnto sun-setting. Then haue I a rectangle triangle *P V N*, wherein the base *P N* is the height of the pole aboue the North part of the horizon, and the angle *P N V* the complement of the inclination to the horizon; and these being knowne,

1 I may finde the angle *N P V* of inclination of the two meridians. For

As the cosine of the latitude
is to the sine of 90 *gr.*
So the tangent of inclination to the horizon,
to the tangent of inclination of meridians.

Extend the compasses from the sine of 38 *gr.* 30 *m.* the complement of the latitude, vnto the sine of 90 *gr.* the same extent will reach from the tangent of 50 *gr.* 0 *m.* the inclination of the plane to the horizon, vnto the tangent of 62 *gr.* 25 *m.* and such is the inclination of the meridian of the plane to the meridian of the place; which being resolued into time, doth giue about 4 houres and 10 *m.* from the meridian, for the place of the substylar among the houre-lines.

2 The height of the pole aboue the plane is here represented by the quantity of the arke of the proper meridian *P V*, betweene the pole and the plane, and may bee knowne by that which wee haue giuen in the former triangle *P V N.* For

As the sine of 90 *gr.*
to the sine of the latitude:
So the cosine of the inclination to the horizon,
to the sine of the height of the pole aboue the plane.

Extend the compasses from the sine of 90 *gr.* vnto 51 *gr.* 30 *m.* the sine of the latitude, the same extent will reach from the sine of 40 *gr.* the complement of the inclination of the plane to the horizon, vnto the sine of 30 *gr.* 12 *m.*

Or as the sine of 90 *gr.*
to the cosine of inclination of meridians:
So the tangent of the latitude
to the tangent of the height of the pole aboue the plane.

Extend the compasses from the sine of 90 *gr.* vnto the tangent of 51 *gr.* 30 *m.* the latitude of the place, the same extent will reach from the sine of 27 *gr.* 35 *m.* the complement
of

of the inclination of the two meridians, vnto the tangent of 30 *gr.* 12 *m.* And such is *P* V the height of the pole aboue the plane, and such must bee the height of the style aboue the substylar.

3 The distance of the substylar from the meridian is here represented by *N* V the arke of the plane betweene the two meridians, and may be found by that which we haue giuen at the first in the former triangle *P* V *N*. For

As the sine of 90 *gr.*
to the sine of the inclination to the horizon:
So the tangent of the latitude
to the tangent of the substylar from the meridian.

Extend the compasses from the sine of 90 *gr.* vnto the tangent of 51 *gr.* 30 *m.* the latitude of the place, the same extent will reach from the sine of 50 *gr.* the inclination of the plane to the horizon, vnto the tangent of 43 *gr.* 55 *m.* And such is the arke *N V* the distance of the substylar from the meridian.

4 The distances of the houre-lines from the substylar, are here also represented by those arkes of the plane, which are here intercepted betweene the proper meridian and the houre-circles, and may bee found by that which we haue giuen in the triangles made by the plane, with his proper meridian and the houre-circles. For the angle at V, betweene the plane and the proper meridian, is well knowne to bee a right angle, and the side P V is the height of the pole aboue the plane, and the angles at the pole betweene the proper meridian and the houre-circles are easily gathered into a Table. The angle V P N betweene V P the proper meridian of the plane, and P N the generall meridian of the place being 62 *gr.* 25 *m.* the angle betweene the proper meridian and the

circle of the houre of 11, will bee 77 *gr.* 25 *m.* and the angle belonging to the houre of 1, 47 *gr.* 25. *m.* and so the rest of the angles at the pole. Then

As the sine of 90 *gr.*
to the sine of the pole aboue the plane:
So the tangent of the angle at the pole,
to the tangent of the houre-line from the substylar.

Wherefore I extend the compasses from the sine of 90 *gr.* vnto the sine of 30 *gr.* 12 *m.* the height of the pole aboue the plane, and I finde the same extent to reach in the line of tangents from 77 *gr.* 25 *m.* vnto 66 *gr.* 4. *m.* for the distance belonging to the houre of 11; and from the tangent of 62 *gr.* 25. *m.* to 43 *gr.* 55 *m.* for the houre of 12. as when I found the the distance of the substylar from the meridian. And so for the rest of the arks of plane betweene the substylar and the houre-circles, as in the Table.

| | | | | |
|---|---|---|---|---|
| Latitude 51 30. | | | | |
| Inclination 50 0. | | | | |
| Diff. Merid. 62 25. | | | | |
| Alt. styli 30 12. | | | | |
| Dist. substy. 43 55. | | | | |
| Hor. | Ang. Po | | Arc. Pla. | |
| | Gr. | M. | Gr. | M. |
| 11 | 77 | 25 | 66 | 4 |
| 12 | 62 | 25 | 43 | 55 |
| 1 | 47 | 25 | 28 | 41 |
| 2 | 32 | 25 | 17 | 43 |
| 3 | 17 | 25 | 8 | 58 |
| 4 | 2 | 25 | 1 | 13 |
| | *Merid* | | *Substyl* | |
| 5 | 12 | 35 | 6 | 26 |
| 6 | 27 | 35 | 14 | 44 |
| 7 | 42 | 35 | 24 | 48 |
| 8 | 57 | 35 | 38 | 23 |
| 9 | 72 | 35 | 58 | 3 |
| 10 | 87 | 35 | 85 | 12 |

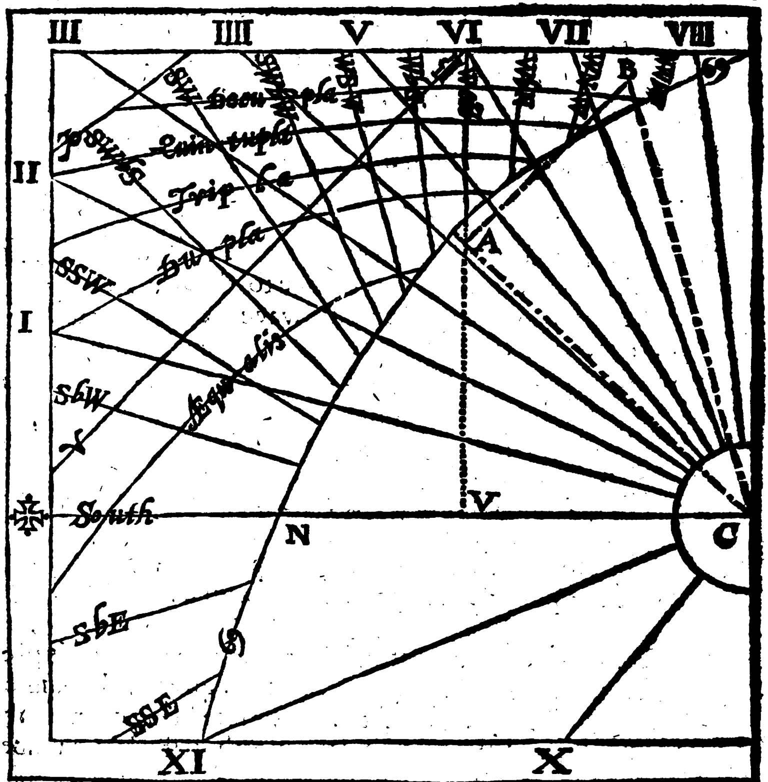
These arks being thus found, will serue to draw the houre-lines on either side of this plane: but supposing it to bee the vpper side,

1 I draw the horizontall line C N, seruing for the meridian and houre of 12.

2. In this line I make choice of a center at C, and thence describe an occult arke of a circle representing the plane proposed.

3 I find a chord of 43 *gr.* 55 *m.* the distance of the substylar from the meridian, and inscribe it into this circle from N vnto A, according as I finde the proper meridian P V to fall in the fundamentall diagram, and there I draw the line C A, seruing for the substylar.

4 The




4 The ſubſtylar being drawne, I may inſcribe the chords of the arkes of the plane from the ſubſtylar, and draw the houre-lines, and ſet vp the ſtyle, as in the former planes.

## CHAP. IX.

### *To draw the houre-lines in a polar declining Plane.*

THoſe planes wherein a line may be drawne parallell to the axis of the world, are called polar planes, becauſe

 that

that line pointeth vnto the poles, and these planes are always parallell to some one of the houre-circles. If they be parallell to the houre of 6, they are called direct polar planes; if to the houre of 12, they are called meridian planes; and both these are described before: if to any other of the houre-circles, they are then called by the name of polar declining planes, because of their inclining to the pole, and declining from the verticall.

These kind of planes may be knowne in this sort: First consider the inclination of the plane to the horizon, which in these parts of the world must alwayes be Northward, and more then the latitude of the place. Then find the declination from the verticall. These two being knowne, if the proportion hold,

As the sine of 90 *gr.*
to the cosine of the declination:
So the tangent of the inclination
to the tangent of the latitude;

it is then a polar declining plane, otherwise not.

For example, in our latitude of 51 *gr.* 30 *m.* a plane is proposed declining from the verticall 65 *gr.* 40 *m.* and inclining Northward 71 *gr.* 51 *m.* the vpper face being open to the Southeast, and the lower to the Northwest. If I number those 65 *gr.* 40 *m.* in the horizon of the fundamentall diagram from *E* vnto *Q*, and draw the line *H C Q*, it shall represent the horizontall line of the plane; then crossing it at right angles with the plane *B Z D* drawne through the zenith, I number 71 *gr.* 51 *m.* for the inclination from *D* vnto *R*, and there draw the circle *H R Q*, this circle so drawne shall represent the plane proposed; and because it also passeth through the pole, it is therefore a polar plane. But for farther triall I extend the compasses from the sine of 90 *gr.* to the sine of 24 *gr.* 20 *m.* the complement of the declination, and I find the same extent to reach from the tangent of 71 *gr.* 51 *m.* the inclination proposed, vnto the tangent of 51 *gr.* 30 *m.* which

is

is the true latitude of the place, and therefore it is a polar plane.

Againe I number the inclination 71 *gr.* 51 *m.* in the circle *BZD* from Z vnto *M.* so this point *M*, will fall at the meeting of *BZD* with the equator and being 90 *gr.* from the plane at *R*, it shall be the pole of this plane, and a circle drawnn through *M* and *P* will be the proper meridian of this plane. This meridian *MP* here falling on the houre of 8 doth giue *MPZ* the angle of inclination of meridians to be 4 houres or 60 degrees, then crossing the plane at the point *P* it shewes that the substylar should be *CP* and be placed at the houre of 8. But because *R* is the pole and *CP* the axis of the world, wherein all the houre circles doe meet, and so there would be no distinction betweene the axis, the substylar and the hourelines, I now suppose the plane in a parallell to the circle *HRQ* according to the distance that I would haue betweene the axis of the style and the substylar then will the style bee parallell to the plane pag. 128 lin. 1.

Here then the style will be parallell to the plane, and the houre-lines parallell one to the other, as in the meridian and direct polar planes. Yet that we may better know how to draw the houre-lines, and where to place the style, we are to consider.

*The arke of the plane betweene the horizon and the pole.*

In a meridian plane the arke betweene the horizon and the pole which represents the arke betweene the horizon and the houre-lines, is alwayes equall to the latitude of the place; in a direct polar it is an arke of 90 *gr*; in these declining polars it is greater then the latitude, and yet lesse then 90 *gr.* This arke is here represented by *PQ*, and may be knowne by resoluing the triangle *QNP*, or *PRZ*.

 As

As the sine of 90 *gr.*
to the cosine of the latitude:
So the sine of the declination
to the cosine of the arke betweene the horizon and the Pole.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 38 *gr.* 30 *m.* the complement of the latitude, the same extent will reach from the sine of 65 *gr.* 40 *m.* the declination proposed, vnto the sine of 34 *gr.* 34 *m.* whose complement is 55 *gr.* 26 *m.* the arke of the plane required betweene the horizon and the pole.

Or as the cosine of inclination to the horizon,
to the sine of 90 *gr.*
So the cotangent of the declination
to the tangent of the arke betweene the horizon and the pole.

And so extending the compasses from the sine of 18 *gr.* 9 *m.* the complement of the inclination to the tangent of 24 *gr.* 20 *m.* the complement of the declination the same extent doth reach from the sine of 90 *gr.* vnto the tangent of 55 *gr.* 26 *m.* And such is *QP* the arke of the plane betweene the horizon and the pole, the measure of the angle *QCP* betweene the horizontall line and the substylar.

## 2 *The inclination of the meridian of the plane, to the meridian of the place.*

The substylar in a direct polar plane is alwaies the same with the houre of 12, in a meridian plane it is the same with the houre-line of 6: in these declining polars it must be placed betweene 12 and 6, according to the inclination of the meridian of the plane to the meridian of the place, which is here

here represented by *M P Z* the complement of the angle *R P Z*, and thus knowne.

As the sine of 90 *gr.*
to the sine of the latitude:
So the tangent of the declination of the plane,
to the tangent of the inclination of meridians.

Extend the compasses from the sine of 90 *gr.* to the sine of 51 *gr.* 30 *m.* the latitude of the place, the same extent will reach from the tangent of 65 *gr.* 40 *m.* the declination proposed, vnto the tangent of 60 *gr.* and such is the angle of inclination betweene the meridian of the place and the proper meridian of the plane, which resolued into time doth make foure houres; and so the substylar must here be placed vpon the houre of 8 in the morning.

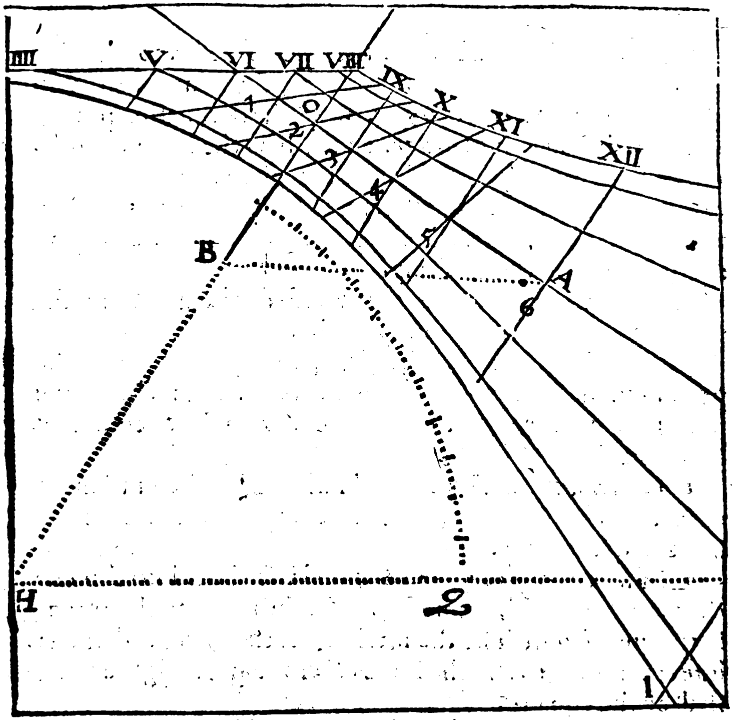
This angle being knowne, the rest of the angles at the pole are easily gathered. For if the houre of 12 be 60 *gr.* distant from the meridian of the plane, the houre of 1 will be 75 *gr.* and the houre of 11, will be 45 *gr.* distant, and the rest of the houres, as in the Table following. Then comming to the plane.

1 I draw an occult horizontall line *H Q*, wherein I make choice of a center *H*, and describe an occult circle for the horizon of the plane.

2 I find a chord of 55 *gr.* 26 *m.* and inscribe it into this circle, from *Q* vnto *B*, according to the situation of the plane; so the line *H B* shall be the meridian of the plane, and therefore the substylar: and the line *A C* crossing it at right angles, shall be the equator.

3 I consider the length of the plane, and how many houres I am to draw vpon it, that so I may proportion the height of the style; and I finde by the fundamentall diagram and the former table, that it will containe all the houres from Sun rising vntill it be past 2 afternoone: and therefore the meridian of the plane falling on the houre of 8 in the morning, there will be foure houres on the one side, and fiue on the

the other side of the substylar. But in all polar planes the height of the style aboue the substylar must be equall to the distance of the third houre from the substylar, or about $\frac{4}{7}$ of the fourth houre, or little more then $\frac{1}{4}$ of the fift houre, and thereupon I allow the height of this style to be equall to *C B*, which you may suppose to be ten inches.




4. Because the equator *A C* is a tangent line in respect of the Radius *B C*, and the parts thereof are such as belong to the angles betweene the meridian of the plane and the houre-lines, which angles are set downe in the table following, I may finde the length of each seuerall tangent in this manner.

As

As the tangent of 45 *gr.*
is to the tangent of the houre;
So the parts of the Radius,
to the parts of the tangent line.

The angle *A B C* betweene the meridian of the plane and the houre of 12, the meridian of the place is 60 *gr.* in the former table, and the Radius *B C* is supposed to be ten inches; whereupon I extend the compasses from the tangent of 45 *gr.* vnto the tangent of 60. *gr.* the same extent will reach from 10 in the line of numbers, vnto 17. 32, which shewes the length of the tangent *A C* betweene the substylar and the houre of 10, to be 17. 32 *cent.* The like reason holds for the rest of the houres.

| | | |
|---|---|---|
| Latitude | 51 | 30 |
| Declinat. | 65 | 40 |
| Inclinati. | 71 | 51 |
| Diff. Mer. | 60 | 0 |
| Diff. subst. | 55 | 20 |

| Hor. | An. Po. Gr. | M. | Tangen In. | Par. |
|---|---|---|---|---|
| 4 | 60 | 0 | 17 | 31 |
| 5 | 45 | 0 | 10 | 00 |
| 6 | 30 | 0 | 5 | 77 |
| 7 | 15 | 0 | 2 | 68 |
| 8 | *Merid* | | *Substyl.* | |
| 9 | 5 | 0 | 2 | 68 |
| 10 | 30 | 0 | 5 | 77 |
| 11 | 45 | 0 | 10 | 00 |
| 12 | 60 | 0 | 17 | 32 |
| 1 | 75 | 0 | 37 | 32 |
| 2 | 90 | 0 | Infinit. | |

5 These lengths being thus found and set downe in the table, I take out 17 inches 32 *cent.* and prick them in the equator from *C* vnto *A* for the houre of 12, and 37 inches 32 *cent.* and prick them downe for the houre of 1. And so the rest of the houre-points.

6 This done, if I draw right lines through each of these points, crossing the equator at right angles, they shall be the houre-lines required: and if I set the style ouer the substylar, so as the edge of it may be parallel to the plane, and the height of it be ten inches equall to the former Radius B C, it shall represent the axis of the world, and be truly placed for casting of the shadow vpon the houre-lines in this declining polar plane.

## CHAP. X.

### *To draw the houre-lines in a declining inclining plane.*

IF a plane shall decline from the prime verticall, and incline to the horizon, and yet not lie euen with the poles of the world, it is then called a declining inclining plane.

Of these there are seuerall sorts; for the inclination being Northward, the plane may fall betweene the horizon and the pole, as the circle B *M D* in the fundamentall Diagram; or betweene the zenith and the pole, as B F D: or the inclination may be Southward, and so be represented by B K D, it may also fall either below the intersection of the meridian and the equator, or aboue it; and each of these haue two faces, the vpper toward the zenith, and the lower towards the nadir; wherein hauing the latitude of the place with the declination and inclination of the plane, we are farther to consider,

1 The arke of the meridian betweene the pole and the plane.
2 The inclination of the plane to the meridian.
3 The arke of the plane betweene the horizon and the meridian.
4 The angle of inclination betweene both meridians.
5 The height of the pole aboue the plane.
6 The distance of the substylar from the meridian.
7 The distances of each houreline from the substylar.

And

And all these seuen may be represented in the fundamentall diagram, as in this example.

In our latitude of 51 *gr.* 30 *m.* a plane is proposed, declining from the verticall 24 *gr.* 20 *m.* and inclining Northward 36 *gr.* the vpper face lying open to the Southwest, the lower to the Northeast. If I number these 24 *gr.* 20 *m.* in the horizon from *E* to B, and there draw the line B C D, it shall represent the horizontall line of the plane: then crossing it at right angles with the plane *H* Z *Q* drawne through the zenith, I number 36 *gr.* for the inclination from *Q* vnto *M*, and there draw the circle B M D, crossing the meridian in the point *a*; this circle so drawne shall represent the plane proposed; and because it doth not passe through the pole, is therefore no polar, but an ordinary declining inclining plane.

1 The arke of the meridian of the place betweene the pole and the plane, is here represented by *P a*, and may be found by resoluing the triangle *D N a*, wherein the angle at *N* is knowne to be a right angle, the angle at *D* is the angle of inclination, the side D N the complement of the declination, which being knowne,

As the sine of 90 *gr.*
to the cosine of declination:
So the tangent of inclination to the horizon,
to the tangent of the meridian betweene the horizon and the plaine.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 65 *gr.* 40 *m.* the complement of the declination, the same extent will reach from the tangent of 36 *gr.* the inclination proposed, vnto the tangent of 33 *gr.* 30 *m.* and such is the arke of the meridian *N a*, between the horizon and the plane. This arke *N a* being compared with the arke *N P*, which is the elevation of the pole aboue the horizon, and is here supposed to be 51 *gr.* 30 *m.* the difference *N a* commeth to 18. *gr.* and such is the of the meridian required betweene the pole and the plane.

 2 The

2 The inclination of the plane to the meridian is here represented by the angle *N a D*, and may be found by that which we haue giuen in the former triangle *D N a*. For

As the sine of 90 *gr.*
 to the sine of the declination from the verticall:
So the sine of inclination to the horizon,
 to the cosine of inclination of the plane to the meridian.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 24 *gr.* 20 *m.* the declination of the plane, the same extent will reach from the sine 36 *gr.* the inclination giuen, vnto the cosine of 76 *gr.* And such is *N a D* the angle of inclination betweene the plane *D a*, and *N a*, the meridian of the place. Or

As the sine of the arke of the meridian betweene the horizon and the plane,
 is to the sine of 90 *gr.*
So the cotangent of the declination
 to the tangent of inclination of the plane to the meridian.

Extend the compasses from the sine of 33 *gr.* 30 *m.* the arke of the meridian betweene the horizon and the plane, vnto the sine of 90 *gr.* the same extent will reach from the tangent of 65 *gr.* 40 *m.* the complement of the declination vnto the tangent of 76 *gr.* And such is the inclination of the plane to the meridian, the same as before.

3 The arke of the plane between the horizon and the meridian, is here represented by *D a*, and may also be found by that which we have giuen in the former triangle *D N a*.

As the cosine of inclination to the horizon
 is to the sine of 90 *gr.*

So

So the cotangent of the declination
to the tangent of the arke of the plane from the horizon to the meridian.

Extend the compasses from the sine of 54 *gr.* the complement of the inclination of the plane to the horizon, vnto the sine of 90 *gr.* the same extent will reach from the tangent of 65 *gr.* 40 *m.* the complement of the declination, vnto the tangent of 69 *gr.* 54 *m.* And such is *D a* the arke of the plane, betweene the horizon and the meridian of the place.

4 The inclination of meridians is here represented by the angle *a P b.* For hauing drawne the proper meridian *b P k*, or let down a perpendicular *P b* from the pole vnto the plane, this perpendicular shall be the meridian of the plane; and we shall haue another triangle *a b P*, wherein the angle at *b* is a right angle, because of the perpendicular, the angle at *a* is the inclination of the plane to the meridian of the place, and the side *P a*, is the arke of the meridian betweene the pole and the plane, which being knowne,

As the cosine of the arke of the meridian betweene the pole and the plane
is to the sine of 90 *gr.*
So the cotangent of the inclination of the plane to the meridian,
to the tangent of inclination of the meridian of the plane, to the meridian of the place.

Extend the compasses from the sine of 72 *gr.* the complement of the arke *P a*, betweene the pole and the plane, vnto the sine of 90 *gr.* the same extent will reach from the tangent of 14 *gr.* the complement of the inclination of the plane to the meridian, vnto the tangent of 14 *gr.* 41 *m.* And such is the angle *a P b* of inclination betweene the meridian of the place and the proper meridian of the plane, which resolued into time, doth make about 59 *minutes*, and so the substylar must here be placed neere the houre of 1, after noone.



5 The

5 The height of the pole aboue the plane is here represented by P *b*, the arke of the proper meridian betweene the pole and the plane, and may be found by that which we haue giuen in the triangle *ab* P. For

As for the sine of 90 *gr.*
to the sine of the meridian of the place betweene the pole and the plane:
So the sine of inclination of the plane to the meridian,
to the sine of the height of the pole aboue the plane.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 18 *gr.* the arke P *a* of the meridian of the place from the pole to the plane, the same extent will reach from the sine of *b a* P the inclination of the plane to the meridian of the place, vnto the sine of 17 *gr.* 26 *m.* Or

As the sine of 90. *gr.*
to the cosine of inclination of meridians:
So the tangent of the meridian of the place betweene the pole and the plane,
to the tangent of the height of the pole aboue the plane.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 75 *gr.* 19 *m.* the complement of *a P b* the inclination of the two meridians, the same extent will reach from the tangent of 18 *gr.* the arke *P a* of the generall meridian betweene the pole and the plane, vnto the tangent of 17 *gr.* 26 *m.* And such is *P b* the height of the pole aboue the plane; and such must be the height of the style aboue the substylar.

6 This distance of the substylar from the meritidian of the place, is here represented by *a b* the arke of the plane between the two meridians, and may be found by that which we had giuen at the first in the former triangle *a b P.* For

As

As the sine of 90 *gr.*
to the cosine of the inclination of the plane to the meridian:
So the tangent of the meridian of the place betweene the pole and the plane,
vnto the tangent of the substylar from the meridian of the place.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 14 *gr.* the complement of *b a P*, the inclination of the plane to the meridian, the same extent will reach from the tangent of 18 *gr.* the arke of the generall meridian betweene the pole and the plane, vnto the tangent of 4 *gr.* 30 *m.* And such is the arke of the plane betweene the two meridians; and such must be the distance from the houre of 12 to the substylar.

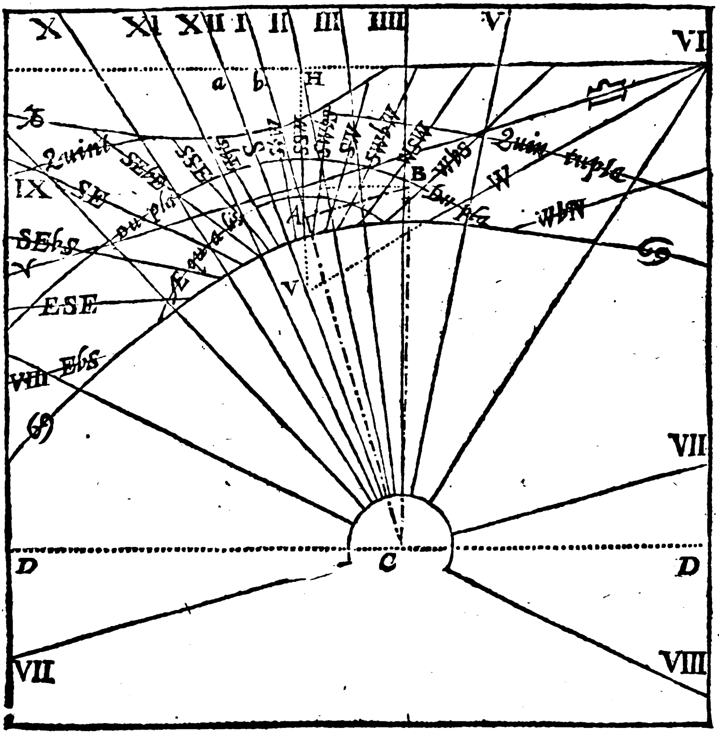
| | | | | |
|---|---|---|---|---|
| Latitude | 51 | 30. | | |
| Declina. | 24 | 20. | | |
| Inclin. N. | 36 | o. | | |
| Alt. Merid. | 69 | 54. | | |
| Diff. Merid. | 14 | 41. | | |
| Alt. styli. | 17 | 26. | | |
| Dist. subst. | 4 | 30. | | |
| Hor. | Ang. Po | | Arc. Pla. | |
| | Gr. | M. | Gr. | M. |
| 7 | 89 | 41 | 88 | 57 |
| 8 | 74 | 41 | 47 | 35 |
| 9 | 59 | 41 | 27 | 9 |
| 10 | 44 | 41 | 16 | 31 |
| 11 | 29 | 41 | 9 | 41 |
| 12 | 14 | 41 | 4 | 30 |
| | *Merid* | | *Substyl* | |
| 1 | 0 | 19 | 0 | 6 |
| 2 | 15 | 19 | 4 | 42 |
| 3 | 30 | 19 | 9 | 56 |
| 4 | 45 | 19 | 16 | 52 |
| 5 | 60 | 19 | 27 | 45 |
| 6 | 75 | 19 | 48 | 51 |

7 The distances of the houre-lines from the substylar, are here also represented by those arks of the plane, which are intercepted between the proper median and the houre-circles. For in these triangles the angle at *b* betweene the plane and the proper meridian is a right angle, the side P *b* is the height of the pole aboue the plane, and then the angles at the pole betweene the proper meridian and the houre-circles being gathered into a table.

As the sine of 90 *gr.*
to the sine of the pole aboue the plane:
So the tangent of the angle at the pole,
to the tangent of the houre-line from the substylar.

Extend

Extend the compaſſes from the ſine of 90 *gr.* vnto the ſine of 17 *gr.* 26 *m.* the height of the pole aboue the plane, the




ſame extent will reach from the tangent of 14 *gr.* 41 *m.* the angle at the pole belonging to the houre of 12, vnto the tangent of 4 *gr.* 30 *m.* for the arke of the plane betweene the ſubſtylar and the houre of 12; and from the tangent of 29 *gr* 41 *m.* vnto the tangent of 9 *gr.* 41 *m.* for the houre of 11, and ſo for the reſt of the arks of the plane between the ſubſtylar and the houre-lines, as in the former table.

Theſe arkes being thus found, will ſerue for the drawing of the houre-lines on either ſide of the plane: but ſuppoſing it it to be the vpper side, I consider how the lines doe fall in the fundamentall diagram, and accordingly

1 I draw an occult horizontall line DD, wherein I make choice of the center *C*, and thence draw an occult circle for the horizon of the plane.

2 I finde a chord of *69 gr. 54 m.* the arke of the plane betweene the horizon and the meridian, and describe it into this circle from D vnto *a*, and there draw the line *Ca* for the houre of 12.

3 I finde a chord of *4 gr. 30 m.* the arke of the plane betweene the two meridians, and inscribe it into this circle from *a* vnto *b*, and there draw the line *Cb* for the substylar.

4 The substylar being drawne, I may inscribe the chords of the arkes of the plane from the substylar, and draw the houre-lines, and set vp the style as in the former planes.

## *A second example of a Plane falling betweene the pole and the zenith.*

In like maner if in our latitude a plane be proposed declining from the verticall 24 *gr.* 20 m. as before, but inclining to the horizon 75 *gr.* 40 *m.* Northward, the vpper face being open to the Southwest, the lower to the Northeast, this plane shall be here represented by the circle B F D, crossing the meridian in the point *d*, betweene the pole and the zenith, and the proper meridian of this plane, by the perpendicular arke *Pe*.

Then in this triangle D N *d* knowing the side D N the complement of the declination, with the angle of inclination to the horizon at D, and the right angle at N, these former Canons will giue *N d* the arke of the meridian betweene the horizon and the plane to be 74 *gr.* 20 *m*; and therefore *P d* the arke of the meridian betweene the pole and the plane will be 22 *gr.* 50 *m.* the angle *D d N* of the inclination of the plane to the meridian, will bee found to be 66 *gr.* 29 *m.*

and *D d* the arke of the plane betweene the horizon and the meridian 83 *gr.* 36 *m.*

Againe, in the triangle *P e d* knowing the side *P d* the arke of the meridian betweene the pole and the plane, with the angle of inclination to the meridian at *d*, and the right angle at *e*, the angle *d P e* of the inclination of the two meridians will be found to be 25 *gr.* 17 *m.* and *P e* the height of the pole aboue the plane to be 20 *gr.* 50 *m.* and *d e* the distance of the substylar from the meridian about 9 *gr.* 32 *m.*

| | | |
|---|---|---|
| *Latitude* | 51 | 30 |
| *Declination* | 24 | 20 |
| *Inclination* | 75 | 40 |
| *Alt. Merid.* | 83 | 36 |
| *Diff. Merid* | 25 | 17 |
| *Dist. substy.* | 9 | 32 |
| *Alti. Styl.* | 20 | 50 |

| Hor. | Ang. Po. Gr. | M. | Arc. Pla. Gr. | M. |
|---|---|---|---|---|
| 8 | 85 | 17 | 76 | 56 |
| 9 | 70 | 17 | 44 | 47 |
| 10 | 55 | 17 | 27 | 11 |
| 11 | 40 | 17 | 16 | 43 |
| 12 | 25 | 17 | 9 | 32 |
| 1 | 10 | 17 | 3 | 41 |
| | *Merid* | | *Substyl* | |
| 2 | 4 | 43 | 1 | 40 |
| 3 | 19 | 43 | 7 | 16 |
| 4 | 34 | 43 | 13 | 50 |
| 5 | 49 | 43 | 22 | 46 |
| 6 | 64 | 43 | 37 | 0 |
| 7 | 79 | 43 | 62 | 58 |

Lastly, hauing found the height of the pole aboue the plane, and gathered the angles at the pole, the arks of the plane from the substylar to the hourelines will be as in this table.

This done, if we consider how the lines doe fall in the fundamentall diagram, wee may there see how the North pole is eleuated aboue the lower face, and the South pole aboue the vpper face of the plane, and accordingly make choice of a center, draw the horizontall, the meridian, the substylar, and the hourelines, and set vp the style as in the other planes.

### *A third example of a Plane inclining to the Southward.*

If in our latitude a plane were proposed declining from the verticall 24 *gr.* 20 *m.* as before, but inclining to the horizon 14 *gr.* 20 *m.* Southward, the vpper face being open to the Northeast, the lower to the Southwest, this plane shall be here represented by the circle *B K D* crossing the meridian in the point *f* betweene the æquator and the horizon, and the proper meridian of this plane by the perpen-

dicular

dicular arke *P g* let downe from the pole to the plane, neere the houre of 11, at the North part of the horizon, as may partly appeare by the neerest extent of the compasses, if the circle *BKD* were drawne round; and the two letters *f* and *g* supplied.

Then in the triangle *B Sf*, knowing the side *B* S the complement of the declination, with the angle of inclination to the horizon at *B*, and the right angle at *S*, we may find *Sf* the arke of the meridian betweene the horizon and the plane to be 13 *gr*. 6 *m*. And therefore *Pf* the arke of the meridian betweene the pole and the plane to the Southward 115 *gr*. 24 *m*. but 64 *gr*. 36 *m*. to the Northward, the angle *BfS* or *DfN* of the inclination of the plane to the meridian, will bee found 84 *gr*. 9 m; and *Bf* or *Df* the arke of the plane between the horizon and the meridian 66 *gr*. 20 *m*.

| | | |
|---|---|---|
| *Latitude* | 51 | 30 |
| *Declination* | 24 | 20 |
| *Inclination* | 14 | 20 |
| *diff. merid.* | 13 | 27 |
| *dist. substy.* | 12 | 8 |
| *Alt. Styl* | 64 | 0 |
| *Alt. merid.* | 66 | 20 |

| Hor. | Aug. Po. Gr. | M. | Arc. pla. Gr. | M. |
|---|---|---|---|---|
| 6 | 76 | 33 | 75 | 6 |
| 7 | 61 | 33 | 58 | 56 |
| 8 | 46 | 33 | 43 | 30 |
| 9 | 31 | 33 | 28 | 55 |
| 10 | 16 | 33 | 14 | 58 |
| 11 | 1 | 33 | 1 | 25 |
| | *Merid* | | *Substyl* | |
| 12 | 13 | 27 | 12 | 8 |
| 1 | 28 | 27 | 25 | 57 |
| 2 | 43 | 27 | 40 | 23 |
| 3 | 58 | 27 | 55 | 38 |
| 4 | 73 | 27 | 71 | 41 |
| 5 | 88 | 27 | 88 | 15 |

Againe, in the triangle *Pgf* knowing the side *Pf* the arke of the meridian betweene the pole and the plane, with the angle of inclination to the meridian at *f*, and the right angle at *g*, the angle *fPg* of the inclination of the two meridians will be found to be 13 *gr*. 72 *m* and *Pg* the height of the pole aboue the plane, about 64 *gr*. and *fg* the distance of the substylar from the meridian 12 *gr*. 8 *m*.

Hauing found the height of the pole aboue the plane, and gathered the angles at the pole, the arkes of the plane from the substylar to the houre-lines will be found as in this table.

This done, if we consider how the lines doe fall in the fundamentall diagram, we may there see how the North pole is eleuated aboue the vpper face, and the

the South pole aboue the lower face of this plane, and accordingly make choice of the center, draw the horizontall, the meridian, the substylar, and the houre-lines, and set vp the style as in the former planes.

## CHAP. XI.

### *To describe the Tropiques and other circles of declination in an æquinoctiall Plane.*

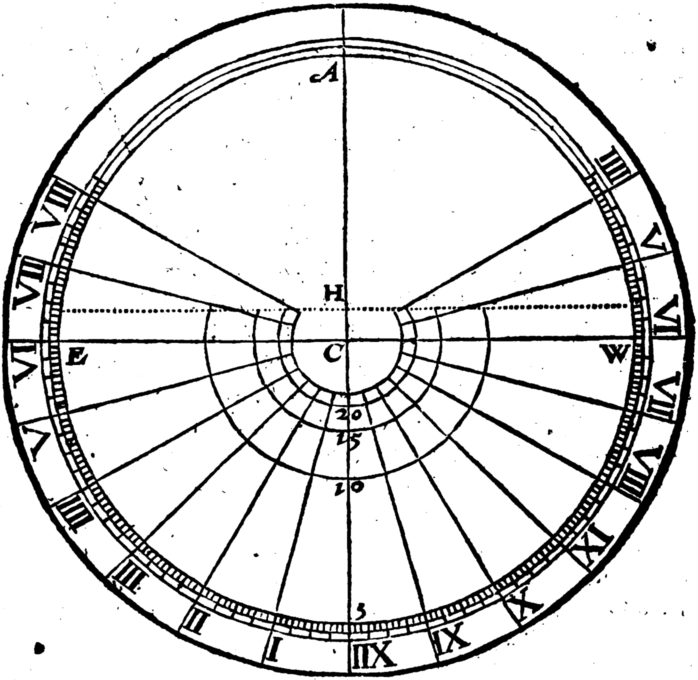
SVch circles as are parallell to the æquinoctiall, and yet fall within the tropiques, may be described on any plane by help of these lines of proportion, but after a different maner, according as the style shall be either perpendicular, or parallell to the plane, or cut the plane with oblique angles.

In an æquinoctiall plane where the style is perpendicular to the plane, the tropiques and other circles of declination will bee perfect circles: wherefore consider the length of the style in inches and parts, and the declination of the circle which you intend to describe in degrees and minutes, the proportion will hold.

As the tangent of 45 *gr.*
to the length of the style:
So the cotangent of the parallell,
to the semidiameter of his circle.

Suppose the length of the style aboue the plane to bee 10 inches, and that it were required to finde the semidiameter of the tropique, whose declination is knowne to be 23 *gr.* 30 *m*: extend the compasses from the tangent of 45 *gr.* vnto the tangent of 66 *gr.* 30 *m.* the same extent will reach in the line of numbers from 10 vnto 23, which shewes the semidiameter of the tropique to be 23 inches. So if the declination bee 20 *gr.* the semidiameter will bee 27 inches 47. *cent*; if 15

*gr.*




*gr.* then 37. 32; if 10 *gr.* then 56. 71; if 5. *gr.* then 114. 305. and ſo in the reſt.

Or if it were required to proportion the ſtyle to the plane,

As the tangent of 45 *gr.*
  to the tangent of the declination:
So the ſemidiameter of the plane,
  to the length of the ſtyle.

As if the ſemidiameter of the greateſt parallell vpon the plane were but ſix inches, and that parallell ſhould be the fift degree of declination: extend the compoſſes from the taugent of 45. *gr.* vnto the tangent of 5 *gr.* the ſame extent will reach in the line of numbers from 6. 00 vnto about 0. 53, which shewes that the length of the style must be 53 parts of an inch diuided into 100; then the length of the style being knowne, the semidiameter of the other circles will be found as before.

I begin here with the fift parallell, and thence proceed vnto the tropique, because the shadow of the rest neere the æquinoctiall, would be ouerlong, and the æquinoctiall it selfe cannot be described. The parallels of North declination are to be set on the North face, and the parallels of South declination on the South face of the plane. Neither need these parallels to be drawne in full circles, but onely to the horizontall line, which shall be described in *Cap.* xviij.

Hauing by these meanes set vp the style to his true height, and drawne the circles of declination, if we shall place the plane so as it shall make an angle with the horizon equall to the complement of the latitude, and then turne it vntill the top of the style cast the shadow vpon the parallel of declination belonging to the time, the meridian of the plane will shew the meridian of the place, and the shadow of the style the houre of the day, without the helpe of a magneticall needle.

## CHAP. XII.

### *To describe the Tropiques and other circles of declination in a polar Plane.*

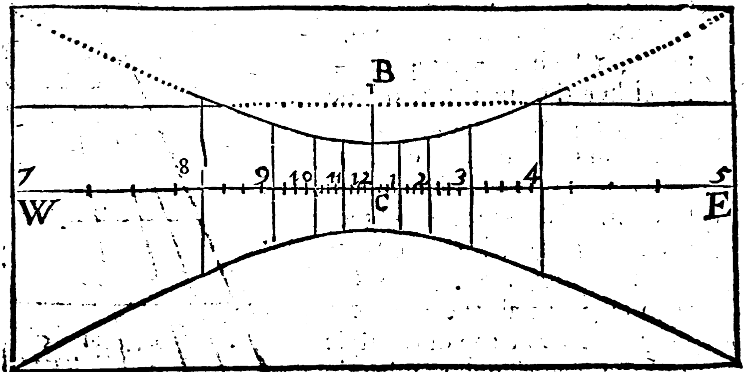
IN all polar planes, whether they be parallel to the meridian or to the circles of the houre of 6, or otherwise declining, the æquinoctiall will be a right line, but the tropiques and other circles of declination will be sections hyperbolicall, and be thus described.

Consi-

Consider the length of the style, the declination of the parallel, and the angle at the pole betweene the substylar and the houre-line, whereon you meane to describe the parallel.

If you would find where the parallels doe crosse the substylar;

As the tangent of 45 *gr.*
to the tangent of declination:
So is the length of the style,
to the distance of the parallel from the æquinoctiall.

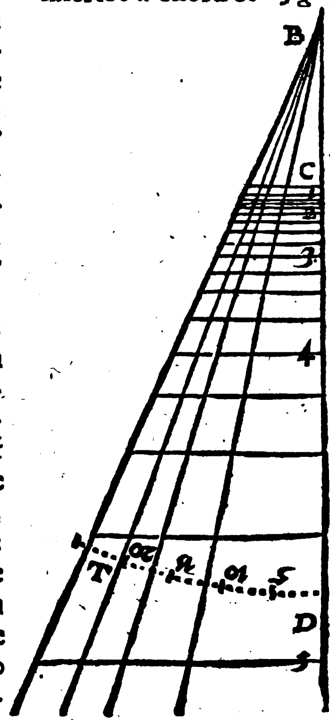



As in the example of the polar plane, where the length of the style *B C* was found to be 1 inch, 61 *cent.* if you desire to know the distance betweene the æquinoctiall and the tropique vpon the substylar line: extend the compasses from the tangent of 45 *gr.* vnto the tangent of 23 *gr.* 30 *m.* the same extent will reach in the line of numbers from 1. 61 vnto 0. 70; and therefore the distance required is 70 parts of an inch diuided into 100. The like reason holdeth for all other parallels of declination crossing the substylar.

But if you would finde where the parallels doe crosse any other of the houre-lines, first find the distance betweene the

the axis of the style and the hour-line, then the distance betweene the æquinoctiall and the parallel, both these may be represented in this maner.

On the center *B* and any semidiameter B D describe an occult arke of a circle, and therein inscribe a chord of 23 *gr.* 30 *m.* form *D* vnto *T*, with such other intermediat declinations as you intend to describe on the plane, so the line B D shall be the æquator, and B T the tropique, and the other intermediate lines the lines of declination.

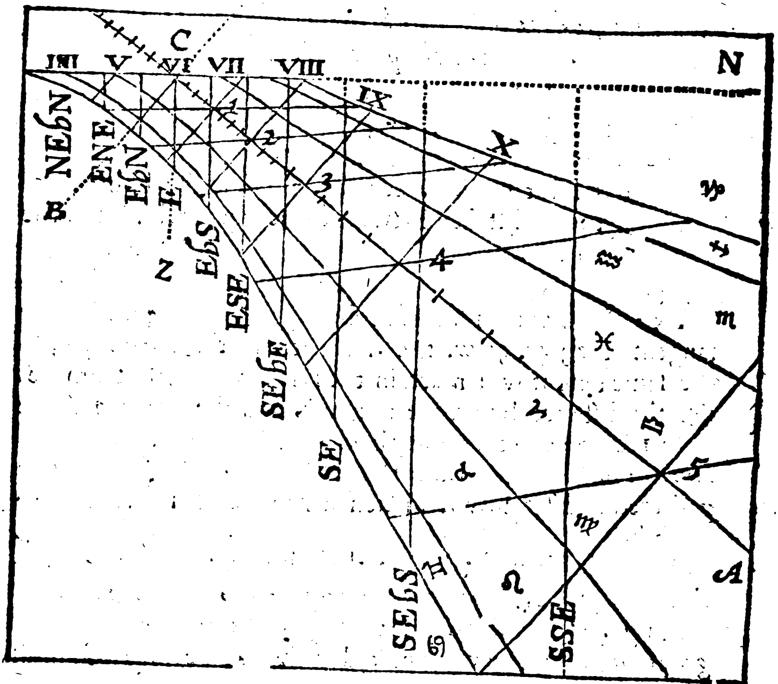



That done, consider your plane, which for example may be either the meridian or the declining polar plane, wherein hauing drawne both the æquator, and the houre-lines as before, first take out the height of the style, and prick that downe in this æquator from *B* vnto *C*; then take out all the distances betweene *B* the top of the style and the seuerall points wherein the houre-lines doe crosse the æquator, transferre them into this æquator B D from the center B, and at the termes of these distances erect lines perpendicular to the æquator, crossing the lines of declination, and note them with the number of the houre from whence they were taken: so these perpendiculars shall represent those houre-lines, and the seuerall distances betweene the æquator and the lines of declination, shall giue the like distances betweene the æquator and the parallels of declination vpon your plane. Vpon this ground it followeth.

To

### *To finde the distance betweene the axis and the houre-lines.*

As the cosine of the houre from the substylar,
is to the sine of *90 gr.*
So the length of the style,
to the distance between the axis and the houre-line.



As if in the former example of the meridian plane, where B C the height of the style is supposed to be 10 inches, it were required to find the distance between B to the top of the style and the point wherein the houre of 11 in the morning doth crosse the æquator, which is here represented by B 5, because it is the fift houre from the substylar, whose angle at the pole is 75 *gr.* Extend the compasses from the sine of 15 *gr.* the complement of the fift houre from the substylar, vnto the sine of 90 *gr.* the same extent will reach from 10.00 in the line of numbers vnto 38.64; and therefore the distance B 5 betweene the axis and the houre-line, is 38 inches and 64 *cent.* and may be called the secant of the houre. Then in the rectangle B 5 T, hauing the side B 5, and the angle of declination at B.

## *To finde the distance betweene the equinoctiall and the parallell.*

As the tangent of 45 *gr.*
to the tangent of the declination:
So the distance betweene the axis and the houre-line,
to the distance betweene the æquinoctiall and the parallel.

Extend the compasses from the tangent of 45 *gr.* vnto the tangent of 23 *gr.* 30 *m.* the declination of the tropique, so the same extent will reach in the line of numbers from 38.64. the distance betweene the axis and the fift houre-line vnto 16.80; and therefore the distance is 16 inches and 80 *cent.* The like reason holdeth for all the rest, which may be gathered and set downe in such a Table as this which followeth.

Wherein I haue set downe these distances for seuerall declinations, for 11 *gr.* 30 *m.* for 16 *gr.* 55 *m.* for 20 *gr.* 12. *m.* for 21 *gr.* 41 *m.* and for the declination of the Tropique 23 *gr.* 30 *m.* which may be applied to the like declinations in all meridian and direct polar planes.

As in the former example of the polar plane, where B C the height of the style is found to be 1 inch 61 *cent.* if it were required to find the distance betweene B the top of the style and

and the points wherein the houre-lines of 7 in the morning or 5 after noone, doe crosse the æquator (which distances, I called the secants of those houres,) either you may extend the compasses from the sine of 15 *gr.* the complement of the houre from the substylar vnto the sine of 90 *gr.* so the same

| Hor. | An.Po. | | Tange. | | Secan. | | 11 30 | | 16 55 | | 20 12 | | 21 41 | | 23 30 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gr. | M. | In. | Pa. | In. | Pa. | In. | Pa. | In. | Pa. | In. | Pa. | In. | Pa. | In. | Pa. |
| 0 | 0 | 0 | 0 | 0 | 10 | 0 | 2 | 3 | 3 | 4 | 3 | 68 | 3 | 98 | 4 | 35 |
| | 3 | 45 | 0 | 65 | 10 | 02 | 2 | 04 | 3 | 05 | 3 | 69 | 3 | 99 | 4 | 36 |
| | 7 | 30 | 1 | 32 | 10 | 09 | 2 | 05 | 3 | 07 | 3 | 71 | 4 | 01 | 4 | 39 |
| | 11 | 15 | 1 | 99 | 10 | 20 | 2 | 07 | 3 | 10 | 3 | 75 | 4 | 05 | 4 | 43 |
| 1 | 15 | 0 | 2 | 68 | 10 | 35 | 2 | 10 | 3 | 15 | 3 | 81 | 4 | 12 | 4 | 50 |
| | 18 | 45 | 3 | 39 | 10 | 56 | 2 | 15 | 3 | 21 | 3 | 89 | 4 | 20 | 4 | 59 |
| | 22 | 30 | 4 | 14 | 10 | 82 | 2 | 20 | 3 | 29 | 3 | 99 | 4 | 30 | 4 | 70 |
| | 26 | 15 | 4 | 93 | 11 | 15 | 2 | 26 | 3 | 39 | 4 | 10 | 4 | 45 | 4 | 85 |
| 2 | 30 | 0 | 5 | 77 | 11 | 55 | 2 | 34 | 3 | 51 | 4 | 24 | 4 | 60 | 5 | 02 |
| | 33 | 45 | 6 | 68 | 12 | 03 | 2 | 44 | 3 | 66 | 4 | 42 | 4 | 78 | 5 | 23 |
| | 37 | 30 | 7 | 67 | 12 | 60 | 2 | 56 | 3 | 83 | 4 | 64 | 5 | 02 | 5 | 48 |
| | 41 | 15 | 8 | 77 | 13 | 30 | 2 | 70 | 4 | 05 | 4 | 89 | 5 | 29 | 5 | 78 |
| 3 | 45 | 0 | 10 | 00 | 14 | 14 | 2 | 87 | 4 | 30 | 5 | 20 | 5 | 63 | 6 | 15 |
| | 48 | 45 | 11 | 40 | 15 | 17 | 3 | 08 | 4 | 62 | 5 | 58 | 6 | 03 | 6 | 00 |
| | 52 | 30 | 13 | 03 | 16 | 43 | 3 | 34 | 5 | 00 | 6 | 04 | 6 | 54 | 7 | 14 |
| | 56 | 15 | 14 | 97 | 18 | 00 | 3 | 66 | 5 | 48 | 6 | 62 | 7 | 00 | 7 | 83 |
| 4 | 60 | 0 | 17 | 32 | 20 | 00 | 4 | 07 | 6 | 08 | 7 | 36 | 7 | 95 | 8 | 70 |
| | 63 | 45 | 20 | 28 | 22 | 61 | 4 | 60 | 6 | 88 | 8 | 32 | 9 | 00 | 9 | 83 |
| | 67 | 30 | 24 | 14 | 26 | 13 | 5 | 31 | 7 | 95 | 9 | 61 | 10 | 39 | 11 | 36 |
| | 71 | 15 | 29 | 46 | 31 | 11 | 6 | 33 | 9 | 47 | 11 | 45 | 12 | 37 | 13 | 53 |
| 5 | 75 | 0 | 37 | 32 | 38 | 64 | 7 | 86 | 11 | 74 | 14 | 20 | 15 | 36 | 16 | 80 |
| | 78 | 45 | 50 | 27 | 51 | 26 | 10 | 43 | 15 | 60 | 18 | 89 | 20 | 38 | 22 | 28 |
| | 82 | 30 | 75 | 96 | 76 | 61 | 15 | 58 | 23 | 32 | 28 | 10 | 30 | 47 | 33 | 31 |
| | 86 | 15 | 152 | 57 | 152 | 90 | 31 | 10 | 46 | 54 | 56 | 26 | 60 | 81 | 66 | 48 |
| 6 | 90 | 0 | Infin. | | Infin. | | Infin. | | Infin. | | Infin. | | Infin. | | Infin. | |

extent will reach in the line of numbers from 1. 61 the length of the style, vnto 6. 21, according to the former Canon. Or else you may make vse of the former Table, extending the compasses in the line of numbers from 10.00 the length of the style in the Table, vnto 1.61 the length of the style belonging to your plane, so the same extent shall reach from 38. 64 the secant in the Table, vnto 6. 21, and such is your secant required, the distance betweene the top of the style and the point of interfection, wherein the fift houre-line from the substylar doth crosse the æquator.

Againe, the same extent will reach from 16. 80 the distance in the Table belonging to the fift houre-line betweene the æquatour and the parallel of 23 *gr*. 30 *m*. declination, vnto 2. 70 for the the like distance vpon your plane; and so for the rest, which may be gathered and set downe in a Table.

That done, and the æquator drawne as before, if you would draw the tropiques in the polar plane, looke into the Table, and take 70 *cent*. out of the line of inches, and pricke them downe in the subhylar on either side of the æquatour, and so 72 *cent*. on the first houre, and 80 on the second houre, and 2 inches 70 *cent*. on the fift houre from the substylar, and the rest of these distances on their seuerall houre-lines, and then draw a crooked line through all these points, so as it makes no angles, the line so drawne shall bee the Tropike requirred. In like maner you may draw any other parallell of declination.

| Hou. | | An. Po Gr. | M. | Tang. In | P. | Secant In. | P. | Trop. In | P. |
|---|---|---|---|---|---|---|---|---|---|
| 12 | | 0 | 0 | 0 | 0 | 1 | 61 | 0 | 70 |
| 11 | 1 | 15 | 0 | 0 | 43 | 1 | 63 | 0 | 72 |
| 10 | 2 | 30 | 0 | 0 | 93 | 1 | 85 | 0 | 80 |
| 9 | 3 | 45 | 0 | 1 | 61 | 2 | 27 | 0 | 99 |
| 8 | 4 | 60 | 0 | 2 | 79 | 3 | 22 | 1 | 40 |
| 7 | 5 | 75 | 0 | 6 | 00 | 6 | 21 | 2 | 70 |

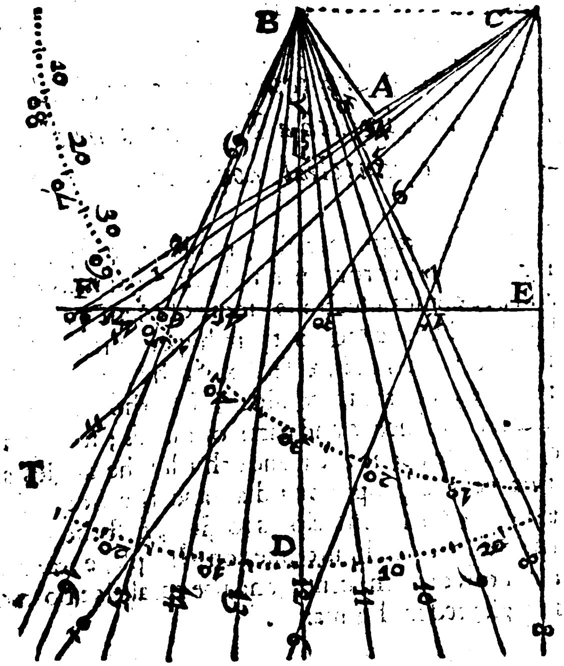
CHAP.

## CHAP. XIII.

### *To describe the Tropiques and other circles of declination in such a Plane as is neither equinoctiall nor polar.*

IN Planes neither æquinoctiall nor polar, the æquatour will be a right line, the tropiques and other parallels of declination will bee conicall sections, some of them parabolicall, some ellipticall, but the most of them hyperbolicall.

To finde the points of intersection of these parallels with the houre-lines, wee are to consider, first the length of the axis of the style in inches and parts of inches; secondly the height of the style aboue the plane; thirdly the angles at the pole betweene the proper meridian and the houre-circles. These being knowne, will help vs to find, first the angle betweene the axis and the houre-lines on the plane; and then the distance betweene the center and the parallels; both these may be represented in this maner.




Let the triangle *A B C* be made equall to the ſtyle belonging to your plane, *A C* the ſubſtylar, *B C* the axis of the ſtyle, A B the length of the ſtyle perpendicular to the plane. Then hauing drawne the line B D perpendicular to the axis on the center B, and any ſemidiameter B D deſcribe an occult arke of a circle, and therein inſcribe a chord of 23 *gr.* 30 *m.* from *D.* vnto ♈, on either ſide of the line, with ſuch other intermediate declinations as you intend to deſcribe on the plane, ſo the perpendicular B D ſhall be the æquator, and B T the tropiques, and the other intermediate lines the parallels of declination. Wherefore you may take out the diſtance *C* ♈ from the center to the æquator, and pricke it downe on the ſubſtylar of your plane from the center at *C* vnto ♈, ſo the line drawne

through

through ♈ perpendicular to your substylar, shall be the æquator of your plane.

That done, take the distance of each houre-line betweene the center and the equator of your plane, and pricke them downe in the æquator of this figure, from the center at *C*, noting the place, where they crosse the æquator, with the n umber belonging to the houre, and drawing the houre-lines from *C* through the lines of declination.

Or hauing the *Sector* you may draw an occult line *C E* perpendicular to the axis B C, and therein pricke downe the tangent of the height of the style aboue the plane, from *C* vnto *E*. Then draw the line *E F* parallell to the axis, crossing the substylar produced in the point *F*, this line *E F* will bee the line of sines vpon the *Sector*, and therein you may pricke downe the sines of the complement of the angles at the pole from *E* toward *F*, and draw the houre-lines by those points through the lines of declination, so the angles at *C* betweene the axis B C and those houre-lines, shall be the angles betweene the axis of your style and the houre-lines on your plane, and the seuerall distances betweene the point *C* and the lines of declination, shall giue you the like distances betweene the center, and the parallels of declination vpon the houre-lines in your plane. Vpon this ground it followeth,

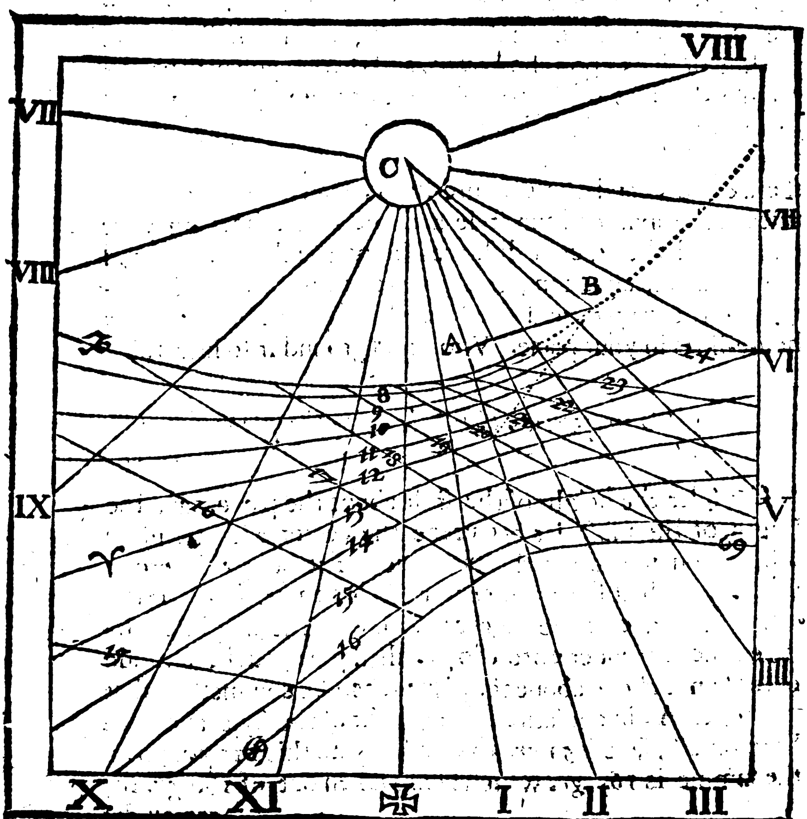
## 1 *To proportion the style vnto the plane.*

Consider the height of the style aboue the plane, and the length of the substylar betweene the center and the place which you intend for the trodique. If it bee the tropique which is farthest from the center, adde 113 *gr.* 30 *m*: if the neerer tropique, adde 66 *gr.* 30. *m.* vnto the height of the style, the remainder vnto 180 *gr.* shall giue you the altitude of the Sunne aboue aboue the plane when he commeth to that tropique. As in our latitude the height of the style aboue an horizontall plane is 51 *gr.* 30 *m.* adde vnto this 113 *gr.* 30 *m.* the summe is 165 *gr.* which being taken out of 180 *gr.* the

remainder

remainder will be 15 *gr.* and such is the altitude of the Sunne aboue this plane when he commeth to be in the Winter tropique: but if you adde 66 *gr.* 30 *m.* vnto 51 *gr.* 30 *m.* the remainder to 180 *gr.* will be 62 *gr.* And such is the altitude of the Sun in the Summer Tropique. Then.

As the sine of 66 *gr.* 30 *m.*
to the sine of the Suns altitude:
So the length of the substylar line,
to the length of the axis of the style.



As in the first examples of the declining verticall, where the height of the style was found to be 34 *gr.* 33 *m.* and is here represented before *pag.* 150. by the angle *B C* ♋; adde to this height 113 *gr.* 30 *m.* for the angle C B ♋, the sum will be 148 *gr.* 3 *m.* and the remainder to 180 *gr.* will be 31 *gr.* 57 *m.* and such is the angle *B* ♋ C of the altitude of the Sun aboue the plane, when he cometh to be in the tropique of ♋, which is here the farthest tropique from the center.

Then supposing the length of the substylar line betweene the center and the place which is fit for the farthest tropique to be about 21 inches, extend the compasses from the sine of *66 gr. 30 m.* vnto the sine of 31 *gr.* 57 *m.* the same extent will reach in the line of numbers from 21 vnto 12. 11, and so the length of the axis of the style should be 12 inch. 11 *cent.* Or it may suffice to make it iust 12 inches, as a more easie ground for the rest of the worke.

But if it were required to proportion the style vnto the plane, so as it may cast the shadow to the full length of the substylar line at all times of the yeare, you may then consider the Sun in the tropique, which is to be set nearest vnto the center, and adde 66 *gr.* 30 *m.* vnto 34 *gr.* 33 *m.* so the remainder vnto 180 *gr.* will be 78 *gr.* 57 *m.* And if you extend the compasses from the sine of 66 *gr.* 30 *m.* vnto the sine of 78 *gr.* 57 *m.* the same extent will reach in the line of numbers from 21 vnto 22.47 for the length of the axis of the style.

### 2 *Hauing the length of the axis, and the height of the style aboue the plane, to find the length of the sides of the style.*

The style of a plane neither æquinoctiall nor polar, may be either a small rod of iron set parallell to the axis of the world, or perpendicular to the plane, or else a thin plate of iron or brasse made in forme of a rectangle triangle *B A C*, with the base *B C* parallell to the axis of the world, the side *A B* perpendicular to the plane, and the side *A C* the same with the substylar line, wherein knowing *B C*, and the angle B A C,

As the sine of 90 *gr.*
to the length of the axis:
So the sine of the height of the style,
to the length of the perpendicular side:
And so the cosine of the height of the style,
to the length of the substylar side.

Thus in the former example, the length of the axis being supposed to be 12 inches, and the height of the style 34 *gr.* 33 *m.* Extend the compasses from the sine of 90 *gr.* (or else from the sine of 5 *gr.* 45 *m.*) vnto 12 in the line of numbers, the same extent will reach from the sine of 34 *gr.* 33 *m* vnto 6. 80 in the line of numbers for the length of the perpendicular side, and from the sine of 55 *gr.* 27 *m.* vnto 9. 88 for the length of the substylar side.

### 3 *To find the distance betweene the center and the æquator upon the substylar line.*

This is here represented by C, ♈, and may be found by resoluing the rectangle triangle C B ♈.

As the cosine of the height of the style,
is to the sine of 90 *gr.*
So the length of the axis,
to the distance of the æquator from the center.

Extend the compasses from the sine of 55 *gr.* 27 *m.* vnto the sine of 90 *gr.* the same extent will reach in the line of numbers from 12 vnto 14. 57. Wherefore if you take 14 *inch.* 57 *cent.* and pricking them downe on your substylar line from C vnto ♈, draw a line through ♈, crossing the substylar at right angles, the line so drawne shall be the æquator.

4 To

## 4 *To find the angles contained betweene the æquatour and the houre-lines vpon your plane.*

These angles made by B ♈ and the houre-lines, are complements of those which are at C, betweene B C the axis and those seuerall houre-lines, and depend vpon the angles at the pole, betweene the proper meridian and the houre-circles.

As the sine of 90 *gr.*
to the cosine of the angle at the pole:
So the cotangent of the height of the style,
to the tangent of the angle betweene the æquator and the houre-line.

In our example the height of the style is 34 *gr.* 33 *m.* and the proper meridian falleth to be the same with the circle of the second houre after noone, whereupon the angle at the pole, betweene this proper meridian, and the circles of the houre of 1 on the one side, and 3 on the other side, will bee 15 *gr*; so betweene this meridian and the houre-circles of 12 and 4, the angle will be 30 *gr.* &c. as in the Table.

| Ho. | | An. Po | | Arc. Pla | | An. Equ | | C ♈ | | C ♋ | | C ♑ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gr. | M | Gr | M. | Gr. | M. | In. | P. | In. | P. | In. | P. |
| *Subst.* | | 0 | 0 | 0 | 0 | 55 | 27 | 14 | 57 | 20 | 80 | 11 | 21 |
| 1 | 3 | 15 | 0 | 8 | 38 | 54 | 30 | 14 | 74 | 21 | 36 | 11 | 25 |
| 12 | 4 | 30 | 0 | 18 | 8 | 51 | 30 | 15 | 33 | 23 | 44 | 11 | 40 |
| 11 | 5 | 45 | 0 | 29 | 33 | 45 | 45 | 16 | 75 | 29 | 05 | 11 | 76 |
| 10 | 6 | 60 | 0 | 44 | 30 | 36 | 0 | 20 | 00 | 50 | 84 | 12 | 77 |
| 9 | 7 | 75 | 0 | 64 | 42 | 20 | 36 | 34 | 10 | Infin. | | 15 | 82 |
| 8 | 8 | 90 | 0 | 90 | 0 | 0 | 0 | Infinit | | | | 27 | 60 |

If then it be required to find the Angle, which the houre-line of 4 after noone doth make with the plane of the æquator, that is the angle C 4 B contained betweene the houre-line C 4 and the line B 4, drawne from the top of the style vnto the intersection of the houre-line of 4 with the æquator.

Extend the compasses from the sine of 90 *gr.* vnto the sine of 60 *gr.* the complement of the angle at the pole, the same extent will reach from the tangent of 55 *gr.* 27 *m.* the complement of the height of the pole, vnto the tangent of 51 *gr.* 30 *m.* and such is the angle C 4 B in the diagram *Pag.* 150.

Or in crosse-worke, if it were required to finde the angle C 9 B, looke into the Table for the houre of 9, and there you shall find the angle at the pole to be 75 *gr*; and if you extend the compasses from the sine of 90 *gr.* vnto the tangent of 55 *gr.* 27 *m.* the same extent will reach from the sine of 15 *gr.* the complement of 75 *gr.* vnto the tangent of 20 *gr.* 36 *m.* and such is the angle C 9 B, made at the æquator betweene the line B 9 drawne from the top of the style, and the houre-line C 9 drawne from the center. The like reason holdeth for the rest, which may be found and set downe in a table: then may you either draw these angles at *C* in the former figure more perfectly, and thence finish your worke, or else proceed

## 5 *To finde the distance betweene the center and the parallels of declination.*

The distances betweene the center and the parallels of declination, may be found by resoluing the triangles made by the axis *B C*, the lines of declination, and the houre-lines. For hauing the angles at the æquator, and knowing the declination of the parallell, if the parallell shall fall betweene the æquator and the center, adde the declination vnto the angle at the æquator; or if it shall fall without the æquator, take the declination out of the angle at the æquator, so shall you haue the angle at the parallell Then

As

As the sine of the angle at the parallell,
to the cosine of the declination:
So the length of the axis of the style,
to the distance betweene the center and the parallell.

Thus in our example, the angle at the æquator belonging to the houre of 4 after noone, was found before to be 51 *gr.* 30 *m.* if you would find the distance betweene the center and the æquator, extend the cōpasses from the sine of 51 *gr.* 30 *m.* vnto the sine of 90 *gr.* the complement of the declination, the same extent will reach in the line of numbers, from 12 vnto 15. 33, and such is the distance vpon the houre-line of 4 betweene the center and the æquator.

If you would finde the distance vpon this houre-line, betweene the center and the inner tropique, whose declination is knowne to be 23 *gr.* 30 *m.* adde the declination to the angle at the æquator, so the angle at the parallel will be 75 *gr.* wherefore extend the compasses from the sine of 75 *gr.* vnto the sine of 66 *gr.* 30 *m.* the complement of the declination, the same extent will reach in the line of numbers, from 12 vnto 11. 40, and such is the length of the houre-line of 4 betweene the center and the tropique of ♑.

If you would finde the distance vpon this houre-line betweene this center and the tropique of ♋, which is here the farthest from the center, take the declination out of the angle at the æquator, so the angle at the parallell will be 28 *gr.* wherefore extend the compasses from the sine of 28 *gr.* vnto the sine of 66 *gr.* 30 *m.* the same extent will reach in the line of numbers, from 12 vnto 23. 44; and such is the distance betweene the center and the tropique of ♋ vpon this houre-line of 4. The like reason holdeth for all the rest, which may be gathered and set downe in a table.

That done and the æquator drawne as before, if you would draw the tropique of ♋, looke into the table, and there finding vnder the title C ♋ the distance of the substylar betweene the center and the parallel of ♋ to be 20 inch. 80 cent. take

20 inch. 80 *cent.* out of the line of inches, and prick them downe in the substylar of your plane from C vnto ♋.

Or if either the center fall without your plane, or the extent be too large for your compasses, you may prick downe the difference betweene C ♈ and C ♋. As here the distance C ♈ betweene the center and the æquator is 14. 57, the distance C ♋ 20. 80, the difference 6. 23, therefore taking 6 inches 23 *cent.* prick them downe on the substylar from ♈ vnto ♋, and you shall haue the same intersection of the tropique and the substylar, as before; and the like reason holdeth for pricking downe of the rest of these distances on their seuerall houre-lines.

Then hauing the points of intersection betweeu the houre-lines and the parallel, you may ioyne them all in a crooked line without making of any angles, the line so drawne shall be the tropique required. And after this maner may you draw any other parallel of declination, whereof you haue examples in the most of the former Diagrams.

## CHAP. XIIII.

### *To describe the parallels of the Signes in any of the former Planes.*

THe æquator and the tropiques before described, doe shew the Suns entrance into 4 of the Signes, the æquator into ♈ and ♎, the one tropique into ♋, and the other into ♑, the rest of the intermediate Signes will be described in the same manner as the tropiques, if first we know their declination.

The manner of finding the declination not onely of the beginning of the Signes, but of all other points of the ecliptique, is is before set downe in 2 *Prop. Astronomicall, pag.* 52. by which you may find the declination of the beginning of ♉, ♍, and ♏, ♓ to be 11 *gr.* 30 *m.* and of ♊, ♌, ♐ and ♒ to bee 20 *gr.* 12 *m.* If then you inscribe the chords of 11 *gr.* 30 *m.* and of 20 *gr.* 12 *m.* into the former figure B D T *Pag.* 145. from *D* toward *T*, the lines drawne from B through the termes of those chords shall be the Signes required.

And with these declinations, the height of the style, and the length of the axis, you may finde the angles at the parallels, and then the distances betweene the center and the parallels, which being pricked downe vpon their severall houre-lines shall giue you the points of intersection, by which you may draw the parallels of the Signes, as in the figures belonging to the polar planes.

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# CHAP. XV.

## *To describe the parallels of the length of the day in any of the former Planes.*

THe length of the day will alwayes be 12 houres long when the Sunne commeth to be in the æquator, and this holdeth in all latitudes; but at other times of the yeare the same place of the Sunne, will not giue the same length of the day in another latitude; wherefore the latitude being known, we are first

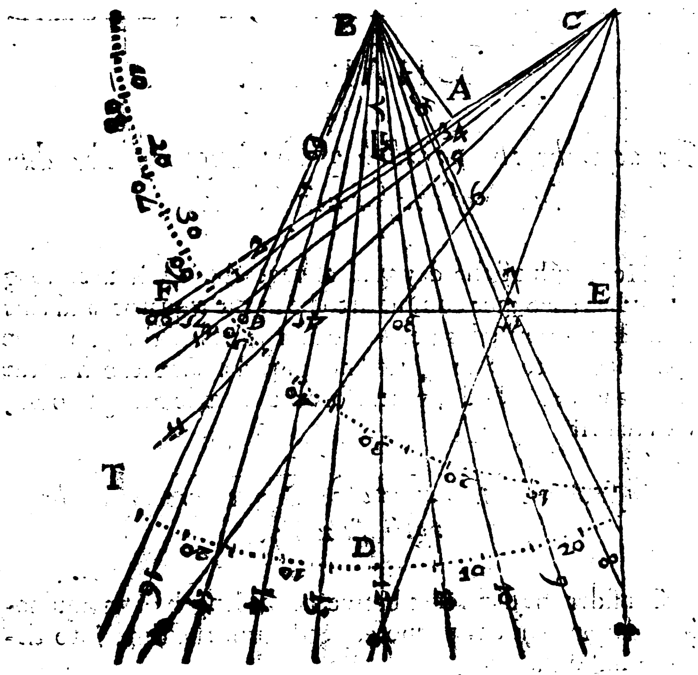
### *To finde the declination of the Sunne agreeing to the length of the day.*

Consider the difference betweene the length of an æquinoctiall day and the day proposed, and turne the time into degrees and minutes.

As

As the sine of 90 *gr.*
is to the sine of halfe the difference:
So the cotangent of the latitude.
to the tangent of the declination.

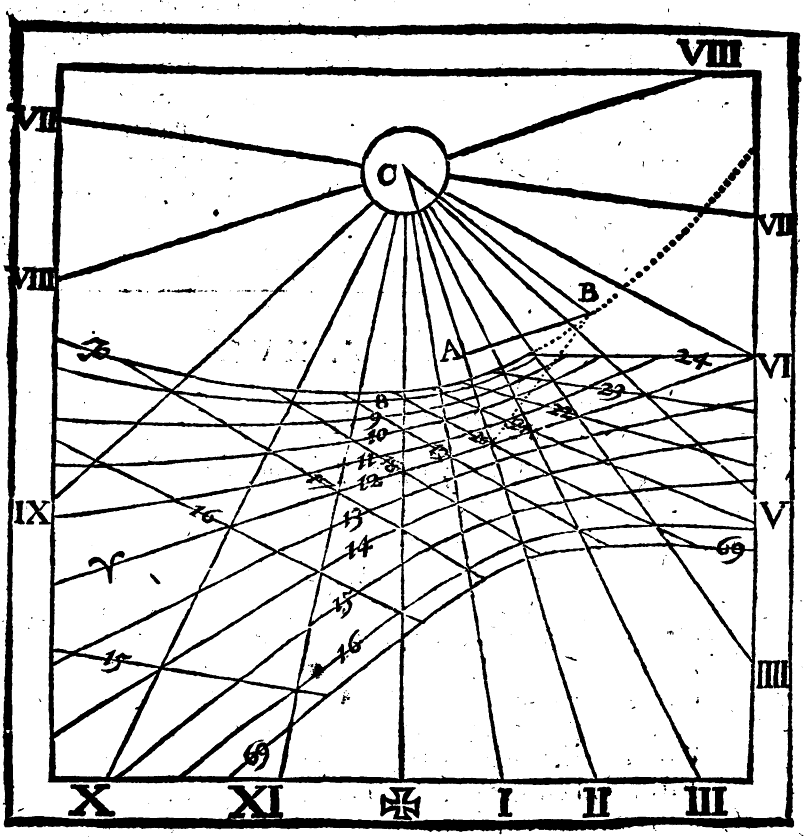
As if the length of the day proposed were 15 houres, the difference betweene this and an æquinoctiall day (whose length is alwaies 12 houres) would be three houres, which make 45 *gr.* and the halfe difference is 22 *gr.* 30 *m.* wherefore extend the compasses from the sine of 90 *gr.* vnto the tangent of 38 *gr.* 30 *m.* the complement of the latitude, the same extent will reach from the sine of 22 *gr.* 30 *m.* vnto the tangent of 16 *gr.* 55 *m.* for the declination of the Sunne at




such

such time as the length of the day is either 9 or 15 houres; and from the sine of 30 *gr.* vnto the tangent of 21 *gr.* 40 *m.* for the declination belonging to 8 or 16 houres, and from the sine of 15 *gr.* vnto the tangent of 11 *gr.* 38 *m.* for the declination belonging to 10 or 14 houres, and from the sine of 7 *gr.* 30 *m.* vnto the tangent of 5 *gr.* 56 *m.* for the declination of the Sun when the length of the day is either 11 or 13 houres.

If then you inscribe the chords of these arkes into the for-



mer figure *B D T*, the lines drawne from *B* through the termes of these arks, shall be the lines belonging to the diurnall arkes, and the seuerall distances betweene them and the point *C* giue the like distances betweene the center and the parallels of the length of the day vpon the houre-lines in your plane.

Or comparing these angles of declination with the angles at the æquator, you may haue the angles at the parallel, and then find the distances betweene the center and the parallel, which being pricked downe vpon the seuerall houre-lines, shall giue you the points of intersection, by which you may draw the parallels of the length of the day, whereof you haue another example in the diagram belonging to an horizontall plane *pag.* 105: And by the same reason you may draw the parallels of those circles to which the Sunne is verticall, the parallels of the principall feasts, or what else depends on the declination of the Sunne.

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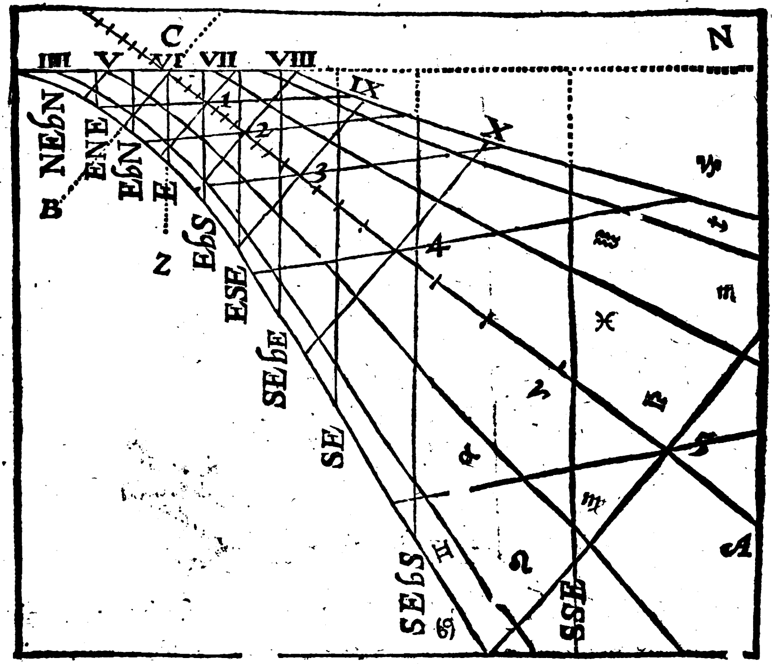
## CHAP. XVI.

### *To draw the old vnequall houres in the former Planes.*

IT was the manner of the Ancients to diuide the day into twelue equall houres, and the night into twelue other equal houres, and so the whole day and night into 24 houres. Of these 24, those which belonged vnto the day, were either longer or shorter (excepting the two æquinoctiall dayes) then those which belonged vnto the night; and the Summer houres alwayes longer then the houres in the Winter, according to the lengthening of the dayes, whereupon they are called the old vnequall (and by some the Planetary) houres.

To




To expresse these in the former Planes: first draw the common houre-lines, the æquaror, and the tropiques, as before: then describe two occult parallels of the length of the day, one for 9 houres, the other for 15 houres; for so you may draw a straight line for the first vnequall houre through 5 *ho.* 45 *m* in the parallel of 15, and through 8 *ho.* 15 *m.* in the parallel of 9. This straight line shall passe directly through 7 *ho.* 0 *m.* in the æquator, and so cut off a twelfth part of the arkes aboue the horizon, both from these two parallels and the æquator: and being continued vnto the tropiques, it shall also cut off about a twelfth part from them, and all the rest of the parallels of declination, without any sensible error.

In like manner may you draw the second vnequall houre through 7 *ho.* in the parallel of 15, through 8 *ho.* in the æquator, and through 9 *ho.* in the parallel of 9, and so in the rest, as in this Table.

| Hora. | 15 | | Eq. | 9 | |
|---|---|---|---|---|---|
| | Ho. | M. | Ho | Ho. | M |
| 0 | 4 | 30 | 6 | 7 | 30 |
| 1 | 5 | 45 | 7 | 8 | 15 |
| 2 | 7 | 0 | 8 | 9 | 0 |
| 3 | 8 | 15 | 9 | 9 | 45 |
| 4 | 9 | 30 | 10 | 10 | 30 |
| 5 | 10 | 45 | 11 | 11 | 15 |
| 6 | 12 | 0 | 12 | 12 | 0 |
| 7 | 1 | 15 | 1 | 0 | 45 |
| 8 | 2 | 30 | 2 | 1 | 30 |
| 9 | 3 | 45 | 3 | 2 | 15 |
| 10 | 5 | 0 | 4 | 3 | 0 |
| 11 | 6 | 15 | 5 | 3 | 45 |
| 12 | 7 | 30 | 6 | 4 | 30 |

And of these vnequall houres you haue a farther example in the diagram belonging to the polar declining plane, *Pag.* 130.

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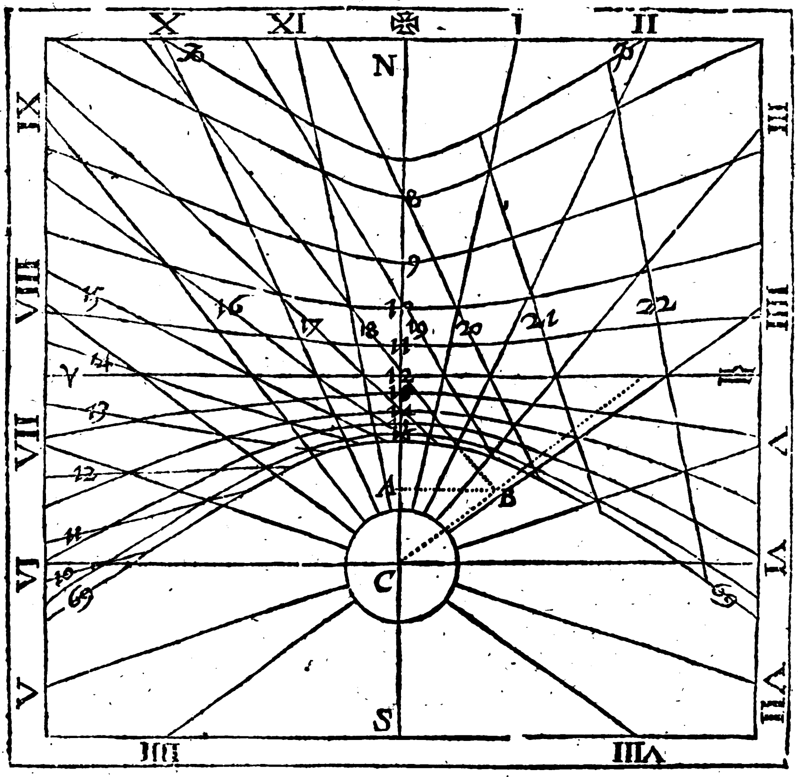
## CHAP. XVII.

### *To draw the houres from Sunne rising and Sunne setting in the former Planes.*

TO know how many houres are past since the Sun rising, or how many remaine to the Sun setting; first draw the common

common houre-lines, the æquator, and the tropiques, as before: then describe two occult parallels of the length of the day, one for 8 houres, and the other for 16 houres. For so




you may draw the first houre from the Sun rising through the common houres of 5 in the parallell of 16, of 7 in the æquator, and of 9 in the parallel of 8. In like manner the second houre from Sun rising through the common houres of 6 in the parallel of 16, of 8 in the æquator, and of 10 in the parallel of 8. And so the rest in their order.

The first houre before Sun setting, or the 23 houre from the last Sun setting, may be drawne in like sort through the common houres of 3 after noone in the parallel of 8 of 5 in the æquator, and of 7 in the parallel of 16. The second houre before Sun setting, or the 22 houre after the last Sun setting through the common houres of 2 in the parallel of 8, of 4 in the æquator, and of 6 in the parallel of 16. And so the rest in the like order, whereof you haue another example in the Diagram belonging to the declining verticall, *Pag.* 116.

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## CHAP. XVIII.

### *To draw the horizontall line in the former planes.*

THe common houre-lines doe common depend on the shadow of the axis, but the parallels of the Signes, and of the length of the day, the houre-lines from Sun rising and Sun setting, with many others, depend on the shadow of the top of the style, or some one point in the axis, which here signifieth the center of the world, and is represented by the point B. And these lines so depending, are then onely vsefull when they fall betweene the two tropiques, and within the horizon.

There may be seuerall horizontall lines drawne vpon euery plane, as I shewed before in finding the inclination of a plane; but the proper horizontall line which is here meant, must alwaies be in the same plane with B the top of the style; so that in an horizontall plane there can be no such horizontall line, but in all other planes it may be found by applying the horizontall legge of the *Sector* vnto the top of the style, and then working as before; and the intersection of this line with the meridian or substylar line, may be found by propor-

1 To

## 1 *To finde the intersection of the horizon with the meridian, in an æquinoctiall plane.*

As the tangent of 45 *gr.*
to the tangent of the latitude:
So is the height of the ſtyle,
to the diſtance between the ſtyle and the horizontall line.

As in the example of the former æquinoctiall plane, *Pag.* 142. extend the compaſſes from the tangent of 45 *gr.* vnto 51 *gr.* 30 *m.* the tangent of the latitude, the ſame extent will reach in the line of numbers, from 52 the length of the ſtyle vnto 66, and ſuch is the diſtance betweene the ſtyle and the horizontall line; wherefore I take 66 parts out of a line of inches, and prick them downe in the meridian line from C vnto H aboue the ſtyle in the upper face, but below the ſtyle in the lower face of the plane, ſo a right line drawne through *H*, parallel to the houre of 6, ſhall be the horizontall line.

## 2 *To find the interſection of the horizon with the meridian, in a direct polar plane.*

As the tangent of 45 *gr.*
to the cotangent of the latitude:
So the length of the ſtyle,
to the diſtance betweene the ſtyle and the horizontall line.

As in the example of the former polar plane, *Pag.* 144. extend the compaſſes from the tangent of 45 *gr.* vnto tangent of 38 *gr.* 30 *m.* the complement of the latitude, the ſame extent will reach in the line of numbers, from 1. 61 the length of the ſtyle, vnto 1. 28, and ſuch is the diſtance vpon the meridian

ridian betweene the style and the horizontall line.

In all vpright planes, whether they be direct verticall, or declining, or meridian planes, the horizontall line must alwayes be drawne through *A* the foot of the style, as may appeare in the examples before, *Pag*. 102. 107. 116.

And generally in all planes whatsoeuer, the horizontall line must be drawne through the intersection of the æquatour with the houre of 6. Or if that intersection fall without the plane, yet if any arks of the length of the day be drawne on the plane, the horizontall line may be drawne through their intersections, with the houres of the Suns rising or setting.

## CHAP. XIX.

### *To describe the verticall circles in the former Planes.*

THe verticall circles commonly called Azimuths, are great circles drawne through the zenith, by which we may know in what part of the heauen the Sun is, how far from the East or West, and how neere vnto the meridian.

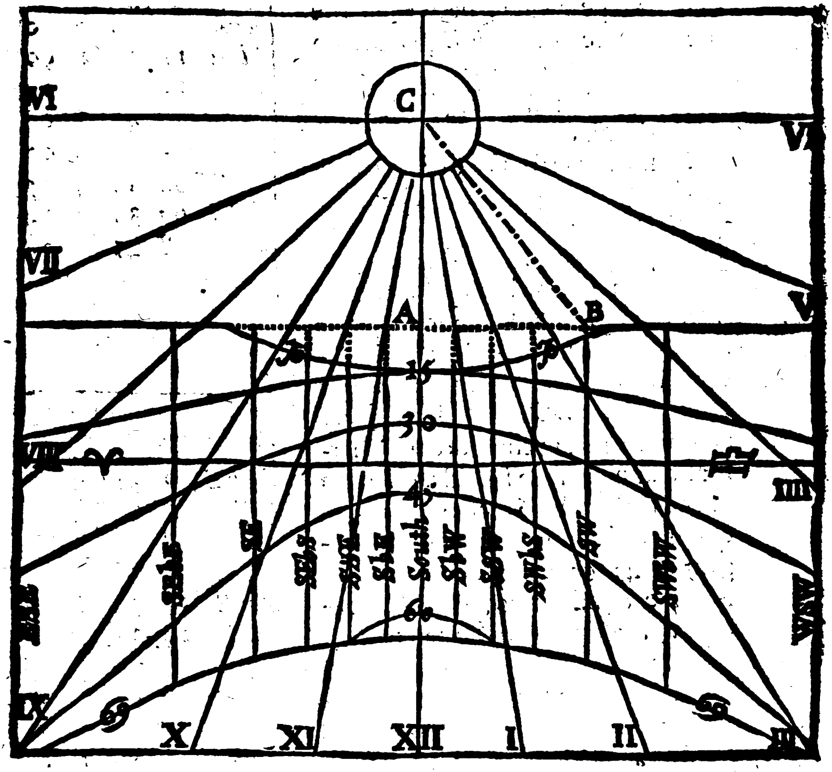
In all vpright planes, whether they be direct verticals, or declining, or meridian planes, the semidiameter of the horizon will be the same with *A B* the perpendicular side of the style, and these Azimuths will be parallels one to the other, and the distance of each Azimuth, from the foote of the style vpon the horizontall line, may be found in this maner.

Consider the length of the style in inches and parts of inches, and the distance of each Azimuth from the style, according to the angle at the zenith in degrees and minutes.

As the tangent of 45 *gr*.
to the tangent of azimuth:

So

So the length of the style,
to the length of the horizontall line betweene the style and the azimuth.




As if it were required to draw the common azimuths on the South face of the verticall plane before described, where *A B* the length of the style may be supposed to be 10 inches.
Here the plane hauing no declinatiõ, the style is in the plane of the meridian, and so pointeth directly into the South. The point of S *b E* is 11 *gr.* 15 *m.* distant from the style, and

SSE 22 *gr.* 30 *m.* and the rest in their order: wherefore extend the compasses from the tangent of 45 *gr.* vnto 10 in the line of numbers, the same extend will reach from the tangent of 11 *gr.* 15 *m.* vnto 1.99 in the line of numbers for the length of the tangent line, betweene the style and the point *S b E*, and from the tangent of 22 *gr.* 30 *m.* vnto 4.14 for *S S E*, and so for the rest, as in this Table.

| *Azimuths.* | An Zen Gr. | M. | Tangen In. | Pa. |
|---|---|---|---|---|
| *South* | 0 | 0 | 0 | 0 |
| *S b E* | 11 | 15 | 1 | 99 |
| *S S E* | 22 | 30 | 4 | 14 |
| *S E b S* | 33 | 45 | 6 | 68 |
| *S E* | 45 | 0 | 10 | 00 |
| *S E B E* | 56 | 15 | 14 | 97 |
| *E S E* | 67 | 30 | 24 | 14 |
| *E b S* | 78 | 45 | 50 | 27 |
| *East* | 90 | 0 | Infin. | |

In like maner in the first example of the declining plane, where the style standeth according to the declination 24 *gr.* 20 *m.* distant from the South toward the West. The next point of *S b W* is but 13 *gr.* 5 *m.* distant from the style; and the second of *S S W* onely 1 *gr.* 50 *m.* and the third of *S W b S* is againe 9 *gr.* 25 *m.* and the rest in their order. Wherefore hauing before found the length of the style to be 6 inches 80 parts, extend the compasses from the tangent of 45 *gr.* vnto 6. 80 parts in the line of numbers, the same extent will reach from the tangent of 24 *gr.* 20 *m.* vnto 3.07 in the line of numbers for the length of the tangent line betweene the style and the South, and from the tangent of 13 *gr.* 5 *m.* vnto 1. 58 for the point of *S b W*; and so for the rest, as in this Table.

| *Azimuths.* | An. Zen. Gr. | M. | Tangen In. | Pa. |
|---|---|---|---|---|
| *S E b E* | 80 | 35 | 41 | 00 |
| *S E* | 69 | 20 | 18 | 03 |
| *S E b S* | 58 | 5 | 10 | 91 |
| *S S E* | 46 | 50 | 7 | 25 |
| *S b E* | 35 | 35 | 4 | 86 |
| *South* | 24 | 20 | 3 | 07 |
| *S b W* | 13 | 5 | 1 | 58 |
| *S S W* | 1 | 50 | 0 | 22 |
| *The* | *foote of* | | *the styl* | |
| *S W b S* | 9 | 25 | 1 | 13 |
| *S W* | 20 | 40 | 2 | 57 |
| *S W b W* | 31 | 55 | 4 | 24 |
| *W S W* | 43 | 10 | 6 | 37 |
| *W b S* | 54 | 25 | 9 | 50 |
| *West* | 65 | 40 | 15 | 02 |
| *W b N* | 76 | 55 | 29 | 26 |
| *W N W* | 88 | 10 | 212 | 45 |

That done, if you take these parts out of a line of inches, and pricke them downe in the horizontall line on either side of the style, drawing right

right lines perpendicular to the horizon through these intersections, but so as they may be contained betweene the horizontall and the tropiques, the lines so drawne shall be the azimuths required.

In an horizontall plane these azimuths are drawne more easily. For here the perpendicular side of the style is the same with the axis of the horizon, and the foote of the style is the verticall point, in which all the azimuth lines doe meete as their circles doe in the zenith: wherefore let any circle described on the center A, at the foote of the style, be diuided first into foure parts, beginning at the meridian, and then each quarter subdiuided either into eight equall parts, according to the points of the Mariners compasse, or into 90 *gr.* according to the Astronomicall diuision; if you draw right lines through the center and these diuisions, the lines so drawne shall be the azimuths required.

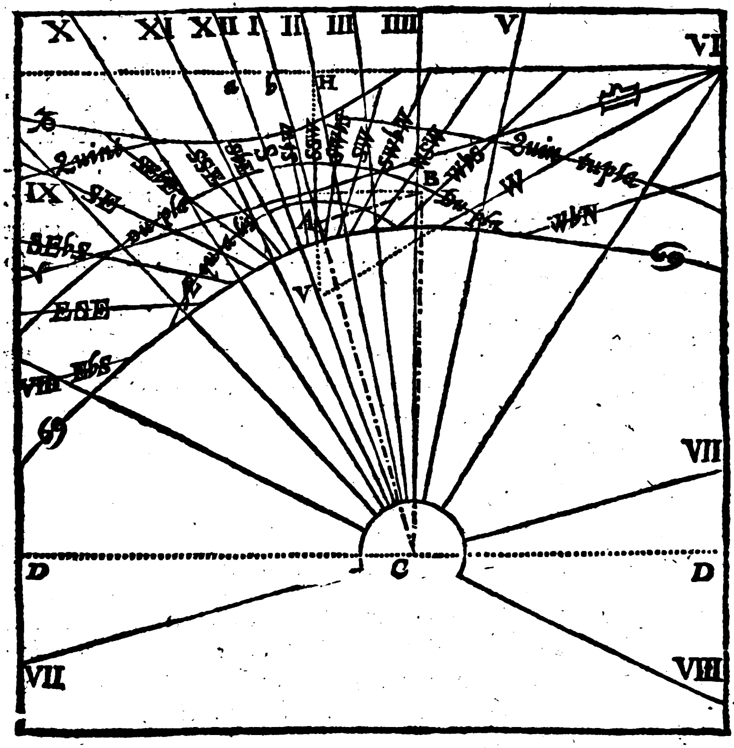
In all other planes inclining to the horizon, these verticall circles will meete in a point, but that verticall point being more or lesse distant from the foote of the style, the angles at this point will be vnequall.

## 1 *To find the distance betweene the foote of the style, and the verticall point.*

The verticall point wherein all the verticall lines do meet, will be alwayes in the meridian, directly vnder or ouer the top of the style; and the angle betweene the perpendicular side of the style and the verticall line, will be equall to the inclination of the plane to the horizon. Wherefore

As the tangent of 45 *gr.*
 to the tangent of the inclination of the plane:
So is the length of the style,
 to the distance betweene the foote of the style and the verticall point.

Thus in the first example of the declining inclining planes, where the vpper face of the plane looking Southwest, the declination was 24 *gr.* 20 *m.* the inclination 36 *gr*; and you may suppose *A B* the length of the style to be 6 inches: if you extend the compasses from the tangent of 45 *gr.* vnto the tan-




gent of 36 *gr.* the same extent will reach in the line of numbers from 6.00 vnto 4.36, for the distance *A V* betweene *A* the foote of the style and *V* the verticall point.

2. *To find the distance betweene the foote of the style and the horizontall line.*

As the tangent of the inclination of the plane,
is to the tangent of 45 *gr.*
So the length of the style,
to the distance betweene the foote of the style and the horizontall line.

So the same extent of the compasses as before, will reach in the line of numbers from 6.00 vnto 8 26 for the distance *AH* betweene the foote of the style and the horizontall line.

Then may you take 4 inches 36 *cent.* and pricking them downe from *A* the foot of the style vnto *V* the verticall point in the meridian, draw the line *VA*, which being produced shall cut the horizon in the point *H* with right angles, and be that particular azimuth which is perpendicular to the plane.

Or you may take 8 inches 26 *cent.* and pricke them downe in the former line *VA* produced from *A* vnto *H*, and so draw the horizontall line through *H* perpendicular vnto *VH*, which horizontall line being produced will crosse the æquator in the same point wherein the æquator crosseth the houre-line of 6, vnlesse there be some former error.

3 *To find the angles made by the azimuth lines at the verticall point.*

The angles at the zenith depend on the declination of the plane, as in our example, where the style standeth according to the declination 24 *gr.* 20 *m.* distant from the South toward the West, the azimuth of 10 *gr.* from the meridian Eastward will be 34 *gr.* 20 *m.* the azimuth of 10 *gr.* Westward will be onely 14 *gr.* 20 *m.* distant from the style, and so the rest in their order.

Or if you would rather describe the common azimuths, the point of S *b E* will be 35 *gr.* 35 *m.* the point of S *b W* 13 *gr.* 5 *m.* distant from the style, and so the rest in their order. Then

As the sine of 90 *gr.*
to the cosine of the inclination of the plane:
So the tangent of the angle at the zenith,
to the tangent of the angle at the verticall point betweene the line drawne through the foot of the style and the azimuth required.

Wherefore the inclination of the plane in our example being 36 *gr.* extend the compasses from the sine of 90 *gr.* vnto the sine of 54 *gr.* the same extent shall reach in the line of tangents, from 24 *gr.* 20 *m.* vnto 20 *gr.* 5 *m.* for the angle *HVa* at the verticall point, betweene the line *VH* drawn through *A* the foote of the style and the South. Againe, the same extent will reach from the tangent of 13 *gr.* 5 *m.* vnto 10 *gr.* 38 *m.* for the angle belonging to S *b W*; and so for the rest, as in this table.

| *Azimuths.* | Ang. Ze. Gr. | M | Ang. Ve. Gr. | M. |
|---|---|---|---|---|
| *SEbE* | 80 | 55 | 78 | 25 |
| S *E* | 69 | 20 | 65 | 0 |
| S *E b* S | 58 | 5 | 52 | 25 |
| *S S E* | 46 | 50 | 40 | 46 |
| *S b E* | 35 | 35 | 30 | 3 |
| *South* | 24 | 20 | 20 | 5 |
| *S b W* | 13 | 5 | 10 | 39 |
| *S S W* | 1 | 50 | 1 | 29 |
| | *Style.* | | 0 | 0 |
| *SW b S* | 9 | 25 | 7 | 38 |
| *S W* | 20 | 40 | 16 | 58 |
| *SWbW* | 31 | 55 | 26 | 45 |
| *W S W* | 43 | 10 | 37 | 11 |
| *W b S* | 54 | 25 | 48 | 30 |
| *West* | 65 | 40 | 60 | 48 |
| *WbN* | 76 | 55 | 73 | 58 |
| *WNW* | 88 | 10 | 87 | 44 |

These angles being knowne, if on the center *V*, at the verticall point, you describe an occult circle, and therein inscribe the chords of these angles from the line *VH*, and then draw right lines through the verticall point, and the terms of those chords, the lines so drawne shall be the azimuths required.

The

The like reason holdeth for the drawing of the azimuths vpon all other inclining planes, whereof you haue another example in the Diagram belonging to the meridian incliner, *Pag* 126.

Or for further satisffaction you may finde where each azimuth line shall crosse the equator.

As the sine of 90 *gr.*
to the sine of the latitude:
So the tangent of the azimuth from the meridian,
to the tangent of the æquator from the meridian.

Extend the compasses from the sine of 90 *gr.* vnto the sine of our latitude 51 *gr.* 30 *m.* the same extent will reach in the line of tangents from 10 *gr.* vnto 7 *gr.* 50 *m.* for the intersection of the æquator with the azimuth of 10 *gr.* from the meridian. Againe, the same extent will reach from 20 *gr.* vnto 15 *gr.* 54 *m.* for the azimuth of 20 *gr.* And so the rest, as in these tables.

| *Azim.* | | *Equat.* | |
|---|---|---|---|
| *Gr.* | *M* | *Gr.* | *M.* |
| 10 | 0 | 7 | 50 |
| 20 | 0 | 15 | 54 |
| 30 | 0 | 24 | 20 |
| 40 | 0 | 33 | 18 |
| 50 | 0 | 43 | 0 |
| 60 | 0 | 53 | 35 |
| 70 | 0 | 65 | 3 |
| 80 | 0 | 77 | 18 |
| 90 | 0 | 90 | 0 |

| *Azim.* | | *Equa.* | |
|---|---|---|---|
| *Gr.* | *M.* | *Gr.* | *M.* |
| 11 | 15 | 8 | 51 |
| 22 | 30 | 17 | 58 |
| 33 | 45 | 27 | 36 |
| 45 | 0 | 38 | 2 |
| 56 | 15 | 49 | 30 |
| 67 | 30 | 62 | 6 |
| 78 | 45 | 75 | 44 |
| 90 | 0 | 90 | 0 |

By which you may see that the azimuth 90 *gr.* distant from the meridian, which is the line of East and West, will crosse the æquator at 90 *gr.* from the meridian in the same point, with the horizontall line and the houre of 6. And that the azimuth

zimuth of 45 *gr.* will crosse the æquator at 38 *gr.* 2 *m.* from the meridian, that is, the line of SE will crosse the æquator at the houre of 9 and 28 *m.* in the morning, and the line of SW at 2 *ho.* 32 *min.* in the afternoone; and so for the rest, whereby you may examine your former worke.

## CHAP. XX.

### *To describe the parallels of the horizon in the former planes.*

THe parallels of the horizon, commonly called Almicanters, or parallels of altitude (whereby we may know the altitude of the Sun aboue the horizon) haue such respect vnto the horizon, as the parallels of declination vnto the æquator, and so may be described in like maner.

In an horizontall plane, these parallels will be perfect circles; wherefore knowing the length of the style in inches and parts, and the distance of the parallell from the horizon in degrees and minutes.

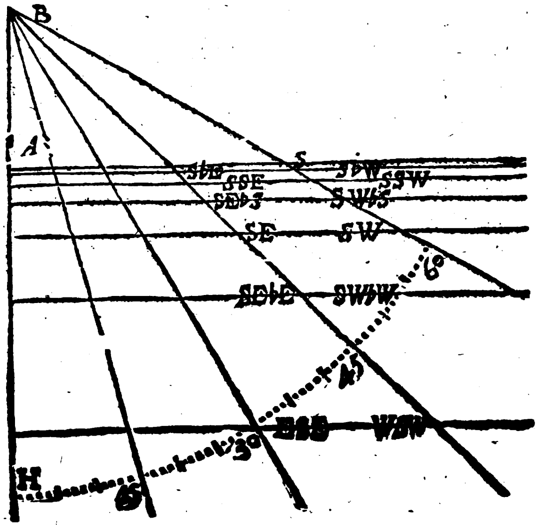
> As the tangent of 45 *gr.*
> is the length of the style:
> So the cotangent of the parallell
> to the semidiameter of his circle.

Thus in the example of the horizontall plane, *Pag.* 164. if *A B* the length of the style shall be 5 inches, and that it were required to finde the semidiameter of the parallell of 62 *gr.* extend the compasses from the tangent of 45 *gr.* vnto 5. 00 in the line of numbers, the same extent will reach from the tangent of 28 *gr.* the complement of the parallell vnto 2. 65, and if you describe a circle on the center *A* to the semidiameter of 2 inches 65 *cent.* it shall be the parallell required.

In

In all vpright planes, whether they be direct verticals, or declining, or meridian planes, these parallels will be conicall sections, and may be drawne through their points of interse-ction, with the azimuth lines, in the same maner as the pa-rallels of declination, through their points of intersection with the houre-lines. To this end you may first finde the di-stance between the top of the style and the azimuth; and then the distance betweene the horizon and the parallell, both which may be represented in this maner.

On the center *B* and any semidiameter *B H*, describe an occult arke of a circle, and therein inscribe the chords of such parallels of altitude as you intend to draw on the plane, (I haue here put them for 15. 30. 45 and 60 *gr.*) then draw right lines through the center and the termes of those chords, so the line *B H* shall be the horizon, and the rest the lines of altitude, according to their distance from the horizon.




That done, consider your plane (which here for example is the South face of our verticall plane, *page* 168) wherein hauing drawne both the horizontall and verticall lines, as I shewed before, first take out *A B* the length of the style, and pricke that downe in this horizontall line from *B* vnto *A*; then take out all the distances betweene *B* the top of the style and the seuerall points wherein the verticall lines doe crosse the horizontall, transferre them into this horizontall line B H, from the center B, and at the termes of these distances erect lines perpendicular to the horizon, noting them with the number or letter of the azimuth from whence they were taken, so these perpendiculars shall represent those azimuths, and the seuerall distances betweene the horizon and the lines of altitude shall giue the like distances, betweene the horizontall and the parallels of altitude vpon the azimuths in your plane. Vpon this ground it followeth,

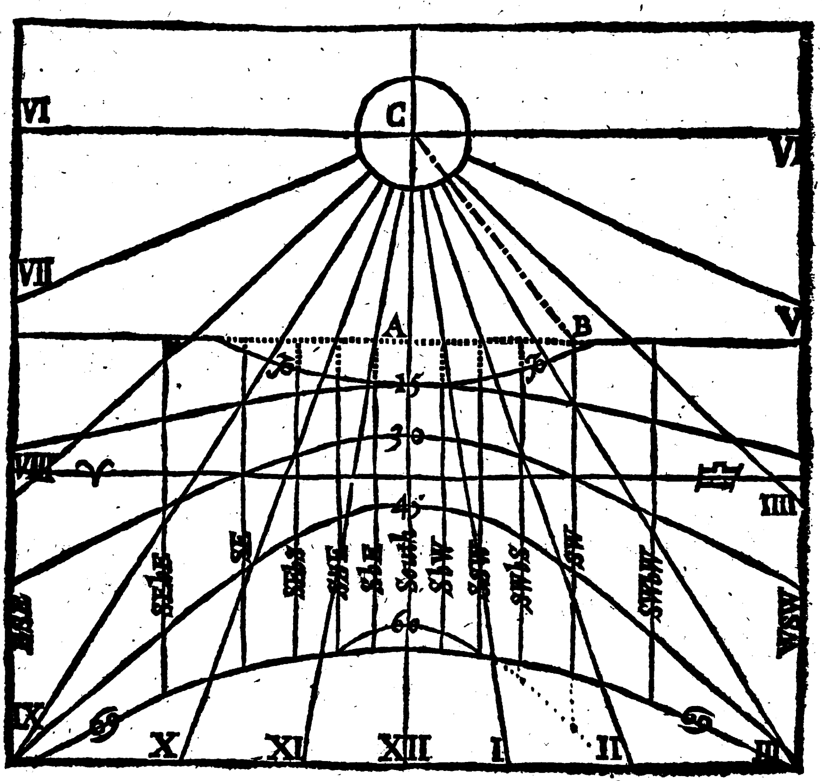
---

*1 To find the distance betweene the top of the style, and the seuerall points whecein the azimuths doe crosse the horizontall line.*

Hauing drawne the horizontall and azimuth lines as before, looke into the table by which you drew them, and there you shall haue the angles at the zenith. Then

As

As the cosine of the angle at the zenith,
is to the sine of 90 *gr*.
So the length of the style,
to the distance required.




 As

| *Azimuths.* | Ang. Ze. Gr. | M. | Tangent Inch. | P. | Secant. Inch. | P. | Par. 15. Inch. | P. | Par. 30. Inch. | P. |
|---|---|---|---|---|---|---|---|---|---|---|
| *South.* | 0 | 0 | 0 | 0 | 10 | 00 | 2 | 68 | 5 | 77 |
| S *b* E | 11 | 15 | 1 | 99 | 10 | 20 | 2 | 73 | 5 | 90 |
| S S E | 22 | 30 | 4 | 14 | 10 | 82 | 2 | 90 | 6 | 24 |
| *S E b S* | 33 | 45 | 6 | 68 | 12 | 03 | 3 | 23 | 6 | 94 |
| S E | 45 | 0 | 10 | 00 | 14 | 14 | 3 | 80 | 8 | 16 |
| *S E b E* | 56 | 15 | 14 | 97 | 18 | 00 | 4 | 82 | 10 | 40 |
| *E S E* | 67 | 30 | 24 | 14 | 26 | 13 | 7 | 02 | 15 | 08 |
| *E b S* | 78 | 45 | 50 | 27 | 51 | 26 | 13 | 73 | 29 | 60 |
| *East.* | 90 | 0 | Infinit. | | Infinit. | | Infinit. | | Infinit. | |

As in our example of the verticall plane, where *A B* the length of the style was supposed to be 10 inches, extend the compasses from the sine of 78 *gr.* 45 *m.* (the complement of 11 *gr.* 15 *m.* the angle at the zenith, belonging to S *b* *E* and S *b W*) vnto the sine of 90 *gr.* the same extent will reach from 10, 00 the length of the style, vnto 10. 20 for the distance betweene the top of the style and the intersection of the azimuth S *b E* with the horizontall line, which distance may be called the *secant* of the azimuth, and may serve for the drawing of the parallel of 45 *gr.* from the horizon. The like reason holdeth for the rest of these distances here represented in the line *B H*.

### 2 *To finde the distance betweene the horizon and the parallels.*

As the tangent of 45 *gr.*
  to the tangent of the parallell :
So the secant of the azimuth,
  to the distance required.

As if it were required to draw the parallell of 15 *gr.* from the

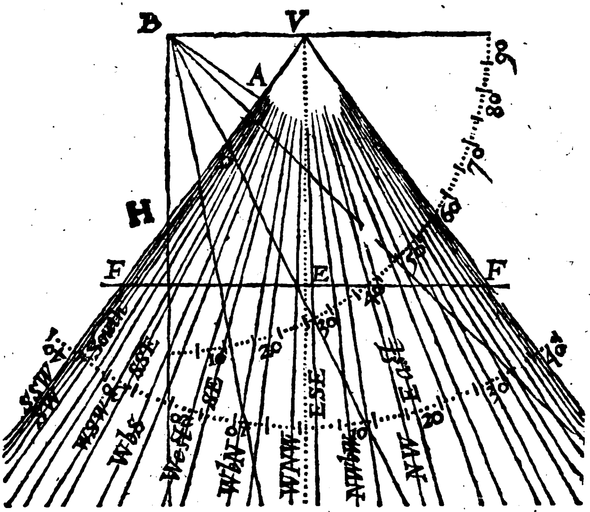
the horizon, vpon this verticall plane; extend the compasses from the tangent of 45 *gr.* vnto the tangent of 15 *gr.* the same extent will reach in the line of numbers from 10.00 the secant of the South azimuth vnto 2.68, and therefore the distance betweene the horizon and the parallell of 15 *gr.* is 2 inches 68 *cent.* vpon the South azimuth. Againe, the same extent will reach from 10.20 the secant of *S b E* vnto 2.73 for the like distance belonging to *S b E* and *S b W*; and so for the rest, which may be gathered and set downe in the table.

That done, and the horizon and azimuths being drawne, pricke downe 10 inches from the horizontall line vpon the South azimuth, and 10 inches 20 *cent.* on the azimuths of *S b E* and *S b W*, and 10 inches 82 *cent.* on the azimuths of *S S E* and *S S W*, and 12 inches 3 *cent.* on the azimuth of *S E b S* and *S W b S*, and so the rest of these distances on their seuerall azimuths: then if you draw a crooked line through these points, that may make no angles, the line so drawne shall be the parallell of 45 *gr.* from the horizon. In like manner may you draw the parallel of 15 *gr.* or any other parallell of altitude vpon any verticall plane.

If the plane incline to the horizon, after we haue found the verticall point, and drawne the horizontall line, we are farther to finde the length of the axis of the horizon, then the angles betwixt this axis and the azimuth lines, and so the seuerall distances betweene the parallels and the verticall point, all which may be represented in this manner.

On the center *B*, and any semidiameter, describe an occult quadrant of a circle, and therein inscribe the chords of such parallels of altitude as you intend to draw on the plane, drawing right lines through the center and the termes of these chords, so the line B H shall be the horizon, and his perpendicular B V the axis of the horizon, and the rest the lines of altitude, according to their distance from the horizon.

That done, consider your plane, which here for example is the first of our three declining inclining planes, wherein hauing drawne both the horizontall and verticall lines as I shewed before, first take out the axis of the horizon, which




is the line between *B* the top of the style and V the verticall point, and pricke that downe in this figure from *B* vnto *V*; then take out both the line *V H* and all the rest of the distances betweene V the verticall point and the seuerall points wherein the verticall lines doe crosse the horizontall line of this figure, from the point *V*, noting the place where they crosse the horizontall line with the number or letter of the azimuth from whence they were taken, and drawing the azimuth lines from V through the lines of altitude.

Or hauing the *Sector* you may draw an occult line *V E* perpendicular to the axis *V* B, and therein prick downe the tangent of the complement of the inclination of the plane from *V* vnto *E*: then draw the line *E* F parallel to the axis, crossing the line V H produced in the point F, so this line E F will be as the line of sines vpon the *Sector*, and therein you

you may prick downe the sines of the complement of the angles at the zenith from *E* towards F, and draw the verticall lines by those points through the lines of altitude, so the angles at V, betweene the axis V B and those azimuth lines, shall be the angles betweene the axis of the horizon and the azimuth lines on your plane, and the seuerall distances betweene the point V and the lines of altitude, shall giue the like distances betweene the verticall point and the parallels of altitude vpon the azimuths in your plane. Vpon this ground it followeth,

### 1 *To finde the length of the axis of the Horizon.*

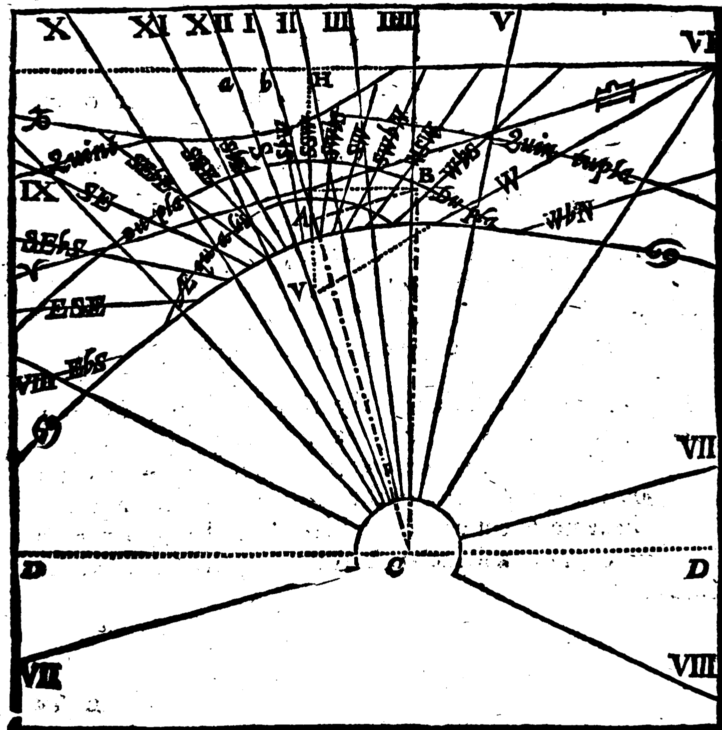
The verticall point is alwayes either directly ouer or vnder the top of the style, and the distance betweene them is that which I call the axis of the horizon, which may thus be found,

As the cosine of the inclination,
to the sine of 90 *gr.*
So the length of the style,
to the length of the axis of the horizon.

For example in the first of the three declining inclining planes, the inclinatiou to the horizon is 36 *gr.* the length of the style A B sixe inches, extend the compasses from the sine of 54 *gr.* the complement of the inclination vnto the sine of 90 *gr.* the same extent will reach in the line of numbers from 6.00 vnto 7.42, and such is V B the length of the axis required.

## 2 *To finde the angles contained betweene the horizon and the verticall lines vpon your plane.*

The angles at the verticall point betweene the axis of the horizon and the azimuth lines vpon your plane are represented in this figure by those at V, betweene V B and the azimuths. The angles betweene the horizon and the azimuth lines being complements to the former, are represen-

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ted either by those which are made by VE or by BH, and the azimuth lines which are drawne from V.

That you may finde them, looke into the Table, by which you drew the azimuth lines, there shall you finde the angles at the zenith. Then

As the sine of 90 *gr.*
to the cosine of the angle at the zenith:
So the tangent of the inclination to the horizon,
to the tangent of the angle betweene the horizon
and the verticall line.

In our example where the inclination to the horizon is 36 *gr.* and the angle at the zenith betweene the azimuth at the style and the meridian, is according to the declination 24 *gr.* 20 *m.* extend the compasses from the sine of 90 *gr.* vnto the tangent of 36 *gr.* the same extent will reach from the sine of 65 *gr.* 40 *m.* the complement of the angle at the zenith, vnto the tangent of 33 *gr.* 30 *m.* for the angle contained betweene the horizon and the South part of the meridian line. Againe, the same extent will reach from the cosine of 35 *gr.* 35 *m.* the angle at the zenith belonging to *S b E* vnto the tangent of 30 *gr.* 3 *m.* for the angle betweene the horizon and the azimuth line of *S b E.* The like reason holdeth for the rest, which may be found and set downe in the Table.

| *Azimuths.* | Ang Ze | | Ang. V. | | Ang. Ho | | Horizon | | 11 | 18 | 26 | 34 | 45 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gr. | M. | Gr. | M. | Gr. | M. | Inch. | P. | Inch. | P. | Inch. | P. | Inch. | P. |
| *East.* | 114 | 25 | 119 | 12 | 16 | 40 | In- | | | | 38 | 60 | 11 | 05 |
| *E b S* | 103 | 5 | 106 | 2 | 9 | 20 | fi- | | 210 | 24 | 22 | 40 | 9 | 00 |
| *E S E* | 91 | 50 | 92 | 16 | 1 | 20 | nite. | | 41 | 98 | 15 | 57 | 7 | 60 |
| *SE b E* | 80 | 35 | 78 | 25 | 6 | 47 | 62 | 82 | 23 | 44 | 12 | 07 | 6 | 68 |
| *S E* | 69 | 20 | 65 | 0 | 14 | 23 | 29 | 87 | 16 | 79 | 10 | 12 | 6 | 00 |
| *SE b S* | 58 | 5 | 52 | 25 | 21 | 0 | 20 | 70 | 13 | 61 | 8 | 99 | 5 | 79 |
| *S S E* | 46 | 50 | 40 | 46 | 26 | 25 | 16 | 68 | 11 | 90 | 8 | 31 | 5 | 53 |
| *S b E* | 35 | 35 | 30 | 3 | 30 | 35 | 14 | 58 | 10 | 90 | 7 | 90 | 5 | 42 |
| *South* | 24 | 20 | 20 | 5 | 33 | 30 | 13 | 44 | 10 | 32 | 7 | 66 | 5 | 35 |
| *S b W* | 13 | 5 | 10 | 39 | 35 | 17 | 12 | 84 | 10 | 02 | 7 | 55 | 5 | 33 |
| *S S W* | 1 | 50 | 1 | 29 | 35 | 59 | 12 | 62 | 9 | 90 | 7 | 47 | 5 | 31 |
| | *Style.* | | 0 | 0 | 36 | 0 | 12 | 62 | 9 | 90 | 7 | 47 | 5 | 31 |
| *SWbS* | 9 | 25 | 7 | 38 | 35 | 37 | 12 | 74 | 9 | 96 | 7 | 50 | 5 | 32 |
| *S W* | 20 | 40 | 16 | 58 | 34 | 12 | 13 | 20 | 10 | 20 | 7 | 59 | 5 | 34 |
| *SWbW* | 31 | 55 | 26 | 45 | 31 | 40 | 14 | 13 | 10 | 67 | 7 | 81 | 5 | 39 |
| *W S W* | 43 | 10 | 37 | 11 | 27 | 55 | 15 | 85 | 11 | 50 | 8 | 15 | 5 | 49 |
| *W b S* | 54 | 25 | 48 | 30 | 22 | 55 | 19 | 05 | 12 | 94 | 8 | 73 | 5 | 66 |
| *West* | 65 | 40 | 60 | 48 | 16 | 40 | 25 | 87 | 15 | 51 | 9 | 60 | 5 | 96 |
| *W b N* | 76 | 55 | 73 | 58 | 9 | 20 | 45 | 75 | 20 | 64 | 11 | 32 | 6 | 46 |
| *W NW* | 88 | 10 | 87 | 44 | 1 | 20 | 318 | 88 | 33 | 27 | 14 | 18 | 7 | 25 |
| *NWbW* | 99 | 25 | 101 | 35 | 6 | 47 | In fi- | | 92 | 40 | 19 | 60 | 8 | 48 |
| *N W* | 111 | 40 | 110 | 0 | 14 | 23 | nite. | | | | 31 | 44 | 10 | 30 |

Then may you either draw these angles at V in the former figure more perfectly, and thence finish your worke, or else procced.

### 3 *To finde the distance betweene the verticall point and the parallells of the horizon.*

These distances may be found by resolving the triangles in the last figure made by the axis, the lines of altitude, and the azimuth

azimuth lines. For hauing the length of the axis and the angles at the horizon, if you adde the distance of the parallell from the horizon vnto the angle at the horizon, you shall haue the angle at the parallel. Then

As the sine of the angle at the parallel,
to the cosine of the altitude:
So the length of the axis,
to the distance betweene the verticall point and the parallell.

Thus is our example if it were required to finde the distance vpon the stylar azimuth V H, betweene the verticall point and the horizon, you haue the rectangle triangle V B H wherein the angle at the horizon here represented by B H V is (equall to the inclination of the plane) 36 *gr.* and B V the axis of the horizon betweene the plane and the top of the style, is 7 inches 42 *cent.* Wherefore extend the compasses from the sine of 36 *gr.* vnto the sine of 90 *gr.* the complement of the altitude, the same extent will reach in the line of numbers from 7. 42 vnto 12. 62, and such is the distance of the perpendicular azimuth line V H betweene the verticall point and the horizon.

In like manner if you would finde the distance vpon the meridian between the verticall point and the horizon, extend the compasses from the sine of 33 *gr.* 30 *m.* the angle at the horizon, to the sine of 90 *gr.* the same extent will reach in the line of numbers from 7. 42 vnto 13. 44, and such is *V a* the distance betweene the verticall point and the horizon vpon the line of the South azimuth, that is, upon the meridian line.

But if you would finde the distance vpon the meridian betweene the verticall point and any other parallell of the horizon, as vpon the parallel of 26 *gr.* 34 *m.* then adde these 26 *gr.* 34 *m.* vnto 33 *gr.* 30 *m.* the angle at the horizon, so shall you haue 60 *gr.* 4 *m.* for B D V the angle at the parallel. And if you extend the compasses from the sine of 60 *gr.* 4 *m.* vnto the sine of 63 *gr.* 26 *m.* the complement of the parallell from the horizon, the same extent will reach in the line of numbers from 7.42 the length of the axis, vnto 7.66, and such is the distance *V D* betweene the verticall point and the parallell of 26 *gr.* 34 *m.* vpon the meridian line. The like reason holdeth for all the rest, which may be gathered and set downe in the table.

That done, and the horizon drawne as before, if you would draw the parallel of 26 *gr.* 34 *m.* from the horizon, looke into the table, and there finding vnder the title of the parallel of 26 34, the distance on the South azimuth line to be 7.66, take 7 inches 66 *cent.* out of a line of inches, and prick them down on the meridian of your plane, from the verticall point at *V.*

Or if either the verticall point fall without your plane, or the extent at any time be too large for your compasses, you may pricke downe the distance betweene the horizon and the parallel. As here the distance betweene the verticall point and the parallel is 7.66, betweene the verticall point and the horizon 13.44, the difference betweene them 5.78 is the distance from the horizon to the parallel, which being pricked downe upon the meridian, shall giue the same intersection as before. And the like reason holdeth for the pricking downe the rest of these distances on their seuerall azimuths.]

Hauing the points of intersection betweene the azimuths and the parallel, you may ioyne them all in a crooked line without making of angles, the line so drawne shall be the parallell required. And vpon this ground it followeth,

*To describe such parallels on the former planes, as may shew the proportion of the shadow vnto the gnomon.*

The proportion of a mans shadow vnto his height, or other shadow to his gnomon set perpendicular to the horizon, may be shewed by parallels to the horizon, if they be drawne to a due altitude, which may thus be found:

As the length of the shadow,
to the length of the gnomon:
So the tangent of 45 *gr.*
to the tangent of the altitude.

As if it were required to finde the altitude of the Sunne when the shadow of a man shall be decuple to his height, extend the compasses from 10 vnto 1 in the line of numbers, the same extent will reach in the tangent of 45 *gr.* vnto the tangent of 5 *gr.* 42 *m*; which shewes that when the Sun commeth to the altitude of 5 *gr.* 42 *m*, your shadow, vpon a levell ground, will be ten times as much as your height. In the same maner you may finde that at 7 *gr.* 7 *m.* of altitude your shadow will be octuple, at 9 *gr.* 27 *m.* sextuple, at 11 *gr.* 18 *m.* quintuple, at 14 *gr.* 2 *m.* quadruple, at 18 *gr.* 26 *m.* triple, at 26 *gr.* 34 *m.* double to your height, at 33 *gr.* 41 *m.* as 3 vnto 2, at 36 *gr.* 52 *m.* as 4 vnto 3, at 38 *gr.* 40 *m.* as 5 vnto 4, at 45 *gr.* equall, at 51 *gr.* 20 *m.* as 4 vnto 5, at 53 *gr.* 7 *m.* as 3 vnto 4, at 56 *gr.* 19 *m.* as 2 vnto 3, at 59 *gr.* 2 *m.* as 3 vnto 5, at 63 *gr.* 26 *m.* as 1 vnto 2, &c.

If then you draw a parallell to the horizon at 5 *gr.* 42 *m.* another at 7 *gr.* 7 *m.* and so the rest, when the shadow of the style falleth on the parallell, you haue the proportion, and thereby may you know the shadow by the height, and the height by the shadow, whereof you haue examples *Pag.* 126. and 137.

I might here proceed to shew the description of the circles of position, the Signes of the Zodiack in the meridian, the Signes ascending and descending, with such other gnomonicall conclusions; but these would proue superfluous to such as vnderstand the doctrine of the Sphere; and for others, that which is deliuered may suffice for ordinary vse, it being my intention not so much to explane the full vse of shadowes (whereof I haue lately giuen a large example in an other place) as the vse of these lines of proportion, that were not extant heretofore.

# An Appendix concerning

## *The description and vse of a small portable Quadrant, for the more easie finding of the houre and Azimuth.*

## CHAP. I.

### *Of the description of the Quadrant.*

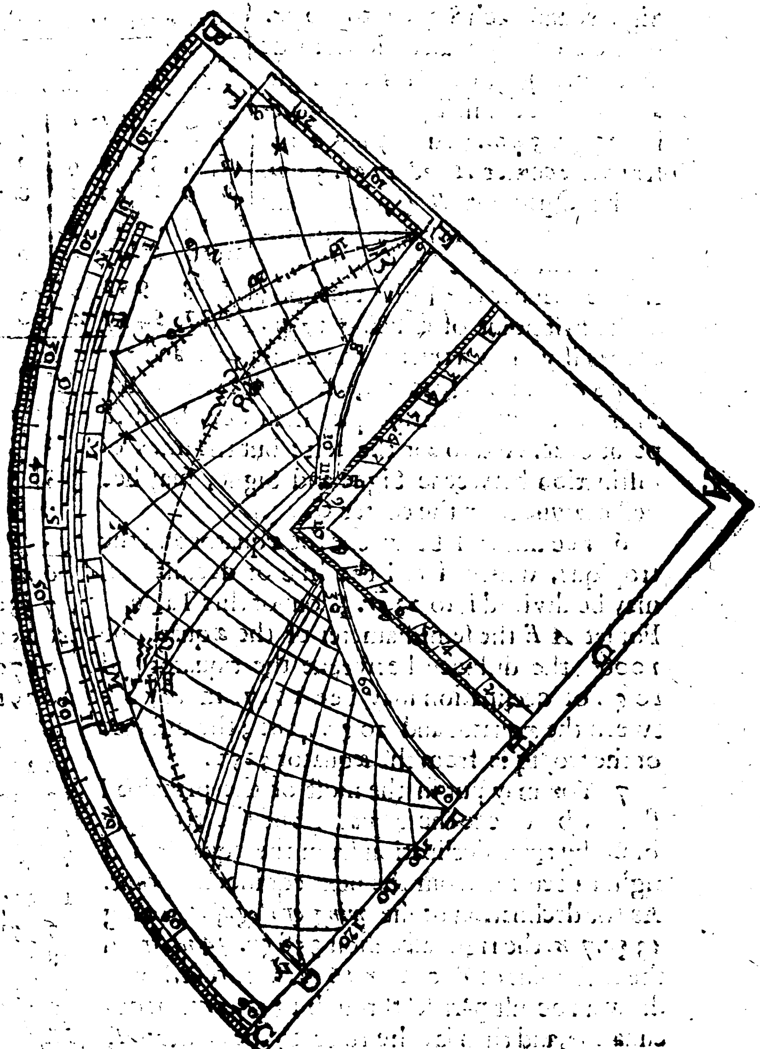
HAuing described these standing planes, I will now show the most of these conclusions by a small Quadrant. This might be done generally for all latitudes, by a quarter of the generall Astrolabe, described before in the vse of the *Sector*, *pag.* 58 . and particularly for any one latitude, by a quarter of the particular Astrolabe, there also described, *pag.* 65. which if it be a foote semidiameter, may shew the azimuth vnto a degree, and the time of the day vnto a minute; but for ordinary vse this smaller Quadrant may suffice, which may bee made portable in this manner.

1 Vpon the center *A*, and semidiameter *A B*, describe the arke *B C*: the same samidiameter will set of 60 *gr.* and the halfe of that will be 30 *gr.* which being added to the former 60 *gr.* will make the arke *B C* to be 90 *gr.* the fourth part of the whole circle, and thence comes the name of a Quadrant.

2 Leauing some little space for the inscription of the moneths and dayes, on the same center *A*, and semidiameter *A T*, describe the arke *T D*, which shall serue for either tropique.

3 Divide the line *A T* in the point *E*, in such proportion, as that *A T* being 10000, *A E* may be 6556, and there draw another arke *E F*, which shall serue for the Equator, or *A E* being 10000 let *E T* be 5253.

4 Divide *A F* the semidiameter of the æquator in the point *G*, so as *A F* being 10000, the line *A G* may bee 4343; and



nd on the center *G* and semidiameter *GD* describe the arke *E D*, which shall serue for a fourth part of the ecliptique.

5 This part of the ecliptique may be divided into three Signes,

Signes, and each Signe into 30 *gr.* by a table of right ascensions, made as before, *pag.* 60. As the right ascension of the first point of ♉ being 27 *gr.* 54 *m.* you may lay a ruler to the center *A* and 27 *gr.* 54 *m.* in the Quadrant *B C*, the point where the ruler crosseth the Ecliptique, shall be the first point of ♉. In like manner the right ascension of the first point of ♊ being 57 *gr.* 48. *m.* if you lay a ruler to the center *A*, and 57 *gr.* 48 *m.* in the Quadrant, the point where the ruler crosseth the ecliptique, shall bee the first point of ♊. And so for the rest: but the lines of distinction betweene Signe and Signe, may bee best drawne from the center *G*.

A Table of right Ascensions.

| Gr. | ♈ Gr. | ♈ M. | ♉ Gr. | ♉ M. | ♊ Gr. | ♊ M. |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 27 | 54 | 57 | 48 |
| 5 | 4 | 35 | 32 | 42 | 63 | 3 |
| 10 | 9 | 11 | 37 | 35 | 68 | 21 |
| 15 | 13 | 48 | 42 | 31 | 73 | 43 |
| 20 | 18 | 27 | 47 | 33 | 79 | 7 |
| 25 | 23 | 9 | 52 | 38 | 84 | 32 |
| 30 | 27 | 54 | 57 | 48 | 90 | 0 |

6 The line *E T* betweene the æquator and the tropique, which I call the line of declination, may be divided into 23 *gr.* ½. out of this Table. For let *A E* the semidiameter of the æquator be 10000, the distance betweene the æquator and 10 *gr.* of declination may bee 1917. more; betweene the æquator and 20 *gr.* 4281; the distance of the tropique from the æquator 5252.

7 You may put in the most of the principall starres betweene the æquator and the tropique of ♋, by their declination from the æquator, and right ascention from the next equinoctial point. As the declination of the *wing of Pegasus*, being 13 *gr.* 7 *m.* the right ascension 358 *gr.* 34 *m.* from the first point of ♈, or 1 *gr.* 26 *m.* short of it. If you draw an occult parallel through 13 *gr.* 7 *m.* of declination, and then lay the ruler to the center *A*, and 1 *gr.* 26 *m.* in the quadrant *B C*, the point where the ruler crosseth the parallell shall be the place for the *wing of Pegasus*, to which you may set

| Gr. | Parts. |
|---|---|
| 1 | 176 |
| 2 | 355 |
| 3 | 537 |
| 4 | 723 |
| 5 | 913 |
| 6 | 1106 |
| 7 | 1302 |
| 8 | 1503 |
| 9 | 1708 |
| 10 | 1917 |
| 11 | 2130 |
| 12 | 2348 |
| 13 | 2571 |
| 14 | 2799 |
| 15 | 3032 |
| 16 | 3270 |
| 17 | 3514 |
| 18 | 3763 |
| 19 | 4019 |
| 20 | 4281 |
| 21 | 4550 |
| 22 | 4825 |
| 23 | 5108 |
| Tro | 5252 |

et the name and the time when he cometh to the South, at midnight in this maner, *W. Peg.* * 23 *Ho.* 54 *M.* and so for the rest of these fiue, or any other starres.

| | | Ho. | M. | R. Ascen | | Decl. | M |
|---|---|---|---|---|---|---|---|
| *Pegasus wing* * | *March* 8 | 23 | 54 | 1 | 26 | 13 | 7 |
| *Arcturus* * | *October* 14 | 13 | 58 | 29 | 37 | 21 | 20 |
| *Lions heart* * | *August* 7 | 9 | 48 | 32 | 58 | 13 | 45 |
| *Buls eye* * | *May* 16 | 4 | 15 | 63 | 33 | 15 | 42 |
| *Vulturns heart* * | *Ianua.* 1 | 19 | 33 | 66 | 56 | 7 | 58 |

8 There being space sufficient betweene the æquator and the center, you may there describe the quadrat, and diuide each of the two sides farthest from the center *A* into 100 parts, so shall the Quadrant be prepared generally for any latitude.

But before you draw the particular lines, you are to fit foure tables vnto your latitude.

First a table of meridian altitudes for diuision of the circle of dayes and moneths, which may be thus made: Consider the latitude of the place and the declination of the Sun for each day of the yeare. If the latitude and declination be alike both North or both South, add the declination to the complement of the latitude, if they bee vnlike, one North, and the other South, substract the declination from the complement of the latitude, the remainder will be the meridian altitude belonging vnto the day.

Thus in our latitude of 51 *gr.* 30 *m.* Northward, whose complement is 38 *gr.* 30 *m.* the declination vpon the tenth day of Iune will be 23 *gr.* 30 *m.* Northward, wherefore I adde 23 *gr.* 30 *m.* vnto 38 *gr.* 30 *m*, the summe of both is 62 *gr.* for the meridian altitude at the tenth of Iune, The declination vpon of December will be 23 *gr.* 30 *m.* Southward, wherefore I take these 23 *gr.* 30 *m.* out of 38 *gr.* 30 *m.* there will remaine 15 *gr.* for the meridian altitude at the tenth of December, and in this maner you may find the meridian altitude for each day of the yeere, and set them downe in a table.

| Dies | 0 | | 5 | | 10 | | 15 | | 20 | | 25 | | 30 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mo. | Gr. | M. | Gr | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. |
| *Ianuary* | 16 | 31 | 17 | 24 | 18 | 26 | 19 | 37 | 20 | 57 | 22 | 24 | 23 | 58 |
| *February* | 24 | 17 | 25 | 59 | 27 | 45 | 29 | 35 | 31 | 29 | 33 | 25 | | |
| *March* | 34 | 35 | 36 | 33 | 38 | 32 | 40 | 30 | 42 | 27 | 44 | 22 | 46 | 15 |
| *April* | 46 | 37 | 48 | 26 | 50 | 11 | 51 | 50 | 53 | 25 | 54 | 53 | 56 | 15 |
| *May* | 56 | 15 | 57 | 29 | 58 | 35 | 59 | 33 | 60 | 22 | 61 | 2 | 61 | 31 |
| *Iune* | 61 | 36 | 61 | 54 | 62 | 0 | 61 | 58 | 61 | 45 | 61 | 22 | 60 | 49 |
| *Iuly* | 60 | 49 | 60 | 6 | 59 | 14 | 58 | 13 | 57 | 4 | 55 | 48 | 54 | 24 |
| *August* | 54 | 7 | 52 | 36 | 50 | 59 | 49 | 17 | 47 | 31 | 45 | 41 | 43 | 49 |
| *September* | 43 | 26 | 41 | 30 | 39 | 33 | 37 | 36 | 35 | 38 | 33 | 41 | 31 | 46 |
| *October* | 31 | 46 | 29 | 53 | 28 | 3 | 26 | 16 | 24 | 35 | 22 | 59 | 21 | 29 |
| *Nouember* | 21 | 12 | 19 | 51 | 18 | 39 | 17 | 36 | 16 | 43 | 16 | 0 | 15 | 28 |
| *December* | 15 | 28 | 15 | 5 | 17 | 0 | 15 | 2 | 15 | 17 | 15 | 44 | 16 | 22 |

The Table being made, you may inscribe the moneths, and dayes of each moneth into your quadrant, in the space left below the tropique. For lay the ruler vnto the center *A*, and 16 *gr.* 31 *m.* in the quadrant *B C*, there may you draw a line for the end of December and beginning of Ianuary; then laying your ruler to the center *A*, and 24 *gr.* 17 *m.* in the quadrant, there draw the end of Ianuary and beginning of February, and so the rest, which may be noted with *I*, *F*, *M*, *A*, *M*, *I*, &c. the first letters of each moneth, and will here fall betweene 15 *gr.* and 62. *gr.*

The second Table which you are to fit, may serue for the drawing and diuiding of the horizon. For drawing of the horizon.

As the cotangent of the latitude,
to the tangent of the greatest declination:
So the sine of 90 *gr.*
to the sine of intersection, where the horizon shall crosse the tropiques.

So in our latitude of 51 *gr.* 30 *m.* we shall find the horizon

to

to cut the tropique in 33 *gr.* 9 *m:* wherefore if you lay the ruler to the center *A*, and 33 *gr.* 9. *m.* in the quadrant, the point where the ruler crosseth the tropique shall be the point where the horizon crosseth the tropique. And if you finde a point at *H*, in the line *AC*, whereon setting the compasses, you may bring the point at *E*, and this point in the tropique both into a circle, the point *H* shall be the center, and the arke so drawne shall be the horizon. Then for the diuision of this horizon.

As the sine of 90 *gr.*
to the sine of the latitude;
So the tangent of the horizon,
to the tangent of the arke in the quadrant, which shall diuide the horizon.

So in our latitude of 51 *gr.* 30 *m.* we shall finde 7 *gr.* 52 *m.* belonging to 10 *gr.* in the horizon, and 15 *gr.* 54 *m.* belonging 20 *gr.* And to the rest, as this Table.

| Ho | Gr. | M. | Ho | Gr. | M. | Ho | Gr. | M. | Ho | Gr. | M | Ho | Gr | M. | Ho | Gr. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 15 | 11 | 51 | 30 | 24 | 19 | 45 | 38 | 2 | 60 | 53 | 35 | 75 | 71 | 5 |
| | 0 | 47 | | 12 | 39 | | 25 | 11 | | 39 | 1 | | 54 | 41 | | 72 | 19 |
| | 1 | 34 | | 13 | 27 | | 26 | 4 | | 40 | 0 | | 55 | 48 | | 73 | 33 |
| | 2 | 21 | | 14 | 16 | | 26 | 57 | | 41 | 0 | | 56 | 56 | | 74 | 48 |
| | 3 | 8 | | 15 | 4 | | 27 | 50 | | 42 | 0 | | 58 | 4 | | 76 | 3 |
| 5 | 3 | 55 | 20 | 15 | 54 | 35 | 28 | 43 | 50 | 43 | 0 | 65 | 59 | 13 | 80 | 77 | 18 |
| | 4 | 42 | | 16 | 43 | | 29 | 37 | | 44 | 1 | | 60 | 22 | | 78 | 33 |
| | 5 | 29 | | 17 | 33 | | 30 | 32 | | 45 | 3 | | 61 | 31 | | 79 | 49 |
| | 6 | 17 | | 18 | 22 | | 31 | 27 | | 46 | 5 | | 62 | 41 | | 81 | 5 |
| | 7 | 4 | | 19 | 12 | | 32 | 22 | | 47 | 8 | | 62 | 52 | | 82 | 21 |
| 10 | 7 | 52 | 25 | 20 | 2 | 40 | 33 | 18 | 55 | 48 | 11 | 70 | 65 | 3 | 85 | 83 | 37 |
| | 8 | 39 | | 20 | 53 | | 34 | 14 | | 49 | 14 | | 66 | 15 | | 84 | 53 |
| | 9 | 27 | | 21 | 44 | | 35 | 10 | | 50 | 19 | | 67 | 27 | | 86 | 10 |
| | 10 | 14 | | 22 | 36 | | 36 | 7 | | 51 | 24 | | 68 | 39 | | 87 | 26 |
| | 11 | 2 | | 23 | 27 | | 37 | 4 | | 52 | 29 | | 69 | 52 | | 88 | 43 |
| 15 | 11 | 51 | 30 | 24 | 19 | 45 | 38 | 2 | 60 | 53 | 35 | 75 | 71 | 5 | 90 | 90 | 0 |

Wherefore you may lay the ruler to the center *A*, and 7 *gr.* 52 *m.* in the quadrant *B C*, the point where the ruler crosseth the horizon shall be 10 *gr.* in the horizon; and so for the rest: but the lines of distinction betweene each fift degree, will be best drawne from the center *H*.

The third table for drawing of the houre-lines, must be a Table of the altitude of the Sunne aboue the horizon at euery houre, especially when he cometh to the æquator, the tropiques, and some other intermediate declinations.

If the Sunne be in the æquator, and so haue no declination.

As the sine of 90 *gr.*
to the cosine of the latitude:
So the cosine of the houre from the meridian
to the sine of the altitude.

Thus in our latitude of 51 *gr.* 30 *m.* at six houres from the meridian the Sun will haue no altitude, at fiue the altitude will be 9 *gr.* 17 *m*; at foure 18 *gr.* 8 *m*; at three 26 *gr.* 7 *m*; at two 32 *gr.* 37 *m.* at one 36 *gr.* 58 *m*; at noone it will be 38 *gr.* 30 *m.* equall to the complement of the latitude.

If the Sun haue declination, the meridian altitude will be found as before, for the Table of dayes and moneths.

If the houre proposed be six in the morning or six at night.

As the sine of 90 *gr.*
to the sine of the latitude:
So the sine of the declination
to the sine of the altitude.

Thus in our latitude the declination of the Sun being 23 *gr.* 30 *m.* the altitude will be found to be 18 *gr.* 11 *m*: the declination being 11 *gr.* 30 *m.* the altitude will be 9 *gr.*

If the houre proposed be neither twelue nor six.

As the cosine of the houre from the meridian,
to the sine 90 *gr.*

So

So the tangent of the latitude,
to the tangent of a fourth arke.

So in our latitude and one houre from the meridian, this fourth arke will be found to be 52 *gr.* 28 *m.* at two 55 *gr.* 26 *m.* at three 60 *gr.* 39 *m.* at foure 68 *gr.* 22 *m.* and at fiue houres from the meridian 78 *gr.* 22. *m.*

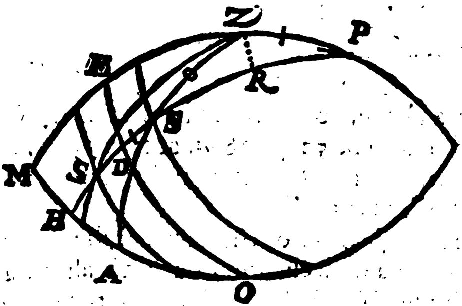
Then consider the declination of the Sun and the houre proposed; if the latitude and declination be both alike, as with vs in North latitude, North declination, and the houre fall betweene noone and six, take the declination out of the fourth arke, the remainer shall be your fift arke.

But if either the houre fall betweene six and midnight, or the latitude and declination shall be vnlike, adde the declination vnto the fourth arke, and the summe of both shall be your fifth arke: or if the summe shall exceed 90 *gr.* you may take the complement vnto 180 *gr.* This fifth arke being knowne:

As the sine of the fourth arke,
to the sine of the latitude:
So the cosine of the fift arke,
to the sine of the altitude.

Thus in our latitude of 51 *gr.* 30 *m.* Northward, the Sun hauing 23 *gr.* 30 *m.* of North declination, if it shall be required to finde the altitude of the Sun for seuen in the morning: here because the latitude and declination are both alike to the Northward, and the houre proposed falleth betweene noone and six, you may take 23 *gr.* 30 *m.* the arke of the declination out of 78 *gr.* 22 *m.* the fourth arke belonging to the fift houre from the meridian, so there will remaine 54 *gr.* 52 *m.* for your fift arke. Then working according to the Canon, you shall find,

As the sine of 78 *gr.* 22 *m.* your fourth arke,
to the sine of 51 *gr.* 30 *m.* for the latitude.




In rectangulo O D H,
vt O E Radius
ad E M Cotan.lat.
ita O D Cosi.hora.
ad D H Tan.DH.
Cui æqualis est P R cuius compl. D R, novis dr. arcus quartus.

Conferatur arcus D H cum arcu declinationis D S, ita dabitur arcus H S, cuius compl. est S R & prius dr. arcus quintus. Vnde erit

| | |
|---|---|
| vt Cosi. P R | hoc est vt Sin. D R. |
| ad Cosi. P Z | ad Sin. E Z, |
| ita Cosi. S R | ita Sin. H S |
| ad Cosi. S Z | ad Sin. A S. |

Hinc forte præstabit vocare H S arcum quintum ita secunda operatio instituetur per solos sinus,

Vel si libet subtractionem sinus quarti arcus evitare, inveniatur angulus O H D quod fieri potest varijs modis. Nam

| | | | |
|---|---|---|---|
| 1 vt Radius | 2 vt Sin. D H | 3 vt Sin. D H | 4 vt Sin. D R, |
| ad Sin. ang. O | ad Sin. O | ad Tan. D O | ad Sin. E Z, |
| ita Cosi. lat. O D | ita Sin. D O | ita Radius | ita Rad. |
| ad Cosi. an. OHD | ad Sin. H | ad tan. ang. H. | ad Sin. H. |

Invento vtcunque angulo ad H, erit in rectangulo H A S,

vt sinus recti anguli H A S,
ad sinum arcus quinti H S,
ita sinus anguli ad horiz. S H A,
ad sin. solaris altitudinis S A.

As

So the sine of 35 *gr.* 8 *m.* the complement of your fift arke,
to the sine of 27 *gr.* 17 *m.* the altitude required.

If in the same latitude and declination, it were required to finde the altitude for fiue in the morning, here the houre falling betweene sixe and midnight, if you adde 23 *gr.* 30 *m.* vnto 78 *gr.* 22 *m.* the summe will be 101 *gr.* 52 *m.* and the complement to 180 *gr.* will be 78 *gr* 8 *m.* for your fifth arke. Wherefore

As the sine of 78 *gr.* 22 *m.*
to the sine of 51 *gr.* 30 *m.*
So the cosine of 78 *gr.* 8 *m.*
to the sine of 9 *gr.* 32 *m.* for the altitude required.

If in the same latitude of 51 *gr.* 30 *m.* Northward, the Sunne hauing 23 *gr.* 30 *m.* of South declination, it were required the altitude for nine in the morning; here because the latitude and declination are vnlike, the one North, and the other South, you may adde 23 *gr.* 30 *m.* the arke of declination, vnto 60 *gr.* 39 *m.* the fourth arke belonging to the third houre from the meridian, so shall you haue 84 *gr.* 9 *m.* for your fift arke. Wherefore

As the sine of 60 *gr.* 39 *m.*
to the sine of 51 *gr.* 30 *m.*
So the cosine of 84 *gr.* 9 *m.*
to the sine of 5 *gr.* 15 *m.* for the altitude required.

And so by one or other of these meanes you may finde the altitude of the Sunne for any point of the ecliptique at all houres of the day, and set them downe in such a Table as this.

A Table

## A Table for the altitude of the Sunne in the beginning of each Signe at all houres of the day, calculated for 51 gr. 30 m. of North latitude.

| Ho. | | ♋ | | ♊ ♌ | | ♉ ♍ | | ♈ ♎ | | ♓ ♏ | | ♒ ♐ | | ♑ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. |
| 12 | | 62 | 0 | 58 | 42 | 50 | 0 | 38 | 30 | 27 | 0 | 18 | 18 | 15 | 0 |
| 11 | 1 | 59 | 43 | 56 | 34 | 48 | 12 | 36 | 58 | 25 | 40 | 17 | 6 | 13 | 52 |
| 10 | 2 | 53 | 45 | 50 | 55 | 43 | 12 | 32 | 37 | 21 | 51 | 13 | 38 | 10 | 30 |
| 9 | 3 | 45 | 42 | 43 | 6 | 36 | 0 | 26 | 7 | 15 | 58 | 8 | 12 | 5 | 15 |
| 8 | 4 | 36 | 41 | 34 | 13 | 27 | 31 | 18 | 8 | 8 | 33 | 1 | 19 | | |
| 7 | 5 | 27 | 17 | 24 | 56 | 18 | 18 | 9 | 17 | 0 | 6 | | | | |
| 6 | 6 | 18 | 11 | 15 | 40 | 9 | 0 | 0 | 0 | | | | | | |
| 5 | 7 | 9 | 32 | 6 | 50 | | | | | | | | | 11 | 37 |
| 4 | 8 | 1 | 32 | | | | | | | | | | | 21 | 40 |

Laftly, you may find what declination the Sun hath when he riseth or fetteth at any houre,

As the fine of 90 gr.
to the fine of the houre from fixe:
So the cotangent of the latitude,
to the tangent of the declination.

And fo in the latitude of 51 *gr.* 30 *m.* you fhall finde that when the Sun rifeth, either at fiue in the Summer, or feuen in the Winter, his declination is 11 *gr.* 37 *m.* when he rifeth at foure in the Summer, or eight in the Winter, his declination is 21 *gr.* 40 *m.* which may be alfo fet downe in the Table.

That done, you may there fee that in this latitude the meridian altitude of the Sunne in the beginning of ♋ is 62 *gr.* in ♊ 58 *gr.* 42 *m.* in ♉ 50 *gr.* in ♈ 38 *gr.* 30 *m.* &c. But the beginning of ♋ and ♑ is reprefented by the tropiques *T D*, drawne at 23 *gr.* 30 *m.* of declination, and the beginning of ♈ and ♎, by the æquator *E F*. If you draw an occult parallell betweene the æquator and the tropique, at 11 *gr.* 30 *m.* of declination,

clination, it shall represent the beginning of ♉, ♍, ♏, and ♓; if you draw an other occult parallell through 20 *gr.* 12 *m.* of declination, it shall represent the beginning of ♊, ♌, ♐, and ♒.

Then you may lay a ruler to the center *A*, and 62 *gr.* in the quadrant B C, and note the point where it crosseth the tropique of ♋; then moue the ruler to 58 *gr.* 52 *m.* and note where it crosseth the parallell of ♊; then to 50 *gr.* and note where it crosseth the parallell of ♉, and againe to 38 *gr.* 30 *m.* noting where it crosseth the æquator; so the line drawne through these points shall shew the houre of 12 in the Summer, while the Sunne is in ♈, ♉, ♊, ♋, ♌, or ♍. In like maner if you lay the ruler to the center *A*, and 27 *gr.* in the quadrant, and note the point where it crosseth the parallel of ♓, then moue it to 18 *gr.* 18 *m.* and note where it crosseth the parallell of ♒; and againe to 15 *gr.* noting where it crosseth the tropique of ♑; the line drawne through these points shall shew the houre of 12 in the Winter, while the Sunne is in ♎, ♏, ♐, ♑, ♒ and ♓, and so may you draw the rest of these houre-lines: onely that of 7 from the meridian in the Summer, and 5 in the Winter, will crosse the line of declination at 11 *gr.* 37 *m.* and that of 8 in the Summer, and 4 in the Winter at 21 *gr.* 40 *m.*

The fourth table for drawing of the azimuth lines, must likewise be fitted for the altitude of the Sun aboue the horizon at euery azimuth, especially when he commeth to the æquator, the tropiques, and some other intermediate declination.

If the *Sunne* be in the æquator, and so haue no declination:

As the sine of 90 *gr.*
  to the cosine of the azimuth from the meridian:
*S*o the cotangent of the latitude,
  to the tangent of the altitude at the æquator.

Thus in our latitude of 51 *gr.* 30 *m.* at 90 *gr.* from the meridian, the *Sunne* will haue no altitude; at 80 *gr.* the altitude will be 7 *gr.* 52 *m*; at 70 *gr.* it will be 15 *gr.* 30 *m*; at 60 *gr.* it will be 21 *gr.* 41 *m.*

If the Sun haue declination, the meridian altitude will be easily found as before, for the table for dayes and moneths. And for all other azimuths.

As the sine of the latitude,
to the sine of the declination:
So the cosine of the altitude at the æquator,
to the sine of a fourth arke.

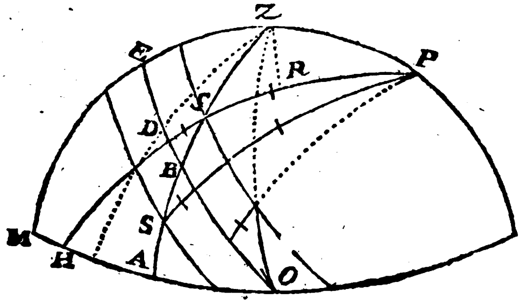
When the latitude and declination are both alike in all azimuths from the prime verticall vnto the meridian, adde this fourth arke vnto the arke of altitude at the æquator.

When the latitude and declination are both alike, and the azimuth more then 90 *gr.* distant from the meridian, take the altitude at the æquator out of this fourth arke.

When the latitude and declination are vnlike, take this fourth arke out of the arke of altitude at the æquator, so shall you haue the altitude of the Sun belonging to the azimuth.

Thus in our latitude of 51 *gr.* 30 *m.* Northward, if it were required to finde the altitude of the Sunne in the azimuth of 60 *gr.* from the meridian, when the declination is 23 *gr.* 30 *m.* Northward, you may finde the altitde at the æquator belonging to this azimuth to be 21 *gr.* 41 *m.* by the former Canon, and by this last Canon you may finde the fourth arke to be 28 *gr.* 15 *m.* Then because the latitude and declination are both alike to the Northward, if you adde them both together, you shall haue 49 *gr.* 56 *m.* for the altitude required.

If the declination had been 23 *gr.* 30 *m.* to the Southward, you should then haue taken this fourth arke out of the ark at the æquator, which because it cannot here be done, it is at a signe that the *Sunne* is not then aboue the horizon. But if you take the arke at the æquator out of this fourth arke, you shall haue 6 *gr.* 34 *m.* for the altitude of the Sunne when he is in




*O M Radius*
*Me Cotan. lat.*
*O A Cosi.azim.*
*AB Tan aequa.*

*EZ Sin. lat.*
*ZB Cosi. AB.*
*DS Sin. decli.*
*SB Sin. arc. 4.*

*Tables for the a titude of the sun in the beginning of each signe for every tenth azimuth.*

| | Merid | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|
| *Lat. 50 Gr. 0 M* | | | | | | | | | | |
| ♋ | 63 30 | 63 14 | 62 23 | 60 54 | 58 42 | 55 32 | 51 25 | 46 2 | 39 17 | 31 22 |
| ♊ | 60 12 | 59 54 | 59 0 | 57 23 | 55 1 | 51 43 | 47 18 | 41 40 | 34 47 | 26 48 |
| ♉ | 51 30 | 51 9 | 50 3 | 48 10 | 45 23 | 41 34 | 36 38 | 30 30 | 23 12 | 15 5 |
| ♈ | 40 0 | 39 34 | 38 15 | 36 0 | 32 44 | 28 20 | 22 45 | 16 0 | 8 17 | 0 0 |
| ♓ | 28 30 | 28 0 | 26 27 | 23 50 | 20 5 | 15 6 | 8 52 | 1 30 | 6 38 | |
| ♒ | 19 48 | 19 14 | 17 31 | 14 37 | 10 27 | 4 57 | 1 48 | 9 40 | 18 13 | |
| ♑ | 16 30 | 14 54 | 14 7 | 11 6 | 6 46 | 1 8 | 5 55 | 14 2 | 22 43 | |
| *Lat. 51 Gr.* | | | | | | | | | | |
| ♋ | 62 30 | 62 14 | 61 22 | 59 54 | 57 40 | 54 35 | 50 27 | 45 8 | 38 33 | 30 53 |
| ♊ | 59 12 | 58 54 | 57 59 | 56 23 | 54 0 | 50 43 | 46 22 | 41 51 | 34 6 | 26 23 |
| ♉ | 50 30 | 50 7 | 49 3 | 47 11 | 44 25 | 40 40 | 35 47 | 29 48 | 22 43 | 14 52 |
| ♈ | 39 0 | 38 34 | 37 16 | 35 3 | 31 49 | 27 30 | 22 2 | 15 29 | 8 0 | 0 0 |
| ♓ | 27 30 | 27 1 | 25 29 | 22 55 | 19 13 | 14 20 | 8 17 | 1 10 | 6 43 | |
| ♒ | 18 48 | 18 14 | 16 33 | 13 43 | 9 38 | 4 17 | 2 18 | 9 53 | 18 6 | |
| ♑ | 15 30 | 14 54 | 13 10 | 10 12 | 5 58 | 0 25 | 6 23 | 14 10 | 22 33 | |
| *Lat. 52 Gr.* | | | | | | | | | | |
| ♋ | 61 30 | 61 14 | 60 22 | 58 52 | 56 38 | 53 33 | 49 29 | 44 14 | 37 58 | 30 24 |
| ♊ | 58 12 | 58 54 | 56 28 | 56 22 | 53 0 | 49 43 | 44 25 | 40 0 | 33 28 | 26 0 |
| ♉ | 49 30 | 49 9 | 48 3 | 46 11 | 43 26 | 39 44 | 34 58 | 29 6 | 22 15 | 14 40 |
| ♈ | 38 0 | 37 35 | 36 17 | 34 5 | 30 54 | 26 40 | 21 20 | 14 57 | 7 44 | 0 0 |
| ♓ | 26 30 | 26 1 | 24 31 | 22 0 | 18 22 | 13 26 | 7 42 | 0 48 | 6 46 | |
| ♒ | 17 48 | 17 16 | 15 36 | 12 48 | 8 49 | 3 37 | 2 45 | 10 6 | 18 0 | |
| ♑ | 14 30 | 14 56 | 12 12 | 9 18 | 5 10 | 0 13 | 6 49 | 14 19 | 22 30 | |

in the azimuth of 60 *gr.* from the North, and 120 gr. from the South part of the meridian. The like reason holdeth for the rest of these altitudes, which may be gathered and set downe in a table.

Lastly when the Sun riseth or setteth vpon any azimuth, to find his declination.

As the sine of 90 *gr.*
to the cosine of the latitude:
So the cosine of azimuth from the meridian,
to the sine of the declination.

And thus in our latitude of 51 *gr.* 30 *m.* when the azimuth is 80 *gr.* from the meridian, the declination will be found to be 6 *gr.* 12 *m*; if the azimuth be 70 *gr.* the declination will be found 12 gr. 18 m; if 60 gr. then 18 gr. 8 m. And so for the rest, which may be also set downe in the Table.

*A Table for the altitude of the Sunne in the bginning of each signe for euery tenth azimuth, in 51 gr. 30 m. of North latitude.*

| Az. | ♋ | | ♊ ♌ | | ♉ ♍ | | ♈ ♎ | | ♓ ♏ | | ♒ ♐ | | ♑ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gr. | M. | Gr. | M. | Gr. | M | Gr. | M. | Gr. | M. | Gr. | M | Gr. | M. |
| 0 | 62 | 0 | 58 | 42 | 50 | 0 | 38 | 30 | 27 | 0 | 18 | 18 | 15 | 0 |
| 10 | 61 | 43 | 58 | 24 | 49 | 38 | 38 | 4 | 26 | 30 | 17 | 45 | 14 | 25 |
| 20 | 60 | 51 | 57 | 28 | 48 | 33 | 36 | 46 | 25 | 0 | 16 | 5 | 12 | 41 |
| 30 | 59 | 52 | 55 | 52 | 46 | 40 | 34 | 34 | 22 | 27 | 13 | 15 | 9 | 45 |
| 40 | 57 | 10 | 53 | 29 | 43 | 55 | 31 | 21 | 18 | 48 | 9 | 14 | 5 | 34 |
| 50 | 54 | 3 | 50 | 12 | 40 | 11 | 27 | 5 | 13 | 58 | 3 | 57 | 0 | 6 |
| 60 | 49 | 56 | 45 | 53 | 35 | 23 | 21 | 41 | 8 | 0 | | | | |
| 70 | 44 | 40 | 40 | 25 | 29 | 27 | 15 | 13 | 1 | 0 | | | | |
| 80 | 38 | 11 | 33 | 46 | 21 | 29 | 7 | 52 | | | | | | |
| 90 | 30 | 38 | 26 | 10 | 14 | 25 | 0 | 0 | | | | | | |
| 100 | 22 | 27 | 18 | 2 | 6 | 45 | | | | | | | 6 | 12 |
| 110 | 14 | 14 | 9 | 58 | | | | | | | | | 12 | 18 |
| 120 | 6 | 34 | 2 | 30 | | | | | | | | | 18 | 8 |

Tha

That done, if you would draw the line of East or West, which is 90 gr. from the meridian, lay the ruler to the center *A*, and 30 gr. 38. *m.* numbred in the quadrant from *C* toward *B*, and note the point where it crosseth the tropique of ♋; then moue the ruler to 26 gr. 10 m. and note where it crosseth the parallell of ♊; then to 14 gr. 45 m. and note where it crosseth the parallell of ♉; then to 0 gr. 0 m. and you shall find it to crosse the æquatour in the point F; so a line drawne through these points, shall shew the azimuth belonging to East and West. The like reason holdeth for all the rest.

These lines being thus drawne, if you set two sights vpon the line *A C*, and hand a thread and plummet on the center, *A* with a bead vpon the thread, the foreside of the quadrant shall shall be fully finished.

On the backside of the quadrant you may place the Nocturnall described before in the vse of the Sector pag. which consisteth of two parts.

The one is an houre-plane diuided æqually according to the 24 houres of the day and each houre into quarters, or minutes as the plane will beare. The center represents the North pole, the line drawne through the center from XII to XII, stands for the meridian and the lower XII stands for the houre of XII at midnight.

The other part is a rundle for such starres as are neere the north pole together with the twelue moneths, and the dayes of each moneth fitted to the right ascension of the Sunne and starres this in manner.

First consider where the Sun will be at the beginning of the 5, 10, 15, 20, 25, 30, and if you will euery day of each moneth, and finde the right ascension belonging to the place of the sun as I shew before *Pag.*

For example the sun at midnight the last of December or beginning of Ianuary will be *communibus annis* about 20 gr. 40 *m.* of ♑ whose right ascension is 292 gr. 20 m. At midnight the last of Ianuary or beginning of February he will be about 22 gr. 12 m. of ♒ whose right ascension is 324 gr. 35 m. and so the rest which may be set downe in a table.

That done consider the longitude and latitude of the starres and thereby finde their right ascension and declination as I shew before, *Pag.* and set them downe in a Table. These Tables thus made, let the vttermost part of the rundle be made euen with the innermost circle of the houre-plane, and a conuenient space allowed to containe the deuisions for the dayes and names of the moneths. Then lay the center of this rundle vpon the center of some other circle divided into 360 *gr.* and by the center and 291 *gr.* 20 *m.* in that circle draw a line for the beginning of Ianuary. In like maner by the center and 324 gr. 35 *m.* draw a line for the end of Ianuary and beginning of February, and so the rest of the dayes of each moneth.

For the inscription of the starres let one of the lines from the center as that at the beginning of Iuly, or rather let a moueable index be diuided from the center toward the inward circle of the moneths into 40 gr. more or lesse, which may be done for speed equally, but for exactnesse in such maner as the semidiameter of the generall Astrolabe was divided before, *Pag.* So laying the Index to the right ascension in the outward circle you may prick downe the starres by their declination in the Index.

For example, if the right ascension of the pole-starre be 6 gr. 28 *m.* end his declination 87 gr. 20 m. hauing set the center of the Index both to the center of the rundle and of the other circle, turne the Index to 6 gr. 28 m. in that outward circle, and prick downe the starre by 87 gr. 20 m. in the edge of the Index, that is at the distance of 2 gr. 40 m. from the pole. The like reason holdeth for the rest of the starres, which may be distinguished according to their magnitudes, and then be reduced into their formes, as in the example. So the quadrant will bee fitted both for day and night.

Of

## CHAP. II.

### *Of the vse of the Quadrant in taking the altitude of the Sunne, Moone, and Starres.*

THe Quadrant is the fourth part of a circle, diuided equally into 90 gr. and here numbred by 10. 20. 30. &c. vnto 90 gr. each degree being subdiuided into 4.

Lift vp the center of the Quadrant, so as the thread with the plummet may play easily by the side of it, and the *Sunne* beames may passe through both the sights; so shall the degrees cut by the thread, shew what is the altitude at the time or obseruation, as may appeare by this example.

Vpon the 14 day of Aprill, about noone, the *Sun*-beames passing through both the sights, the thread fell vpon 51 gr. 20 *m*. and this was the true meridian altitude of the *Sunne* for that day in this our latitude of 51 gr. 30 *m*. for which this Quadrant was made.

Againe, towards three of the clock in the afternoone, the thread fell vpon 38 gr. 40 m. and such was the *Sunnes* altitude at that time.

CHAP.

# CHAP. III.

## Of the Ecliptique.

### 1 The place of the Sunne being giuen to finde his right ascension.

THe Ecliptique is here represented by the arke, figured with the characters of the twelve Signes, ♈, ♉, ♊, &c. each Signe being diuided vnequally into 30 gr. and they are to be reckoned from the character of the Signe.

Let the thread be laid on the place of the Sunne in the Ecliptique, and the degrees which it cutteth in the Quadrant shall be the right ascention required.

As if the place of the Sunne giuen be the fourth degree of ♊, the thread laid on this degree shall cut 62 degrees in the Quadrant, which is the right ascension required.

But if the place of the Sunne giuen be more then *90 gr.* from the beginning of ♈, there must be more then *90 gr.* allowed to the right ascension; For this instrument is but a quadrant: and so if the Sunne be in 26 gr. of ♋, you shall find the thread to fall in the same place, and yet the right ascension to the 118 gr.

### 2 The right ascention of the Sunne being given, to finde his place in the Ecliptique.

Let the thread be laid on the right ascension in the Quadrant, and it shall crosse the place of the Sun in the Ecliptique, as may appeare in the former example.

CHAP.

# CHAP. IIII.

## Of the line of declination.

### 1 The place of the Sunne being given to finde his declination.

THe line of declination is here drawne from the center to the beginning of the Quadrant, and divided from the beginning of ♈ downward into 23 gr. 30 m.

Let the thread be laid, and the beade set on the place of Sunne in the ecliptique; then moue the thread to the line of declination, and there the bead shall fall upon the degrees of the declination required.

As if the place of the Sunne giuen be the fourth degree of ♊, the bead first set to this place, and then moued to the line of declination, shall there shew the declination of the Sunne at that time to be 21 gr. from the æquator.

### 2 The declination of the Sunne being given, to finde his place in the Ecliptique.

Let the thread and beade be first laid to the declination, and then moued to the Ecliptique.

As if the declination be 21 gr. the bead first set to this declination, and then moued to the ecliptique, shall there shew the fourth of ♊, the fourth of ♐, the 26 of ♋, and the 26 of ♑; and which of these foure is the place of the Sunne, may appeare by the quarter of the yeere.

# CHAP. V.

## *Of the circle of Moneths and Dayes.*

THis circle is here represented by the arke, figured with these letters, *I*, *F*, *M*, *A M*, &c. signifying the moneths January, February, March, Aprill, &c. each moneth being divided vnequally, according to the number of the dayes that are therein.

### *A Table for the inscription of the moneths in the Nocturnall.*

| Dies | 0 | | 5 | | 10 | | 15 | | 20 | | 25 | | 30 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. |
| *Ian.* | 292 | 20 | 297 | 46 | 303 | 7 | 308 | 21 | 313 | 30 | 318 | 36 | 323 | 36 |
| *Feb.* | 324 | 35 | 329 | 28 | 334 | 16 | 339 | 1 | 343 | 42 | 348 | 21 | | |
| *Ma.* | 351 | 17 | 355 | 52 | 0 | 26 | 4 | 58 | 9 | 30 | 14 | 2 | 18 | 34 |
| *Apr.* | 19 | 30 | 24 | 4 | 28 | 42 | 33 | 23 | 38 | 5 | 42 | 52 | 47 | 42 |
| *May* | 47 | 42 | 52 | 35 | 57 | 32 | 62 | 34 | 67 | 39 | 72 | 45 | 77 | 52 |
| *Iune* | 78 | 55 | 84 | 5 | 89 | 17 | 94 | 28 | 99 | 39 | 104 | 48 | 109 | 55 |
| *Iuly* | 109 | 55 | 115 | 0 | 120 | 0 | 124 | 58 | 129 | 54 | 134 | 45 | 139 | 30 |
| *Aug* | 140 | 27 | 145 | 9 | 149 | 48 | 154 | 25 | 159 | 0 | 163 | 32 | 168 | 0 |
| *Sept.* | 168 | 57 | 173 | 26 | 177 | 56 | 182 | 26 | 186 | 56 | 191 | 28 | 196 | 5 |
| *Octo* | 196 | 5 | 200 | 45 | 205 | 25 | 210 | 12 | 215 | 3 | 220 | 0 | 225 | 0 |
| *No.* | 226 | 2 | 231 | 10 | 236 | 23 | 241 | 40 | 247 | 2 | 252 | 30 | 258 | 2 |
| *Dec.* | 258 | 2 | 263 | 35 | 269 | 8 | 274 | 42 | 280 | 16 | 285 | 46 | 291 | 15 |

CHAP.

## 1 *The day of the moneth being given, to finde the altitude of the Sunne at noone.*

Let the thread be laid to the day of the moneth, and the degrees which it cutteth in the Quadrant shall be the meridian altitude required.

As if the day giuen be the 15 of May, the thread laid on this day shall cut 59 *gr.* 30 *m.* in the quadrant, which is the meridian altitude required.

## 2 *The meridian altitude being given, to finde the day of the moneth.*

The thread being set to the meridian altitude, doth also fall on the day of the moneth.

As if the altitude at noone be 59 *gr.* 30 *m.* the thread being set to this altitude, doth fall on the 15 of May, and the 9 of Iuly; and which of these two is the true day, may be knowne by the quarter of the yeere, or by another dayes obseruation. For if the altitude proue greater, the thread will fall on the 16 day of May and the 8 of Iuly: or if it proue lesser, the thread will fall on the 14 of May and the 10 of Iuly; whereby the question is fully answered.

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# CHAP. VI.

## *Of the Houre-lines.*

THat arke which is drawne vpon the center of the quadrant by the beginning of declination, doth here represent the æquator: that arke which is drawne by 23 *gr.* 30 *m.* of of declination, and is next aboue the circle of moneths and dayes, representeth the tropiques: those lines which are betweene the æquator and the tropiques, being vndivided and numbred at the æquator by 6,7,8,9,10,11,12. at the tropique by 1,2,3,4,&c. do represent the houre-circles: that which is drawne from 12 in the æquator to the middle of Iune, representeth the houre of 12 at noone in the Summer; and those which are drawn with it to the right hand, are for the houres of the day in the Summer, and the houres of the night in the Winter. That which is drawne from 12 in the æquator to the middle of December, representeth the houre of 12 in the Winter; and those which are drawne with it to the left hand, are for the houres of the day in the Winter, and the houres of the night in the Summer; and of both these, that which is drawne from 11 to 1, serves for 11 in the forenoone, and 1 in the afternoone. That which is drawne from 10 to 2, serues for 10 in the forenoone, and 2 in the afternoone: for the Sunne on the same day is about the same height two houres before noone, as two houres after noone. The like reason holdeth for the rest of the houres.

## 1 *The day of the moneth, or the height at noone being knowne, to finde the place of the Sunne in the Ecliptique.*

The thread being laid to the day of the moneth, or the height at noone, (for one giues the other by the former proposition) marke where it crosseth the houre of 12, and set the bead to that intersection; then moue the thread till the beade fall on the ecliptique, and it shall fall on the place of the Sunne.

As if the day giuen be the 15 of May, or the meridian altitude 59 *gr.* 30 *m.* lay the thread accordingly, and put the bead to the interfection of the thread with the houre of 12; then moue the thread till the bead fall on the ecliptique, and it shall there shew the fourth of ♊, the fourth of ♐, the 26

of

of ♋, and the 26 of ♑; and which of these is the place of the Sunne, may appeare by the quarter of the yeare, or another dayes obseruation.

## 2. *The place of the Sunne in the Ecliptique being knowne, to finde the day of the moneth, &c.*

Let the thread and bead bee first laid on the place of the Sunne in the Ecliptique, and then moued to the line of 12.

As if the place of the Sunne giuen be the fourth of ♊, the bead being laid to this degree, and then moued to the houre of 12, in the Summer, the thread will fall on the 15 day of May, and the 9 of Iuly; or if it be moved to the houre of 12 in the Winter, the thread will fall on the 6 of Ianuary and the 16 of Nouember; which of these is the day of the moneth required, may appeare by the quarter of the yeare.

In this and the former propositions, you haue two wayes to rectifie the bead, by the place of the Sunne, and by the day of the moneth; the better way is by the place of the Sunne, for in the other the Leap-yeare may breed some small difference.

There is yet a third way. For the Sea-men hauing a table for the declination on each day of the yeare, may set the bead thereto in the line of declination.

## 4. *The houre of the day being giuen to find the altitude of the Sunne aboue the horizon.*

The bead being set for the time by either of the three wayes, let the thread be moved from the houre of 12 toward the line of declination, till the bead fall on the houre giuen; and the degrees which it cuts in the Quadrant, shall shew the altitude of the Sunne at that time.

As if the time giuen be the tenth of Aprill, the Sunne be-

 ing

ing then in the beginning of ♉, the bead being rectified, you shall finde the height at noone 50 *gr.* 0 *m.* at 11 in the morning 48 *gr.* 12 *m.* at 10 but 43 *gr.* 12 *m.* at 9 but 36 *gr.* at 8 but 27 *gr.* 30 *m.* at 7 but 18 *gr.* 18 *m.* at 6 but 9 *gr.* at 5 it meeteth with the line of declination, and hath no altitude at all, and therefore you may thinke it did rise much about that houre.

Then if you moue the thread againe from the line of declination toward the houre of 12, you shall find that the Sunne is 8 *gr.* 33 *m.* below the horizon at 4 in the morning; and neere 16 *gr.* at 3, and 21 *gr.* 51 *m.* at 2, and 25 *gr.* 40 *m.* at 1, and 27 *gr.* at midnight.

### 4 *The altitude of the Sunne being giuen, to finde the houre of the day.*

The altitude being obserued as before, let the bead bee set for the time, then bring the thread to the altitude, so the bead shall shew the houre of the day.

As if the 10 of April hauing set the bead for the time, you shall find by the quadrant, the altitude to bee 36 *gr.* the bead at the same time will fall vpon the houre-line of 9 and 3: wherefore the houre is 9 in the forenoone, or 3 in the afternoone. If the altitude be neere 40 *gr.* you shall find the bead at the same time to fall halfe way betweene the houre-line of 9 and 3, and the houre-line of 10 and 2: wherefore it must be either halfe an houre past 9 in the morning, or halfe an houre past 2 in the afternoone; and which of these is the true time of the day, may be soone knowne by a second obseruation: for if the Sunne rise higher, it is the forenoone; if it become lower, it is the afternoone.

5 *The*

### 5 *The houre of the night being giuen, to find how much the Sunne is below the horizon.*

The Sunne is alwayes ſo much below the horizon at any houre of the night, as his oppoſite point is aboue the horizon at the like houre of the day; and therefore the beade being ſet, if the queſtion be made of any houre of the night in the Summer, then moue it to the like houre of the day in the Winter; if of any houre of the night in Winter, then moue it to the like houre of the day in Summer; ſo the degrees which the thread cutteth in the Quadrant, ſhall ſhew how much the Sun is below the horizon at that time.

As if it be required to know how much the Sunne is below the horizon the 10 of April at 4 of the clocke in the morning; the bead being ſet to his place according to the time in the Summer houres, bring it to 4 of the clocke in the afternoone in the Winter houres, and ſo ſhall you finde the thread to cut 8 *gr.* and about 30 *m.* in the quadrant; and ſo much is the Sun below the horizon at that time.

### 6 *The depreſſion of the Sunne ſuppoſed, to giue the houre of the night with vs, or the houre of the day to our Antipodes.*

Here alſo becauſe the Sunne is ſo much aboue the horizon at all houres of the day, as his oppoſite point is below the horizon at the like houre of the night; therfore firſt ſet the bead according to the time, then bring the thread to the degree of the Suns depreſſion below the horizon, ſo ſhall the bead fall on the contrary houre-lines, and there ſhew the houre of the night in regard of vs, which is the like houre of the day in regard of vs, which is the like houre of the day to our Antipodes.

As if the 10 of April the Sunne being then in the beginning

ning of ♉, and by supposition 8 *gr.* 30 *m.* below the horizon in the East, it be required to know what time of the night it is; first set the bead according to the day in the Summer houres, then bring the thread to 8 *gr.* 30 *m.* in the quadrant, so shall the bead fall among the Winter houres, on the line of 4 of the clocke in the afternoone: wherefore to our Antipodes it is 4 of the clocke in their afternoone, and to vs it is then 4 of the clocke in the morning.

### 7 *The time of the yeare or the place of the Sunne being giuen, to find the beginning of day-breake, and end of twi-light.*

This proposition differeth little from the former: for the day is said to begin to breake, when the Sun cometh to be but 18 *gr.* below our horizon in the East, and twi-light to end when it is gotten 18 *gr.* below the horizon in the West; wherefore let the bead be set for the time, and then bring the thread to 18 *gr.* in the quadrant, so shall the bead fall on the contrary houre-lines, and there shew the houre of twi-light as before.

So if it be required to know at what time the day begins to breake on the tenth of April, the Sun being then in the beginning of ♉; first set the bead according to the time in the Summer houres, and then bring the the thread to 18 *gr.* in the quadrant, so shall the bead fall among the Winter houres a little more then a quarter before 3 in the morning; and that is the time when the day begins to breake vpon the tenth of April.

CHAP.

# CHAP. VII.

## *Of the Horizon.*

THe Horizon is here represented by the arke drawne, from the beginning of declination towards the end of February, diuided vnequally, and numbred by 10. 20. 30. 40. &c.

### 1 *The day of the moneth, or the place of the Sunne being knowne, to finde the amplitude of the Sunnes rising and setting.*

Let the bead rectified for the time, be brought to the horizon, and there it shall shew the amplitude required.

As if the day giuen bee the 15 of May, the Sunne being in the fourth degree of ♊, the bead rectified and brought to the horizon, shall there fall on 35 *gr.* 8. *m.* such is the amplitude of the Sunnes rising from the East, and of his setting from the West; which amplitude is alwayes North when the Sunne is in the Northerne signes, and when he is in the Souththerne signes alwayes Southward.

### 2 *The day of the moneth, or the place of the Sunne being giuen, to finde the ascensionall difference.*

Let the bead rectified for the time, be brought to the horizon, so the degrees cut by the thread in the quadrant, shall shew the difference of ascensions.

As if the day giuen be the 15 of May, the Sunne being in the fourth degree of ♊, let the bead be rectified and brought to the horizon; so shall the thread in the quadrant shew the ascensionall difference to be 28 *gr.* and about 50 *m.*

Vpon the ascensionall difference depends this Corollarie.

### *To find the houre of the rising and setting of the Sun, and thereby the length of the day and night.*

The time of the Sunnes rising may be guessed at by the 3 of the last *Cap.* but here by the ascensionall difference it may be better found, and that to a minute of time. For if the ascensionall difference bee conuerted into time, allowing an houre for 15 *gr.* and 4 minutes of an houre for each degree, it sheweth how long the Sun riseth before six of the clocke in the Summer; and after six the Winter.

As if the day giuen be the 15 of May, the Sun being in the fourth of ♊, and his ascensionall difference found as before 28 *gr.* 50 *m*; this conuerted into time, maketh 1 *ho.* and somewhat more then 55 *m.* of an houre: wherfore the Sun at that time, in regard it was summer, rose 1 *ho.* and full 55 *m.* before 6 of the clocke; and so hauing the quantity of the semidiurnall arke, the length of the day and night need not be vnknowne.

## CHAP. VIII.

### *Of the fiue Starres.*

I Might haue put in more starres, but these may suffice for the finding of the houre of the night at all times of the yeare: and first I make choice of *Ala Pegasi*, a starre in the extremity of the *wing of Pegasus* in regard in wants but 6 minutes of time of the beginning of ♈; but because it is but of the second magnitude, and not alwayes to be seene, I made choice of foure more, one for each quarter of the Eclip-

tique,

tique; as *Oculus* ♉ the Buls eye, whose right ascension conuerted into time, is 4 *ho.* 15 *m*; then of *Cor* ♌ the Lions heart whose right ascension is 9 *ho.* 48 *m*; next of *Arcturus*, whose right ascension is 13 *H.* 58 *m*; and lastly of *Aquila*, or the Vultures heart, whose right ascension is 19 *H.* 33 *m.* These fiue starres haue all of them Northerne declination; and if any others, some of these will be seene at all times of the yeere.

The vse of them is,

## *The altitude of any of these fiue Starres being knowne to find the houre of the night.*

First put the beade to the starre which you intend to obserue, take his altitude, and finde how many houres he is from the meridian by the fourth *Prop.* of the sixt *Chap*; then out of the right ascension of the starre, take the right ascension of the sun conuerted into houres, and marke the difference; for this difference being added to the obserued houre of the starre from the meridian, shall shew how many houres the sunne is gone from the meridian, which is in effect the houre of the night.

As if the 15 of May, the sun being in the fourth of ♊, I should set the beade to *Arcturus*, and obseruing his altitude should find him to be in the West about 52 *gr.* high, and the bead to fall on the houre-line of 2 afternoone, the houre would be 11 *ho.* 50 *m.* past noone, or 10 *m.* short of midnight. For 62 *gr.* the right ascension of the sunne, conuerted into time, makes 4 *ho.* 8 *m.* which if we take out of 13 *ho.* 58 *m.* the right ascension of *Arcturus*, the difference will be 9 *ho.* 50 *m.* and this being added to 2 *ho.* the obserued distance of *Arcturus* from the meridian, shewes the houre of the night to be 11 *ho.* 50 *m.* Another example will make all more plaine.

If the 9 of Iuly the sunne being then in 26 *gr.* of ♋, I should set the beade of *Oculus* ♉, and obseruing his altitude should find him to be in the East about 12 *gr.* high, and the bead to fall on the houre-line of 6 before noone, which is

18 *ho.* past the meridian, the houre of the night would be better then a quarter past 2 of the clocke in the morning.

For 118 *gr.* the right ascension of the Sun, conuerted into time, makes 7 *ho.* 52 *m*; this taken out of 4 *ho.* 15 *m.* the right ascension of *Oculus* ♉, adding a whole circle, (for otherwise there could be no substraction) the difference will be 20 *ho.* 23 *m.* and this being added to 18 *ho.* which was the obserued distance of *Oculus* ♉ from the meridian, shewes that the Sun (abating 24 *ho.* for the whole circle) is 14 *ho.* 23 *m.* past the meridian, and therefore 23 *m.* past 2 of the clocke in the morning.

If the *Nocturnall* bee placed on the backside of the quadrant you may auoid this equation of right ascensions. For knowing the time of the yeere when the starre will be in the south at midnight you may bring that time to the houre obserued, then will the day of the moneth wherein you made the obseruation point at the houre of the night required.

As in the first example where on the 15 of May the bead set to Arcturus fell on the houre-line of 2 afternoone, because Arcturus will be in the south the 14 of October compleat at midnight you may place the 14 of October at the houre of 2, so the 15 of May will point to 11 *ho.* 50 *min.*

In the second example, where the 9 of Iuly the bead set to the Bulls eye fell on the houre-line of 6 before noone, because the Bulls eye will be in the south the 16 of May compleat at midnight you may tourne the 16 of may to the houre of 6, and so you shall finde the 9 of Iuly to point to 2 *ho.* 23 *min.* as before.

CHAP.

# CHAP. IX.

## Of the Azimuth-lines.

THose lines which are drawne betweene the æquator and the tropiques, on that side of the quadrant which is nearest vnto the sights, and are numbred by 10. 20. 30. &c. doe represent the azimuths, the vttermost to the left hand representeth the meridian, that which is numbred with 10 the tenth azimuth from the meridian, and that which is numbred with 20 the twentith, and so the rest. Those lines which are drawne from the æquator to the left hand, doe shew the azimuth in the Summer; and those other to the right hand, doe shew the same in the Winter. The vse of them is.

### 1 *The azimuth whereon the Sunne beareth from vs being knowne, to find the altitude of the Sun aboue the horizon.*

First let the bead be set for the time, as in the former Chapter, then moue the thread vntill the bead fall on the azimuth; so the degrees which the thread cutteth in the quadrant, shall shew the altitude of the Sun at that time. Where you are to obserue, that seeing the azimuths are drawne on the right side of the quadrant, you are also to begin to number the degrees of the Sunnes altitude from the right hand toward the left. As if the sights had been set on the line *AB*, and you had turned your right hand towards the Sun in obseruing of of his altitude, contrary to our practise in the former Chapter.

As if the time giuen were the 2 of August, when the Sun hath about 15 *gr.* of North declination, you may set the bead for the time, so you shall find the height at noone when the

Sun is in the south, to be 53 *gr.* 30 *m.* when he is 10 *gr.* from the south 53 *gr.* 10 *m.* when 20 *gr.* then about 52 *gr.* 8 *m.* when 30 *gr.* then 50 *gr.* 20 *m.* when 40 *gr.* then 47 *gr.* 48 *m.* when 50 *gr.* then 44 *gr.* 12 *m.* when 60 *gr.* then 39 *gr.* 35 *m.* when 70 *gr.* then 33 *gr.* 50 *m.* when 80 *gr.* then 27 *gr* when he is in the East or West 90 *gr.* from the meridian, then is the height neare 19 *gr.* 20 *m*; when he comes to be 100 *gr.* then 11 *gr.* 15 *m.* when 110 *gr.* then 3 *gr.* 20 *m*; and before he commeth to the azimuth of 120 *gr.* he hath no altitude. For the sun hauing 15 *gr.* of North declination, will rise and set at 114 *gr.* 34 *m.* from the meridian.

## 2 *The altitude of the Sun being giuen, to find on what azimuth he beareth from vs.*

Let the beade be set for the time, and the altitude obserued as before; then bring the thread to the complement of that altitude, so the bead shall shew the azimuth required.

As if the second of August, hauing set the beade for the time, you shall find the altitude of the sun to be 19 *gr.* 20 *m.* remoue the thread vnto 70 *gr.* 40 *m.* the complement of the altitude; or, which is all one, to 19 *gr.* 20 *m.* from the right hand toward the left, and the bead will fall on the line of 90 *gr.* from the meridian. And therefore the point whereon the sunne beareth from vs, is one of these two, either due East or due West. And which of these is the true point of the compasse, may be soone knowne by a second obseruation: for if the sunne rise higher, it is the forenoone; if it be lower, it is the afternoone.

By knowing the azimuth or point of the compasse whereon the sunne beareth from vs, it is easy to find,

*A meridian line*, and thereby
*The coasting of the Countrey.*
*The site of a building.*
*The variation of the Compasse.*

As if the second of August in the afternoone, I should find by the height of the sun that he beares from me 60 *gr.* from the meridian toward the West: then there being 90 *gr.* belonging to each quarter, the West will be 30 *gr.* to the right hand, the East is opposite to the West, the North and South lie equally betweene them.

## CHAP. X.

### *Of the Quadrat.*

THE Quadrat hath two sides diuided, the other two sides next the Center may be supposed to be diuided, each of them into 100 equall parts: of the sides diuided, that which is next the horizontall line containes the parts of right shadow, the other next the sights, the parts of contrary shadow. The vse of the Quadrat is,

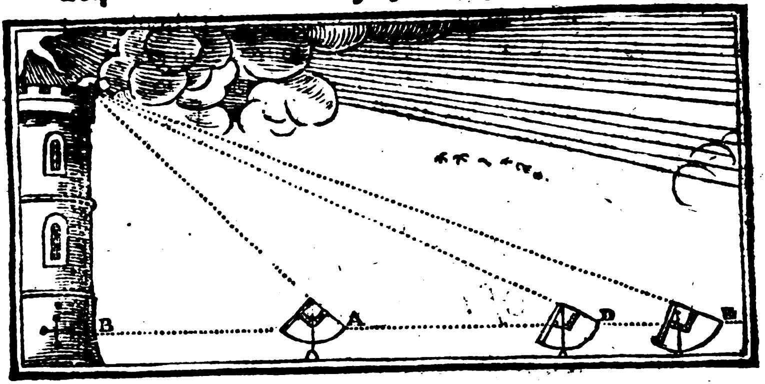
1 *Any point being giuen, to finde whether it be leuell with the eye.*

Lift vp the center of the quadrant, so as the thread with the plummet may play easily by the side of it: then looke through the sights to the place giuen: for now if the thread shall fall on *AB* the horizontall line, then is the place giuen leuell with the eye: but if it shall fall within the said line on any of the diuisions, then it is higher: if without, then it is lower then the leuell of the eye.

2 *To find an height aboue the leuell of the eye, or a distance at one obseruation.*

Looke through the sights to the place, going nearer or farther from it, till the threadfull fall on 100 parts in the quadrat or 45 *gr.* in the quadrant, so shall the height of the place aboue the leuell of the eye, be equall to the distance betweene the place and the eye.

If




If the thread fall on 50 parts of a right ſhadow, the height is but halfe the diſtance: if it fall on 25, it is a quarter of the diſtance: if on 75, it is three quarters of the diſtance. For as oft as the thread falleth on the parts of right ſhadow,

As 100 to the parts on which the thread falleth:
So is the diſtance to the height required.

And on the contrary,

As the parts cut by the thread are to 100:
So the height vnto diſtance.

But when the thread ſhall fall on the parts of contrary ſhadowe: if it fall on 50 parts, the height is double vnto the diſtance; if on 25, it is foure times as the diſtance. For as oft as the thread falleth on the parts of contrary ſhadow,

As the parts cut by the thread are vnto 100:
So is the diſtance vnto the height.

And on the contrary,

As 100 are vnto the parts cut by the thread:
So is the height vnto the diſtance.

And what is here ſaid of the height and diſtance, the ſame may be vnderſtood of the height and ſhadow.

### 3. *To finde a height or a distance at two obseruations.*

As if the place which is to bee measured might not otherwise bee approached, and yet it were required to finde the height B C, and the distance: first if I make choice of a station at A, where the thread may fall on 100 parts in the quadrat, and 45 *gr.* in the quadrant, the distance A B will bee equall to the height B C; then if I goe farther in a direct line with the former distance, and make choice of a second station at D, where the thread may fall on 50 parts of right shadow, the distance B D would bee double to the height B C: wherefore I may measure the difference betweene the two stations A and D, and this difference A D will bee equall both to the distance A B and the height A B.

Or if I cannot make choice of such stations, I take such as I may, one at D, where the thread falleth at 50 parts of right shadow; the second at E, where it falleth on 40 parts: and supposing the height B C to bee 100, I find that

As 50 parts are vnto 100, the side of the quadrat:
So 100 the supposed height, vnto 200 the distance B D,
And as 40 parts, at the second station, vnto 100:
So 100 the supposed height, vnto 250 the distance B E.

Wherefore the difference betweene the stations D and E should seeme to bee 50; and then if in the measuring of it, I should finde it to bee either more or lesse, the proportion will hold, as from the supposed difference to the measured difference, so from height to height, and from distance to distance.

As if the difference between the two stations D and E being measured, were found to be 30.

As 50 the supposed difference, vnto 30 the true difference:
So 100 the supposed height, vnto 60 the true height.
And 200 the supposed distance, vnto 120 the true distãce:
And 250 at the second station, vnto 150 the distance B E.

The like reason holdeth in all other examples of this kind: and if an Index with sights were fitted to turne vpon the Center, it might then serue by the same reason for the finding of all other distances.

FINIS.

# THE GENERALL VSE OF THE CANON AND TABLE of Logarithmes.

LOgarithmetique is a Logicall kinde of Arithmetique, or artificiall vse of numbers inuented for the ease of the calculation wherein each number is fitted with an Artificiall, and these artificiall numbers so ordered, that what is produced by multiplication of naturall numbers, the same may be effected by the addition of these their artificiall numbers; what they performe by diuision, the same is here done by subtraction: and so the hardest part of calculation auoided by an easy prosthaphæresis.

All this shall be made plane by applying that to these Artificiall numbers, which I haue set downe before for the vse of my Lines of numbers sines and Tangents in the vse of the Sector and Crosstaff. Wherein the Reader is to obserue that, what is to be wrought by round numbers only, is best done by *M. Brigges* his Logarithmes, but the astronomicall part concerning arkes and angles, by my Canon of Artificiall sines and Tangents.

## CHAP. I.

*Concerning the use of the line of Numbers, I set downe ten generall Propositions in the use of the Crossestaff. p. 18. and these may bee applied to the table of Logarithmes.*

### PROP. I.

*To multiply one number by another.*

THis is the VI. Proposition of the ten: but I begin with the easiest, adde the Logarithme of the multiplicator to the Logarithme of the multiplied, the summe of both shall be the Logarithme of the product.

| | |
|---|---|
| As when we multiply 25 by 30 the product is | 750 |
| so here adde the Logarithme of 25 viz. | 1397. 94001 |
| to the Logarithme of 30 | 1477. 12125 |
| the summe of both will be | 2875. 06126 |

And this is the Logarithme of 750.

In like manner, if we multiply 10 by 10 the prod. is 100. if 100, by 10; the product is 1000. so here

| | | |
|---|---|---|
| The Logarithme of | 10 being | 1000. 00000 |
| The Logarithme of | 1000 shall be | 2000. 00000 |
| | 1000 | 3000. 00000 |
| | 10000 | 4000. 00000 |
| | 100000 | 5000. 00000 |

And so forward: All intermediate numbers which haue intermediate Logarithmes.

If

If we multiply 101 by 10, the product is 1010 of 102 by 10 the product is 1020: so here

| | | |
|---|---|---|
| The Logarithme of 10 | viz. | 1000. 00000 |
| added the Log. of 101 | | 2004. 32137 |
| giues the Log. of 1010 | | 3004. 32137 |
| The same Logarithme of 10 | | 1000. 00000 |
| added to the Logarithme of 102 | | 2008. 60017 |
| giues the Logarithme of 1020 | | 3008. 60017 |

The difference being only in the first figure, and that is alwayes lesse by one then the number of places, in the number giuen. As when we find the Logarithme to be — 2008 60017 the first figure, 2, is characteristicall, i. the Index shewing that the whole number 102 belonging to this Logarithme, consists of three places. If the Logarithme had beene 1008. 60017 the whole number must haue been 10. 2 consisting of two places, and the rest a fraction of $\frac{2}{10}$.

If the Logarithme were — 0008. 60017 the number belonging to it would be. 1. 02. 1. 1 and $\frac{02}{100}$ And this is one of the reasons why the differences were omitted in the first hundred Logarithmes. All those Logarithmes may be found afterwards vnder a larger Index.

Againe, if we multiply 201. by 5, the product is 1005: so here: if we adde the Logarithme of 5 vnto the Logarithme of 201, the summe of both, shall be the Logarithme of 1005 and the summe of the Logarithmes of 5 and 203 shall be the Logarithme of —1015. Thus the most part of the table may be continued beyond 1000.

## PROP. 2.

### *To diuide one number by another.*

Subtract the Logarithme of the Diuisor out of the Logarithme of the Diuidend, the Remainder, shall be the Logarithme of the Quotient.

As when we diuid 750 by 25 the quotient is 30: so here

| | |
|---|---|
| from the Logarithme of 750 viz | 2875.06126 |
| subtract the Logarithme of 25 | 1397.94001 |
| There remaines the Logarithme of 30. | 1477.12125 |

In like manner when we diuide 11. by 4. the quotient is $2\frac{3}{4}$

| | |
|---|---|
| so here the Logarithme of 4 viz. | 0602.05999 |
| taken from the Logarithme of 11 | 1041.39269 |
| leaues the Logarithme of $2\frac{3}{4}$ | 0439.33270 |

wherefore, if it were required to find the Logarithme of a whole number with a fraction annexed (as one $2\frac{3}{4}$) we might first reduce it into an improper fraction of $\frac{11}{4}$ (or rather of $\frac{275}{100}$) and then subtract as before.

If it were required to find the Logarithme of a single fraction, as of $\frac{4}{11}$, we may subtract as before: But this fraction being lesse then 1, the Logarithme must be lesse then 0. and therefore noted with — a defectiue signe.

| | |
|---|---|
| So the Logarithme of $\frac{11}{4}$ or $2\frac{3}{4}$ is + | 0439.33270 |
| and the Logarithme of $\frac{4}{11}$ — | 0439.33270 |

## PROP. 3.

### *To find the square root of a number.*

Halfe the Logarithme of the number giuen is the full Logarithme of the square Root.

| | |
|---|---|
| So the Logarithme of 144 being | 2158.36249 |
| the halfe thereof is | 1079.18124 |

the Logarithme of 12: and such is the square Roo of 144.

Then by conversion having extracted the square Root, we may soone finde the Logarithme.

| | |
|---|---|
| As, the *Logarithme* of 10,0000 being | 1000.00000 |
| the *Logarithme* of the square R. 316227 is | 0500.00000 |
| and for the Root of that 177827 | 0250.00000 |

PROP. 4.

## PROP. 4.

### *To finde the Cubique Roote of a number.*

The third part of the Logarithme of the number giuen is full Logarithme of the *Cubique Roote*.

| | | | |
|---|---|---|---|
| So the Logarith of | 125 | is | 2096.91001 |
| And ⅓. the Logarithme of | 5 | | 0698.97000 |

By the same reason we may finde the *Biquidrate Roote*, by diuiding the Logarithme of the number giuen by 4: the solid *Roote*, by dividing by 5: and so forward.

And by conversion, hauing extracted the Roote, we may soone finde the Logarithme.

| | | | |
|---|---|---|---|
| As the Logarithme of | 10.000, &c. | is | 1000.00000 |
| The Logar. of the *Cub. R.* 21544. | | | 0333.33333 |
| The Logarithme of | 100.000, &c. | | 2000.00000 |
| the Logarithme of the Cubique R. | 4641. | | 0666.66666 |

Then multiplying these square and *Cubique Rootes* one by another, we may produce infinite other numbers, and haue all their Logarithmes.

## PROP. 5.

### *Three numbers being giuen, to finde a fourth Proportionall.*

This *Golden Rule* the most vsefull of all others, may bee wrought severall wayes as it appeares by this example:

As 12 vnto 24 so 4 to a fourth number.

1. Tactus 2. & 3. divisus per 1. The ordinary way in Arithmetique is by multiplication and division. For first they multiply the second into the third, and then diuide the product by the first number giuen. As here multiplying 24 by 4, the Product is 96, then diuiding 96 by 12 the Quotient will be 8 the fourth number here required.

According to this way we adde the Logarithmes of the second and third, and subtract the Logarithmes of the first, so, that which remaineth, shall be the Logarithme of the fourth number required.

| | | |
|---|---|---|
| Thus the Logarith. of the first numb. | 12 is | 1079.18125 |
| the Logarithme of the second | 24 | 1380.21124 |
| the Logarithme of the third | 4 | 0602.05999 |
| the summe of the second and third Logar. | | 1982.27123 |
| subtract the first and there remaineth | | 0903.08998 |

And thus is the Logarithmes of 8. the fourth Proportionall.

2 Quotiens 2. per 1. diuisi multiplicatus in tertium. A second way in Arithmetique is by division and multiplication. For where the second number is greater than the first, they may diuide the second by the first, and then multiply the third by the quotient. As here dividing 24 by 12 the quotient is 2: then multiplying 4 by 2, the Product will be 8.

According to this way we take the Logarithme of the first out of the Logarithme of the second, and then adde the difference to the Logarithme of the third. So the summe of this addition shall be the Logarithme of the fourth required.

| | | |
|---|---|---|
| Thus the Loga. of the first Numb. | 12 is | 1079.18125 |
| the Logarithme of the second | 24 | 1380.21124 |
| the difference betweene the increasing | | 300.02999 |
| added to the Logarithme of | 4 | 0602.05999 |
| gives the Logarithme of | 8 | 0902.08998 |

3 Quotiens 1. per 2. fit divisor 3. A third way in Arithmetique is by division and division, for where the second number is lesse then the first, they may diuide

diuide the first by the second, and then againe divide the third by the quotient. As here diuiding 12 by 4. the quotient is 3: then diuiding 24 by 3. the quotient is 8.

According to this way we take the Logarithme of the second, out of the Logarithme of the first, and then take the difference out of the Logarithme of the third: So, that which remaineth shall be the Logarithme of the fourth number required.

| | | | |
|---|---|---|---|
| Thus the Logar. of the first numb. | 12 | is | 1079.18125 |
| the Logarithme of the second | 4 | | 0602.05999 |
| The difference decreasing, | | | 477.12126 |
| substracted from the Logarithme of | 24 | | 1380.21124 |
| gives the Logarithme of | 8 | | 0903.08999 |

These two latter wayes by difference of Logarithmes, may be considered as the same. Though there be some difference betweene them, yet that may easily be reconciled, if we have regard to the nature of the question. For three numbers being giuen in direct proportion, if the second be greater then the first, the 4. must be greater then the third: If the second be lesse then the first, the 4. must bee lesse then the third, and their Logarithme accordingly. But in reciprocall proportion, considering the first and second numbers to be of one denomination, we are to obserue the contrary.

If we desire to turne subtraction into addition wee may take the Logarithme which is to bee subtracted out of the *Radius*, and adde the complement. So the summe of this addition, the *Radius* being subtracted shall give the required Logarithme as before.

Thus in the last example: where subtracting the difference 477.12126. out of 1380.21124. the Logarithme of 24 we found the remainder to be 0903.08998. the Logarithme of 8.

| | |
|---|---|
| The *Radius* being | 10000.00000 |
| the Logarithme to be subtracted | 0477.12126 |
| the complement to the *Radius* is | 9522.87874 |

This

| | |
|---|---|
| This added to the Logarithme of 24 | 1380. 21124 |
| giues vs a compound Logarithme | 10903.08998 |

From this, if we subtract the *Radius*, (that is, if we cancell the first figure to the left hand) the rest is 0903.08998 the Logarithme of 8. the fourth Proportionall, as before.

By helpe of this fourth Proportional we may come somewhat neere to finde a Logarithme for a number of 6 places.

As if it were required to finde a logarithme for this number 868624. the table will affoord vs Logarithmes for a lesser and a greater number; and then the intermediate may be found by the part proportionall in this maner.

| | | |
|---|---|---|
| Here we haue the Logarithme of | 868 | 2938.51973 |
| and the Log. of the next following | 869 | 2939.01978 |
| and the tabular difference betweene them | | 50005 |

If the Index be fitted to the number of places

| | | | |
|---|---|---|---|
| the Logarithme of | 868000 | shall be | 5938.51973 |
| and the Logarith. of | 869000 | | 5939.01978 |
| the difference being | 1000 | | 50005 |

Then taking 868000, out of 868624, (the number given) the third difference will be 624. And hauing these three differences the proportion will hold.

| | | | |
|---|---|---|---|
| As | 1000 | vnto | 50005 |
| So | 624 | vnto | 31203 |

the part proportionall to be added to the lesser Logarithme 5938.51973 so shall we haue 5938.83176. for the logarithme required.

In like maner hauing a logarithme given, we may finde the value of it in a number of sixe places.

As if the Logarithme given were 3938.83182 and it were required to find the number to which it belongeth: This Logarithme is not to be found in the Table; but changing the *Index* and making it 2938.83182

| | |
|---|---|
| the next lesser logarithme of 868 is | 2938.51973 |
| and the tabular difference following | 50005 |
| and the proper difference | 31209 |

As

| | | | |
|---|---|---|---|
| As th Tabular difference | 50005 | vnto | 100000 |
| So the proper difference | 31209 | vnto | 62411 |

The part proportionall to be ioyned to the end of the former number 868: so shall we haue 86862411. for the value of this Logarithme. But the Index of the Logarithme being 3. the number required must consist of 4 places: *viz.* 8686 and the rest a fraction of $\frac{24}{100}$.

This I say is somewhat neere the truth. For this number here proposed 868624 is the square of 932,

| | | | |
|---|---|---|---|
| The true Loga, of the Root | 932 | is | 2969.41591 |
| The true Loga. of the Square | 868624. | | 5938.83182 |

## Prop. VI.

### *Three numbers being giuen to finde a fourth in a duplicated Proposition.*

In questions that hold in a duplicated proportion between *Lines* and *Superficies*, the Logarithmes for lines giuen may be doubled, the Logarithmes for lines required may bee halfed, and then the worke will be the same as in the first part of the former Proposition.

Suppose, the *Diameter* being 14, the content of the circle was 154; the *Diameter* being 28, what may the content bee?

Here the question concerning both lines and superficies, I double the Logarithmes of the 2 lines giuen, and then worke as before in this maner.

| | | | |
|---|---|---|---|
| The logarithme of | 14 | is | 1146.12803 |
| the logarithme of | 28 | | 1447.15803 |
| the same againe | | | 1447.15803 |
| the logarithme of | 154 | | 2187.52072 |
| the summe of these last | | | 5081.83678 |
| Subtract the double of the first, | | | 2292.25606 |
| there remaines the logar. of | 616 | | 2789.58072 |

Bbbb

And

And such is the content of the circle here required.

Suppose the content of a Circle being 154, the Diameter of it was 14; the content being *616*, what may the diameter be?

Here being one line giuen, and one line required, I double the Logarithme of the line giuen, and then working as before, the halfe of the remainder shall be the Logarithme of the line required.

| | | | |
|---|---|---|---|
| Thus the loga. of | 154 | is | 2187. 52072 |
| the logarithme of | *616* | | 2789. 58072 |
| the logarithme of | 14 | | 1146. 12803 |
| the same againe | | | 1146. 12803 |
| the summe of these last | | | 5081. 83678 |
| subtract the logarithme of the first | | | 2187. 52072 |
| the remainder will be | | | 2894 31606 |
| the halfe thereof is | | | 1447. 15803 |

The logarithme of 28. the Diameter required.

Or according to the second maner of operation, the difference betweene the logarithmes of lines giuen may be doubled; the difference betweene the logarithmes of the content given may be halfed, and then the worke will be the same as in the latter part of the former proposition.

So, in the first question, where the Diameters were giuen and the content required.

| | | | |
|---|---|---|---|
| The logarithme of | 14 | is | 1146. 12803 |
| the logarithme of | 28 | | 1447. 15803 |
| the difference increasing | | | 301. 03000 |
| the double of this difference | | | 602. 06000 |
| added to the logar. of | 154 | | 2187. 52072 |
| giues the logarith. of | *616* | | 2789. 58072 |

In the second question, where the content of both the circles was knowne, and the Diameter of the one required.

The

| | | | |
|---|---|---|---|
| The logarithme of | 154 | is | 2187.52072 |
| the logarithme of | 616 | | 2789.58072 |
| the difference increasing | | | 602.06000 |
| the halfe of this difference | | | 301.03000 |
| added to the logar. of | 14 | | 1146.12803 |
| giues the logarith. of | 28 | | 1447.15803 |

## PROP. 7.

### *Three numbers being giuen to finde a fourth in a triplicated proportion.*

In questions concerning proportion betweene *Lines* and *Solids* the logarithmes for lines given may bee tripled; the logarithmes for lines required may be diuided into 3. parts; and then the worke will be the same, as in the first way for the rule of Three.

Suppose the *Diameter* of an Iron bullet, being 4 inches, the waight of it was 9 pound, the *Diameter* being 8. inches, what may the waight be?

| | | | |
|---|---|---|---|
| The logaritbme of | 4 | is | 0602.05999 |
| the logarithme of | 8 | | 0903.08999 |
| the Triple of it | | | 2709.26997 |
| the logarithme of | 9 | | 0954.24251 |
| the summe of these last | | | 3663.51247 |
| subtract the triple of the first logar. | | | 1806.17997 |
| there remaines the logar. of 72 | | | 1857.33251 |

and such is the waight required.

Suppose the waight of an Iron bullet being 9 pound, the Diameter was foure inches; the waight being 72 pound, what may the Diameter be?

 The

| | | | |
|---|---|---|---|
| The Logarithme of | 9 | is | 0954.24251 |
| the Logarithme of | 72 | | 1857.33250 |
| the Logarithme of | 4 | | 0602.05999 |
| the double of this againe | | | 1204.11998 |
| the summe of these last | | | 3663.51247 |
| the first Log. substracted there remaines. | | | 2709.26996 |
| the third part thereof is | | | 0903.08999 |

the Logarithme of 8. and such is the diameter required.

Or according to the second manner of operation in the rule of three, the difference betweene the Logarithmes of lines giuen may bee tripled; the difference betweene the Logarithmes of the solidity or weight giuen may be diuided into 3 parts.

So in the first question, where the diameters were knowne, and the weight required.

| | | | |
|---|---|---|---|
| The *Logarithme* of | 4 | is | 0602.05999 |
| the *Logarithme* of | 8 | | 0903.08999 |
| the difference encreasing, | | | 301.03000 |
| the triple of this difference | | | 903.09000 |
| added to the *Logarithme* of | 9 | | 0954.24251 |
| giues the Logarithme of | 72 | | 1857.33251 |

In the second question, where the weight was knowne, and the diameter required.

| | | | |
|---|---|---|---|
| The Logarithme of | 9 | is | 0954.24251 |
| the Logarithme of | 72 | | 1857.33250 |
| the difference increasing | | | 903.08999 |
| the third part of this difference | | | 301.02999 |
| added to the *Logarithme* of | 4 | | 0602.05999 |
| giues the *Logarithme* of | 8 | | 0903.08998 |

PROP.

## Prop. 8.

*Having two numbers giuen to find a third in continuall proportion, a fourth, a fifth, a sixt and so forward.*

According to the first way in the rule of three, we may subtract the Logarithme of the first number, out of double the Logarithme of the second, the remainder shall be the Logarithme of the third, then subtracting the Logarithme of the first number againe out of the Logarithmes of the second and third, that is, out of triple the Logarithme of the second, the remainder shall be the Logarithme of the fourth, and so forward.

As, when we say: As 1 vnto 2, so 2 vnto 4: and 4 vnto 8; and 8 vnto 16 &c. because the first number is 1, there is no need of diuision, but onely to multiply 2 the second number into it selfe, the product giues the third proportionall number to be 4: then multiplying 2 into 4, the fourth proportionall is 8: and multiplying 2 into 8 the fifth proportionall is 16; and so forward. So here the Logarithme of the first number being 1. there is no need of subtraction.

| | |
|---|---|
| But, finding the Logarithme of 2 to be. | 0301.02999 |
| the double giues the Logarithme of 4 | 0602.05999 |
| the triple giues the Logarithme of 8 | 0903.08999 |
| the quadruple giues the Log. of 16 | 1204.11998 |

and so forward in *infininitum*.

In all other numbers that begin not with 1, wee may either subtract the Logarithme of the first number, or adde the complement vnto the *Radius*.

As when the numbers giuen are 100 and 108.

| | | |
|---|---|---|
| The *Logarithme* of the first N. 100. is | | 2000. 00000 |
| the *Logarithme* of the second | 108 | 2033.42376 |
| the double of this second *Logarithme*. | | 4066.84752 |
| subtract the first *Log*. there remaines | | 2066.84752 |

the *Logarithme* of 116 $\frac{64}{100}$ the third proportionall.

| | |
|---|---|
| Againe subtract the first *Logarithme* | 2000. 00000 |
| out of the summe of the *Logarithmes* of | 2033. 42376 |
| the second N. and the third Proportionall | 2066. 84752 |
| there remaines the *Logarithme* | 2099. 27128 |

answering vnto 125 $\frac{971}{}$ the fourth number in continuall proportion.

According to the second manner of operation we may take the difference between the *Logarithmes* of the two numbers giuen; so, this difference applied to the *Logarithme* of the second number shall giue the *Logarithme* of the third Proportionall: the same difference applied to the *Logarithme* of the third Proportionall, shall giue the Logarithme of the fourth Proportionall. Or the double of this difference applyed to the Logarithme of the first number shall giue the Logarithme of the third Proportionall; the treble of this difference applyed to the Logarithme of the first number shall giue the Logarithme of the fourth proportionall: and so forward.

As in the former example, where the two numbers giuen were 100 and 108; suppose 100 increasing to 108, and so yearly in continuall proportion after the rate of 8 in 100, and that it were required to find, what this 100 would grow vnto by the end of 20 yeeres?

| | |
|---|---|
| The Logarithme of the first numb. 100 is | 2000. 00000 |
| the Logarithme of the second 108 | 2033. 42376 |
| the yearely difference increasing | 33. 42376 |
| added to the Loga. of the second giues | 2066. 82752 |

the Logarithme of 116 $\frac{64}{}$ for the third proportionall; And such is the encrease at the end of the second yeare.

Againe the same yeerely difference added to the Logarithme of the third Proportionall giues 2100. 25128 the Logarithme of 125 $\frac{971}{}$ for the fourth Proportionall and the encrease at the end of the third yeare: and so the rest.

But because the question is onely of the 20 yeare without knowing the rest, we may multiply the former yeerely difference 33. 42376

by 20: so the difference of 20 yeare 668. 47520

added

added, to the Log. of the first num. 100. vz. 2000. 00000
giues the Logarithme of 466. 2668. 47520
that is 466. l. 1. s. 11. *d. ferè*. the summe that 100 would grow vnto by the end of 20 yeares at the rate proposed.

In like manner if the two first numbers giuen were 108 and 100: Suppose 108 decreasing to the 100 and so yeere'y in continuall proportion and that it were required to find what 100 would decrease vnto by the end of 20 yeares: Or (which is all one) suppose 100 to be due 20 yeare hence, and that it were required to find the worth thereof in ready money according to the former rate. The Log. of the first N. 108 is 2033. 42376
the Logarithme of the second 100 2000. 00000
the differedce for the yeare decreasing 33. 42376
taken from the Logarithme of 100 leaues 1966. 57624
the Logarithme of 92 $\frac{592}{}$ for the third proportionall, and such is the present worth of 100 l. due at the yeares end.

The same difference subtracted once more leaues 1933. 15248 the Logarithme of 85 $\frac{733}{}$ for the fourth propotionall, and the present worth of 100 l. due at the end of two yeares.

The same difference multiplyed by 20 makes 668. 47520
and subtracted from the Log. of 100 leaues 1331. 52480
the Logarithme of 21 $\frac{4548}{}$ that is 21 l. 9 s. 1 d. and such is the present worth of 100 l. due at the end of 20 yeares: So that this present worth being taken forth of the 100 l. principall debt there remaines 78 l. 10 s. 11 d. for the present worth of the continued gaine that may be made either of the loane of 100 l. or of 8 l. annuity after 20 yeares according to the former rate.

If a lease of 100 l. by the yeare or such other yeerely pension were to continue for 20 yeares, and that it were required to find the worth thereof in ready money. This might bee found vpon the same ground of continuall proportion, and that seuerall wayes.

1 It appeareth before, that 100 l. due at the yeares end is is worth but 92 $\frac{592}{}$ in ready money: If it be due at the end of 2 yeares, the present worth is 85 l. $\frac{733}{}$: then adding these two together, wee haue 178 l. 326 for the present worth of

100. pound Annuity for 2. yeeres and so forward.

2 It appeareth before that the present worth of 8 pound annuity for 20 yeeres is 78 pound 5452: and then it followes by proportion.

| | | |
|---|---|---|
| As an Annuity of | 8.l. 0000 | 0903.08999 |
| is to the worth thereof | 78.5452 | 1895.11953 |
| | | 992.02954 |
| So an Annuity of | 100.0000 | 2000.00000 |
| vnto the worth of it | 981.8147 | 2992.02954 |

3 As the yeerely loane of 100 pound includes an Annuity of 8. pound, So there is a summe equivalent to 100 pound Annuity.

This summe equivalent may be diminished according to the number of yeeres as before: to the complement of the summe diminished to the summe equivalent shall be the present worth of the Annuity.

| | | |
|---|---|---|
| As the yeerely gaine of | 8 | 0903.08999 |
| to the loane of | 100 | 2000.00000 |
| So an Annuity of | 100 | 2000.00000 |
| to the sum equiualent | 1250 | 3096.91001 |

Then for diminishing of this sum equivalent wee may multiply the former yeerely difference 33.42376
by 20. so the difference for 20 yeeres. 668.47520
taken from the logarithme of 1250 3096.91001
there remaines the logar. of 268.1853 2428.43481
whose complement to 1250. is 981.8147. that is 981. *l*.16.*s*. 3.*d*.*ob*. and such is the present worth of 100. pound Annuity for 20. yeeres, at the rate of 8. in 100 *per annum*.

The like reason holdeth for any other rate and time proposed.

PROP.

## PROP. 9.

*Hauing two extreme numbers giuen, to finde a meane Proportionall betweene them.*

Adde the logarithmes of the two extreme numbers the; one halfe of the summe shall be the logarithme of the meane *Proportionall.*

As if the two extreme numbers giuen were 8. and 32

| | | | |
|---|---|---|---|
| The logarithme of | 8 | is | 0903.08999 |
| The logarithme of | 32 | | 1505.14998 |
| The summe of both logarithmes | | | 2408.23997 |
| The halfe of this summe is | | | 1204.11998 |

the logarithmes of 16: and such is the meane proportionall here required.

## PROP. 10.

*Hauing two extreme numbers giuen to find two meanes Proportionalls betweene them.*

In the ordinary way of Arithmetiqne we commonly multiply the greater extreme by the square of the lesser, so the Cubique root of the Product shall be the lesser meane: then multiplying the lesser meane into the greater extreme, the square root of the Product shall be the greater *Meane Proportionall.* Or hauing found the lesser meane, wee may finde the other meane by continuall proportion.

Accordingly we may adde the logarithme of the greater extreme to double the logarithme of the lesser, so the third part of the summe shall be the logarithme of the lesser meane. Then adding this logarithme of the lesser meane, to the logarithme of the greater extreme, the one halfe of the summe shall be the logarithme of the greater *meane Proportionall.*

| | | | |
|---|---|---|---|
| As if the two extreme numbers given were | 8. | and 27 | |
| Adde to the logarithme of | 8 | *viz.* | 0903.08999 |
| the same againe | | | 0903.08999 |
| and the logarithme of | 27 | | 1431.36376 |
| The summe of these will be | | | 3237.54374 |
| the third part of this summe is | | | 1079.18125 |

the logarithme of 12. the *lesser meane Proportionall.*

| | |
|---|---|
| Adde to this logar. of the lesser meane | 1079.18125 |
| the logar. of the greater extreme | 1431.36376 |
| The summe of both logar. will be | 2510.54501 |
| and the halfe of this summe is | 1255.27250 |

the logarithme of 18. the greater of the two meane Proportionalls here required.

Or according to the second manner of operation in the Rule of Three, (which is the worke that I alwaies follow in the line of numbers) we may take the difference betweene the logarithmes of the two extreme numbers, and diuide this difference into three equall parts, so the summe of the logarithmes of the lesser extreme and ⅓ part shall be the logarithme of the lesser Meane; the summe of this logarithme of the lesser meane and the same ⅓ part shall bee the logarithme of the *Greater meane Proportionall.*

| | | | |
|---|---|---|---|
| So the Logarithme of | 8 | being | 0903.08999 |
| the Logarithme of | 27 | | 1431.36376 |
| the difference betweene them | | | 528.27377 |
| The third part of this difference | | | 176.09126 |
| added to the Logarithme of 8. giues | | | 1079.18125 |

the Logarithme of 12. the *lesser Meane.*

The same added to the Logarithme of 12. giues 1255.27251. the Logarithme of 18. the *Greater Meane Proportionall.*

And

And by the same reason, if it were required to find three *Meane Proportionals*, we might divide the former difference into 4. equall parts, and so forward.

As if it were required to finde the first of eleven *Meane Proportionals* betweene 100 and 108. Or (which is all one) suppose 100 pound increasing in continuall proportion, so as that by the end of 12. moneths it came to 108 pound, and that it were required to find what this 100 pound did grow vnto by the end of the first moneth.

| | | |
|---|---|---|
| The Logarithme of the first extreme | 100 is | 2000. 00000 |
| the Logarithme of the second | 108 | 2033. 42376 |
| the yearely difference betweene them | | 33. 42376 |
| The 12 part or monethly difference | | 2. 78531 |
| added to the Logarithme of | 100 giues | 2002. 78531 |

the Logarithme of 100. 64340301 I the first of eleven *meane Proportionals*; and the growth required.

Then having these two, 100. and 100. 64340301 I. together with 108, the last of the twelue, the other intermediate may be found by continuall proportion as before.

This Explication of my ten former *Propositions* may serve for the frugall vse of the Table of Logarithmes. Those which require more may haue recourse to that Treatise which is mencioned before in the front of the Table.

# CHAP. II.

COncerning the vse of the *Lines* of *Sines* and *Tangents* I shewed in generall, *pag.* 21. how the might serue for the resolution of all Sphæricall triangles. More particularly in the vse of my *Sector* (pag. 74) I reduced that which is commonly required in a sphæricall triangle vnto 28 cases. And for these they may be all resolued by my Tables of Artificiall Sines and Tangents without the help of Secants or versed Sines.

This manner of the worke will be alwaies such as in the ordinary rule of Three. For, here we haue three numbers giuen whereby to find a fourth Proportionall. And therefore either we may adde the Logarithmes of the second and third, and subtract the Logarithme of the first:

Or we may take the difference between the Logarithmes of the first and second, and apply that difference to the Logarithme of the third.

The first of these waies is best for the resolution of right angled Triangles where the *Radius*, *viz.* 1000. 0000 is one of the three numbers giuen: But the second way, by differences is more conuenient for the rest.

The like manner of worke may be obserued when we are to consider the Sines or Tangents of Degrees, Minutes, and Seconds. For the Seconds, not expressed in the Canon, will be found by the part proportionall: as I will show in the examples following.

1 If it were required to finde the Sine of 51.*gr.* 32′. 15″. I should finde.

The

| | | |
|---|---|---|
| The Sine of 51 *deg*. 32 *mi*. | is | 9893.7452 |
| the Sine of 51 *deg*. 33 *m*. | | 9893.8455 |
| the Tabular difference betweene them | | 1003 |

Then the difference betweene 32 *m*. and 33 *m*. being 60 Seconds, the Proportion will hold,

As 60 Seconds vnto 1003

So 15. vnto 251 the part Proportionall to be added vnto the Sine 51 *deg*. 32 *m*.

So shall we have 9893. 7703. for the sine of 51 *deg*. 32. *m*. 15 *seconds*.

2 If it were required to finde the Degrees, Minutes and Seconds belonging to this Tangent 10099. 9782
I should finde by the Canon that this is somewhat more then the Tangent of 51 *deg*. 32 *mi*. 10099. 9134
lesse then the Tangent of 51 *deg*. 33. *mi*. 10100.1728

The Tabular difference betweene these is 2594
and the proper difference is 648
betweene the lesser of these Tangents, and the Tangent giuen therefore.

As 2594 vnto 60 Seconds,

So 648 vnto 15 And so, I finde this to be the Tangent of 51 *deg*. 32 *mi*. 15 *seconds*.

3 If it were required to finde the Sine belonging to this Tangent 10099. 9782, I should finde the arke to be somewhat more then 51 *gr*. 32 *m*. and the sine correspondent somewhat more then 9893.7452. then taking out the differences as before, I finde that

| | | |
|---|---|---|
| As the Tabular difference of Tange. | 2594 | 3413.9700 |
| is to the proper difference | 648 | 2811.5750 |
| | | 602.3950 |

| | | |
|---|---|---|
| So the Tabular difference of Sines | 1003 | 3001.3009 |
| to the part Proportionall | 251 | 2398.9059 |

This part proport. added vnto the former Sine. 9893.7452.

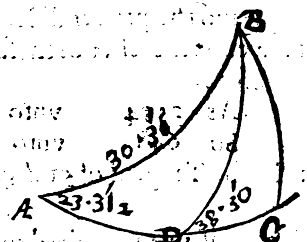
giues 9893 7703 for the signe required.

These premisses considered I come to the 28 Cases before mentioned wherein I set downe a Canon and an Example for each case, and these for the most part the same which I vsed before.

Those which haue no further vse, but of degrees and minutes may take that sine or Tangent, which they find to be next in the Canon, and neglect the seconds.

## IN A RECTANGLE TRIANGLE

### 1 To finde a side by knowing the Base and the Angle opposite to the inquired side.




As in the Rectangle triangle A C B wherein A stands for the æquinoctiall point; A B, an arke of the Ecliptique representing the Longitude of the Sunne in the beginning of ♉; B C an arke of the Declination from the Sun to the æquator; and A C an arke of the Æquator representing the right ascension of the sunne in B: Knowing the Base A B to be 30 *gr.* and the Angle B A C 23 *gr.* 31 *m.* 30″. if it were required to find the side B C

| | D M S | |
|---|---|---|
| As the *Radius* the sine of, | 90. 0. 0. | 10000. 0000 |
| is to the sine of the Base | 30.0.0 | 9698. 9700 |
| So the sine of the opposite angle. | 23. 31. 30. | 9601. 1352 |
| to the sine of the side required | 11. 30. 43. | 19300. 1052 |

And so writing the sine 9601. 1352 in a paper by it selfe and holding it to the sine of the Base in the Canon 1. *gr.* 2, 3, 4, 5, and so forward, it would be no long worke to write the summe somme in a columne by it selfe, and so find the Declination for each degree and Minute of the Ecliptique.

## 2. To finde a side by knowing the Base and the other side.

As in the Rectangle A C B hauing A B 30 *gr.* and B C 11 *gr.* 30 *m.* 43″ S, to finde the side A C.

| | | |
|---|---|---|
| As the cosine of the side giuen | 11. 30. 43. | 9991. 1740 |
| is to the *Radius* | 90. 0. 0. | 10000. 0000 |
| So the cosine of the Base | 30. 0. 0. | 9937. 5306 |
| to the cosine of the side required. | 27. 53. 43. | 9946. 3566 |

## 3. To finde a side by knowing the two oblique Angles.

As in the Rectangle A C B, hauing C A B for the first Angle 23 *gr.* 31 *m.* 30 S. and A B C for the second 69 *gr.* 20 *m.* 35 S to find the side A C.

| | | |
|---|---|---|
| As the sine of the next angle | 23. 31. 30 | 9601. 1352 |
| is to the *Radius* | 90. 0. 0. | 10000. 0000 |
| So the cosine of the opposite angle | 69. 20. 35. | 9547. 4918 |
| to the cosine of the side required | 27. 53. 43. | 9946. 3566 |

## 4. To finde the BASE by knowing both the sides.

As in the Rectangle A C B, hauing A C 27 53 *m.* 43″ and B C, 11 *gr.* 30 *m.* 43 S. to find the Base A B.

As

| | | |
|---|---|---|
| As the *Radius*. | 90. 0. 0. | 10000.0000 |
| to the cosine of the one side | 27. 53. 43. | 9946. 3566 |
| So the cosine of the other side. | 11. 30. 43. | 9991. 1640 |
| to the cosine of the Base | 30. 0. 0. | 9937. 5306 |

## 5 *To finde the BASE by knowing one side and the Angle opposite to that side.*

As if in the former triangle A C B we draw B D an Arke of the Horizon for the Latitude of 51 *gr.* 30 *m.* reputing the amplitude of the Sunnes rising from the East, we shall haue two Triangles more, one rectangle B C D, the other obliquangled A B D. And so, in the Rectangle D C B, hauing B C 11 *gr.* 30 *m.* 43 *s.* and B D C 38 *gr.* 30 *m.* if it were required, to find the Base D B.

| | | |
|---|---|---|
| As the sine of the Angle | 38 30 0 | 9794. 1495 |
| to the sine of the side | 11 30 43 | 9300. 1052 |
| So is the *Radius* | 90 0 0 | 10000. 0000 |
| to the sine of the Base | 18 41 56 | 9505. 9556 |

## 6 *To finde an Angle by knowing the other oblique angle, and the side opposite to the angle required.*

As in the Rectangle A C B, hauing B A C. 23 *gr.* 31 *m.* 30 *s.* and A C 27 *gr.* 53 *m.* 43 *s.* to find the angle A B C.

| | | |
|---|---|---|
| As the *Radius* | 90 0 0 | 10000. 0000 |
| to the sine of the angle giuen | 23 31 30 | 9601. 1352 |
| So the cosine of the side | 87 53 43 | 9946. 3566 |
| to the cosine of the angle required | 69 20 35 | 19547. 4918 |

7 To

## 7 *To finde an angle by knowing the other oblique angle, and the side opposite to the angle giuen.*

As in the Rectangle A C B hauing B A C 23 *gr.* 31 *m* 30 *ſ.* and B C 11 *d.* 30 *m.* 43 *ſ.* to finde the angle A B C.

| | | | | |
|---|---|---|---|---|
| As the cosine of the side | 11 | 30 | 43 | 9991. 1740 |
| to the cosine of the angle giuen | 23 | 31 | 30 | 9962. 3153 |
| So is the *Radius* | 90 | 0 | 0 | 10000. 0000 |
| to the sine of the angle required | 69 | 20 | 35 | 9971. 1413 |

## 8 *To find an angle by knowing the Base, and the side opposite to the angle required.*

As in the Rectangle B C D hauing B D 18 *gr.* 41 *m.* 56 *ſ.* and B C 11 *gr.* 30 *m.* 43 *ſ.* to find the angle B D C.

| | | | | |
|---|---|---|---|---|
| As the sine of the Base | 18 | 41 | 56 | 9505. 0000 |
| is to the *Radius* | 90 | 0 | 0 | 10000. 0000 |
| So the sine of the opposite side | 11 | 30 | 43 | 9300. 1052 |
| to the sine of the angle | 38 | 30 | 0 | 9794. 1495 |

These eight Propositions haue beene wrought by sines alone; the eight following require ioint help of Tangents.

## 9 To find a side, by knowing the other side, and the angle opposite to the side required.

As in the Rectangle A C B, hauing A C 27 *gr.* 53 *m.* 43 *s.* and B A C 23 *gr.* 31 *m.* 30 *s.* to find the side B C.

| | | | | |
|---|---|---|---|---|
| As the *Radius* | 90 | 0 | 0 | 10000.0000 |
| to the sine of the side giuen | 27 | 53 | 43 | 9670.1112 |
| So the Tangent of the opposite angle | 23 | 31 | 30 | 9638.8199 |
| to the Tangent of the side required. | 11 | 30 | 43 | 19308.9311 |

## 10 To find a side by knowing the other side and the angle next the side required.

As in the rectangle B C D hauing B C 11 *gr.* 30 *m.* 43 *s.* and B D C 38 *gr.* 30 *m.* to finde D C.

| | | | | |
|---|---|---|---|---|
| As the Tangent of the angle | 38 | 30 | 0 | 9900.6052 |
| to the Tangent of the side giuen | 11 | 30 | 47 | 9308.9311 |
| So the *Radius* | 90 | 0 | 0 | 10000.0000 |
| to the sine of the side required | 14 | 50 | 11 | 9408.3259 |

## 11 To finde a side by knowing the Base and the Angle next the side required.

As in the rectangle A C B, hauing A B 30 *gr.* 0 *m.* and B A C 23 *gr.* 31 *m.* 30 *s.* to finde the side A C.

As

| | | |
|---|---|---|
| As the *Radius* | 90 0 0 | 10000, 0000 |
| to the cosine of the angle | 23 31 30 | 9962, 3153 |
| So the Tangent of the Base | 30 0 0 | 9761, 4393 |
| to the Tang. of the side required | 27 53 43 | 19723, 7546 |

## 12 *To find the Base by knowing both the oblique Angles.*

As in the rectangle A C B, hauing B A C 23 *gr.* 31 *m.* 30 *s.* and A B C 69 *gr.* 20 *m.* 35 *s.* to find the Base A B.

| | | |
|---|---|---|
| As the Tangent of the one angle | 23 31 30 | 9638, 8199 |
| to the cotangent of the other | 69 20 35 | 9576, 3505 |
| So the *Radius* | 90 0 0 | 10000, 0000 |
| to the cosine of the base | 30 0 0 | 9937, 5306 |

## 13 *To find the Base, by knowing one of the sides and the Angle next that side.*

As in the rectangle A C B, hauing A C 27 *gr.* 53 *m.* 43 *s.* and B A C, 23 *gr.* 31 *m.* 30 *s.* to find the Base A B.

| | | |
|---|---|---|
| As the cosine of the angle | 23 31 30 | 9962, 3153 |
| is to the *Radius* | 90 0 0 | 10000, 0000 |
| So the Tangent of the side | 27 53 43 | 9723, 7547 |
| to the tangent of the base | 30 0 0 | 9761, 4394 |

## 14 *To finde an Angle by knowing both the sides.*

As in the rectangle A C B, hauing A C 27 *gr.* 53 *m.* 43 *s.* and B C 11 *gr.* 30 *m.* 43 *s.* to finde the angle A B C.

| | | |
|---|---|---|
| As the sine of the next side | 11 30 43 | 9300, 1052 |
| is to the *Radius* | 90 0 0 | 10000, 0000 |
| So the tangent of the opposite side | 27 53 43 | 9723, 7547 |
| to the tangent of the angle | 69 20 35 | 10423, 6495 |

## 15 *To find an angle by knowing the Base, and the side next the angle required.*

As in the rectangle B C D, hauing B D 18 *gr.* 41 *m.* 56 *s.* and B C 11 *gr.* 30 *m.* 43 *s.* to finde the angle B D C.

| | | |
|---|---|---|
| As the tangent of the Base | 18 41 56 | 9529, 5063 |
| to the tangent of the side | 11 30 43 | 9308, 9311 |
| So, is the *Radius* | 90 0 0 | 10000, 0000 |
| to the cosine of the angle | 53 0 46 | 9779, 4248 |

## 16 *To finde an angle by knowing the Base and the other oblique angle.*

As in the rectangle A C B, hauing the Base A B 30 *gr.* and B A C 23 *gr.* 31 *m.* 30 *s.* to find the angle B A C.

| | | |
|---|---|---|
| As the cosine of the Base | 30 0 0 | 9937, 0000 |
| is to the *Radius* | 90 0 0 | 10000, 0000 |
| So the cotangent of the angle giuen | 23 31 30 | 1036, 1801 |
| to the tangent of the angle required | 69 20 35 | 10423, 6495 |

These 16 cases are all that can fall out in a Rectangle triangle those which follow doe hold.

In

# In any Sphæricall Triangle whatſoeuer.

**17.** *To finde a ſide oppoſite to an angle giuen by knowing one ſide and two angles, the one, oppoſite to the ſide giuen, the other, to the ſide required.*

As in the triangle A B D, hauing A B 30 *gr.* B D C 38 *gr.* 30 *m.* and B A D 23 *gr.* 31 *m.* 30 *ſ.* to find the ſide B D, which here repreſenteth the amplitude.

| | | | | |
|---|---|---|---|---|
| As the ſine of the next angle | 38 | 30 | 0 | 9794,1495 |
| to the ſine of his oppoſite ſide | 30 | 0 | 0 | 9698,9700 |
| | | | | 95,1795 |
| So the ſine of the oppoſite angle | 23 | 31 | 30 | 9601,1352 |
| to the ſine of the ſide required | 18 | 41 | 56 | 9505,9557 |

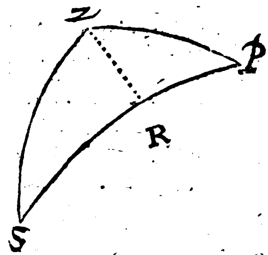
Or changing the ſite of the two middle termes.

| | | | | |
|---|---|---|---|---|
| As the ſine of the next Angle | 38 | 30 | 0 | 9794.1495 |
| to the ſine of the oppoſite Angle | 23 | 31 | 30 | 9601,1352 |
| | | | | 193,0143 |
| So the ſine of the ſide giuen | 30 | 0 | 0 | 9698,9700 |
| to the ſine of the ſide required | 18 | 41 | 56 | 9505,9557 |

And ſo writing this difference 193, 0143 in a paper by it ſelfe and holding it to the ſine of the ſide in the Canon. 1, *gr.* 2, 3, 4, 5 and ſo forward, it would bee no long worke to ſubtract and write the remainder in a columne by it ſelfe, and ſo find the amplitude for each degree & minute of the Eclip-tique.

Or, in steed of subtracting this difference, we might first take the same out of the *Radius*, and then adde the complement as I shewed before, in the generall explication of the Rule of Three.

## 18. *To finde an Angle opposite to a side giuen by knowing one angle and two sides, the one opposite to the angle giuen, the other to the angle required.*




As in the triangle Z P S representing the Zenith, Pole, and Sun: where *Z* P is the complement of the Latitude, P S, the complement of the declination, Z S the complement of the Sunnes altitude, P Z S, the Azimuth; Z P S; the houre of the day from the Meridian and P S Z the angle of the Suns Position in regard of the Pole and Zenith; hauing P *Z* S, 130 *gr.* 3 *m.* 11 *s.* P S 70 *gr.* and Z S 40 *gr.* to finde the angle. *Z* P S.

| | | |
|---|---|---|
| As the sine of the next side | 70 0 0 | 9972, 9858 |
| is to the sine of his opposite angle | 130 3 11 | 9883, 9153 |
| | | 89, 0705 |
| So the sine of the opposite side | 40 0 0 | 9808, 0675 |
| to the sine of the angle required | 31 34 26 | 9718, 9970 |

## 19 *To find an Angle by knowing the three siddes.*

As in the triangle *Z* P S, hauing *Z P* 38 *gr.* 30 *m.* *P S* 70 *gr.* and *Z S* 40 *gr.* to finde the angle *Z P S*, subtending the Base *Z S*,

As

As the Rectangle contained vnder the sines of the sides is to the square of the *Radius*:
*S*o the Rectangle contained vnder the sines of the halfe-summe of the three sides, and the difference betweene this halfe-summe and the Base,
to the *S*quare of the cosine of halfe the angle required.

| | | |
|---|---|---|
| The Base subtended is | 40 *Gr.* | 0 *Mi.* |
| The two sides including the Angle | { 38. | 30 |
| | 70. | 0 |
| The summe of the 3 sides | 148. | 30 |
| The halfe-summe of these 3. | 74. | 15 |
| The diff. between this & the Base | 34. | 15 |

Here for the *S*quare of the *Radius* we take 20000. 0000 to this we adde 9983. 3805 the sine of 74 *gr.* 15 *m.* and 9750. 3579. the sine of 34 *gr.* 15 *m.* which make 39733. 7384.

Then for the *Rectangle* of the sides we adde 9794. 1495 the sine of 38 *gr.* 30 *m.* and 9972. 9858, the sine of 70 *gr.* which make 19767.1353. This we take out of 39733.7384 and there remaines for the Logarithme of the square 19966. 6031, the halfe thereof 9983. 3015 we finde to be the cosine of 15. 47′. 13″. And so, the whole Angle required is 31. 34′. 26″.

Or for such numbers as are to be subtracted, we may take them out of the *Radius*, and write downe their Complements, and then adde them together with the rest, the manner of the worke in either way will be such as followeth.

40 *gr.*

| | | | |
|---|---|---|---|
| 40 gr. 0 | | | |
| 38. 30 | 9794.1495 | | 205.8505 |
| 70. 0 | 9972.9858 | | 27.0142 |
| 148. 30 | 19767.1353 | | |
| 74. 15 | 9983.3805 | | 9983.3805 |
| 34. 15 | 9750.3579 | | 9750.3579 |
| | 20000.0000 | | |
| | 39733.7384 | | |
| | 19966.6031 | | 19966.6031 |
| | 9983.3015 | 15.47'.13". | 09983.3015 |
| | | 31.34.26. | |

In the like manner we may finde the angle *PZS* to be 130 *gr.* 3 *min.* 11 *seconds*, and the angle *ZSP* 30 *gr.* 28 *min.* 11 *seconds*.

## 20 *To finde a SIDE by knowing the three Angles.*

If for either of the Angles next the side required, we take the complement to 180 *gr.* these angles will be turned into sides, and the sides into angles. Then may the worke bee the same, as in the former Proposition.

As in the triangle *ZPS*, knowing the angle *ZPS* to be 31.34'.26". *PZS* 130. 3'.11". and *ZSP* 30. 28'.11". if it were required to finde the side *ZS* opposite to the angle *ZPS*, I would take 130 3' 11" out of 180 *gr.* the remainder will be 49 56 49

Then, as if I had a triangle of 3 knowne sides, one of 31 34' 26", another of 30 28' 11" and the third of 49 56' 49" I would seeke the angle opposite to the first of these sides, by the last Proposition.

So

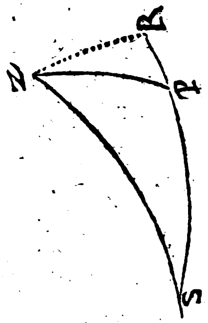
So the angle which is thus found would be the side which is here required.

| | | |
|---|---|---|
| Thus here the Angle oppo. is | 31 34′ 26″ | |
| the lesser of the next Angles | 30 28 11 | 9705.0790 |
| the complement of the other | 49 56 49 | 9883.9153 |
| the summe of these three | 111 59 26 | |
| the halfe summe | 55 59 43 | 9918,5490 |
| the differ, from the opp.ang'e | 24 25 17 | 9616.4170 |
| the summe of double the *Radius* and | | 20000.0000 |
| the sines of halfe summe and difference is | | 39534.9660 |
| Take hence the sines of the next angles | | 19588.9943 |
| there remaines for the square | | 19945.9717 |
| The halfe whereof is the cosine | | 9972.9858 |
| of 20 *gr.* 0′ and so the side required, | 40 *gr*, 0 *m*. | |

The other sides may be found in the same sort; but when we know either three sides and one angle, or three angles and one side, the rest may be found more readily by the 17 or 18 Proposition.

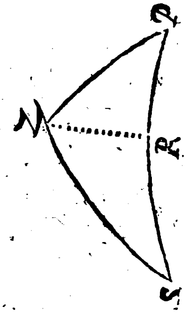
## 21 *To finde a SIDE by hauing the other two sides and the Angle comprehended.*

This and the Proportion following are best resolved by reducing the oblique-angle triangles given into two Rectangles.



As in the Triangle Z P S, hauing Z P 38 *gr.* 30'. P S 70. 0' and Z P S 31. 34' 26'' to finde the side Z S.

In that we haue Z P and Z P S, we may suppose a Perpendicular Z R to be let downe from the angle at Z vpon the greater side P S: So if Z P S the angle giuen be lesse then 90 *gr.* it will fall within the triangle; if more then 90 *gr.* it will fall without the triangle, vpon the side produced, and diuide the triangle giuen into two Rect-angles Z R S and Z R P. Wherein



1 We may finde the quantity of this Perpendicular by the first Proposition of Sphæricall Triangles.

2 Wee may finde the side P R either by the second or tenth, or rather by the eleuenth Proposition: which side P R will giue the side R S.

3 Hauing Z R and R S, wee may find the base Z S by the fourth Proposition, as I shew in the vse of the Sector, *page* 86.

But here for variety, I will shew how the same may bee done of two opperations, both in this and the rest of the cases following, without knowing the quantity of the Perpendicular.

| | | |
|---|---|---|
| 1 As the *Radius* or sine of Z R P | 90. 0' 0'' | 10000.0000 |
| to the cosine of the ang. Z P R | 31. 34 26 | 9930.4223 |
| So the Tangent of the side Z P | 38. 30 0 | 9900.6052 |
| to the tangent of the arke P R | 34. 7 30 | 19831.0275 |

| | | |
|---|---|---|
| 2 As the cosine of P R | 34. 7 30 | 9917,9342 |

to

| | | | |
|---|---|---|---|
| to the cosine of | Z P | 38. 30 0 | 9893. 5443 |
| | | | 24. 3899 |
| So the cosine of | R S | 35. 52 30 | 9908. 6438 |
| to the cosine of | Z S | 40. 0 0 | 9884. 2539 |

## 22 *To finde a* SIDE *by knowing the other two sides and one angle next the side required.*

As in the triangle Z P S hauing Z P, 38. 30′ and Z S 40 *gr.* 0′ and Z P S, 31. 34′ 26″ to find the side P S.

1 Find the arke P R by the 11 Proposition as before.

| | | | |
|---|---|---|---|
| 2 As the cosine of | P Z | 38. 30′ 0″ | 9893. 5443 |
| to the cosine of | P *R* | 34. 7 30 | 9917. 9342 |
| | | | 24. 3899 |
| So the cosine of | Z *S* | 40. 0 0 | 9884. 2539 |
| to the cosine of | *S R* | 35. 52 30 | 9908. 6438 |

## 23 *To finde a* SIDE *by knowing one side and the two Angles next the Side required.*

As in the triangle Z P *S* having *Z P* 38 30 *m.* Z *P S*, 31 34 *m.* 26 *se.* and *Z P S* 30. 28 *m.* 11 *se.* to finde the side P *S*.

1 Finde the arke *P R* as before.

| | | | |
|---|---|---|---|
| 2 As the tangent of | *Z S P* | 30. 28 11 | 9769. 6236 |
| to the tangent of | Z *R S* | 31. 34 26 | 9788. 5746 |
| | | | 18. 9510 |
| So the sine of | P *R* | 34. 7 30 | 9748. 9617 |
| to the sine of | *S R* | 35. 52 30 | 9767. 9127 |

## 24 *To finde a Side by knowing two angles, and the Side inclosed by them.*

As in the triangle ZPS hauing ZP 38 30 *m.* ZPS 31 34 *m.* 26 *se.* and PZS 130 3 *m.* 11 *sec.* to find the side ZS

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | As the cosine of | PZ | 38 | 30′ | 0″ | 9893.5443 |
| | is to the *Radius* | | 90 | 0 | 0 | 10000.0000 |
| | So the cotangent of | ZPS | 31 | 34 | 26 | 10211,4253 |
| | to the tangent of | PZR | 64 | 18 | 50 | 10317.8810 |
| 2 | As the cosine of | SZR | 65 | 44 | 22 | 9613,7228 |
| | to the cosine of | PZR | 64 | 18 | 50 | 9636,9311 |
| | | | | | | 23,2083 |
| | So the tangent of | PZ | 38 | 30 | 0 | 9900,6052 |
| | to the tangent of | ZS | 40 | 0 | 0 | 9923,8135 |

## 25 *To finde an angle by knovving the other tvvo Angles and the side inclosed by them.*

As in the triangle ZPS hauing ZP 38 30 *m.* ZPS 31 34 *m.* 26 *se.* and PZS 130 3 *m.* 11 *se.* to finde the angle ZSP.

1 Finde the angle PZR by the 16 Proposition at before.

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | As the sine of | PZR | 64. | 18 | 50 | 9954.8122 |
| | to the sine of | SZR | 65. | 44 | 21 | 9959.8453 |
| | | | | | | 5.0331 |
| | So the cosine of | ZPS | 31. | 34 | 26 | 9930.4223 |
| | to the cosine of | ZSP | 30. | 28 | 11 | 9935.4554 |

26 *To*

## 26 *To finde an angle by knowing the other two Angles and one side next the angle required.*

As in the triangle Z *P* S, hauing *Z* P 38. 30 *m.* Z P S, 31 *gr.* 34 *m.* 26 *se.* and Z S *P* 30. 28 *m.* 11 *se.* to finde the angle P Z S.

1 Finde the angle *P Z* R as before.

| | | | | | |
|---|---|---|---|---|---|
| 2 As the cosine of | *Z P* S | 31. | 34 | 26 | 9930.4223 |
| to the cosine of | Z S *P* | 30. | 28 | 11 | 9935.4554 |
| | | | | | 5.0331 |
| So the sine of | *P* Z R | 64. | 18 | 50 | 9954.8122 |
| to the sine of | S Z R | 65. | 44 | 21 | 9959.8453 |

## 27 *To finde an Angle by knowing two sides and the angle contained by them.*

As in the triangle Z *P* S, hauing *Z P* 38. 30 *m.* *P* S 70 *gr.* and Z *P* S, 31. 34 *m.* 26 *se.* to finde the angle Z S P.

1 Finde the arke *P R* as before.

| | | | | | |
|---|---|---|---|---|---|
| 2 As the sine of | S R | 35. | 52' | 30" | 9767.9127 |
| to the sine of | *P* R | 34. | 7 | 30 | 9748.9617 |
| | | | | | 18.9510 |
| So the tangent of | *Z P* S | 31. | 34 | 26 | 9788.5746 |
| to the tangent of | Z S *P* | 30. | 28 | 11 | 9769.6236 |

## 28 *To finde an angle by knowving the tvvo next sides, and one of the other angles.*

As in the triangle Z P S hauing Z P 38. 30 *m.* Z S 40 *gr.* and Z P S 31. 34 *m.* 26 *se.* to finde the angle P Z S.

1 Finde the angle P Z R, as before.

| | | | | | |
|---|---|---|---|---|---|
| 2 | As the tangent of | Z S | 40 0 0 | | 9923.8135 |
| | to the tangent of | Z P | 38. 30 0 | | 9900.6052 |
| | | | | | 23.2083 |
| | So the cosine of | P Z R | 64. 18 50 | | 9636.9311 |
| | to the cosine of | S Z R | 65. 44 21 | | 9613.7228 |

These 28 Cases are those which I set downe in the vse of the *Sector*, and all that are commonly required in a sphæricall triangle. I will here adde two more, to shew how that which is found before, by the 22. 23. 26 and 28. Propositions may sometimes be found more easily. *viz.*

## 29 *To finde a Side by knowving the other tvvo Sides and their opposite angles.*

As in the triangle Z P S, hauing P S 70 *gr.* and P Z S 130 3 *m.* 11 *se.* together with Z S 40 *gr.* and Z P S 31. 34 *m.* 26 *s.* to finde the third side Z P.

As the sine of halfe the difference of the angles giuen,
to the sine of halfe the summe of those angles:
So the tangent of halfe the difference of the sides giuen,
to the tangent of halfe the side required.

30 *To finde an Angle by knowing the other two angles, and their opposite sides.*

As in the triangle ZPS, hauing the former parts PS, PZS, ZS and ZPS, to finde the third angle ZSP.

As the sine of halfe the difference of the sides giuen,
to the sine of halfe the summe of those sides;
So the tangent of halfe the difference of the angles giuen,
to the cotangent of halfe the angle required.

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# CHAP. III.

Concerning the ioynt vse of the Lines of Numbers, Sines and tangents, I shewed how they might serue for the resolution of right lined Triangles, whereof I set downe fiue propositions, *page* 24. And these also may be applyed to the Table and Canon of Logarithmes.

The sides of these triangles are measured by absolute numbers, and so represented by Logarithmes.

The angles are measured by degrees and minutes, and so to be found by sines and tangents in the Canon.

PROP.

# PROP. I.

## *Hauine three Angles, and one side to finde the other two* SIDES.

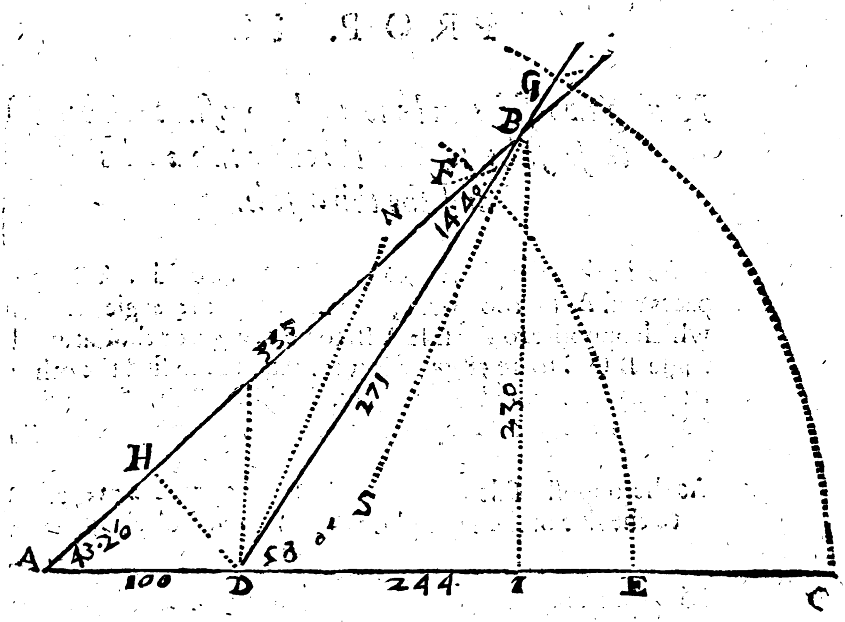
If it be a rectangle triangle, wherein one side about the right angle being knowne, it were required onely to finde the other, this might bee readily done by Sines and Tangents. As in the rectangle A I B, knowing the angle B A I to be 43. 20. and the side A I to be 244, if it were required to finde the other side A I.

| | | | | |
|---|---|---|---|---|
| As the *Radius* (the tangent of) | | 45 *gr.* | 0 *m.* | 10000. 0000 |
| is to the tangent of the angle | | 43 | 20 | 9974. 7195 |
| So is the side ginen | A I | 244. | 000 | 2387. 3898 |
| to the side required | B I | 230. | 202 | 12362. 1093 |

But where both the other sides are required, it is best done by Logarithmes and Sines. As in the same rectangle A I B, hauing the 3 angles and the side A I, to finde both B I and A B.

| | | | | |
|---|---|---|---|---|
| As the sine of the opposite angle | A B I | 46. | 40 | 9861,7575 |
| is to the side giuen | A I | 244. | 000 | 2387. 3898 |
| | | | | 7474. 3677 |
| So the sine of the second angle | B A I | 43. | 20' | 9836. 4770 |
| to his opposite side | B I | 230. | 202 | 2362. 1093 |
| As the sine of the third angle | A I B | 90. | 0 | 10000. 0000 |
| to his opposite side | A B | 335. | 453 | 2525. 6323 |

The




The like holdeth also in obliqu-angled triangles.

As in the Triangle A B D (which I proposed page 13. as an example for the finding of distances) where knowing the distance between A and D, to be 100 paces; the angle BAC to be 43. 20 *m.* the angle B D A 122, or the outward angle B D C, 58 *gr.* and consequently the angle A B D opposite to A D the side giuen to be 14. 40 *m.* it was required to find the distances A B and D B.

| | | *Gr.* | *M.* | |
|---|---|---|---|---|
| As the sine of the opposite angle | A B D | 14 | 40 | 9403.4554 |
| is to the side giuen | A D | 100. | 000 | 2000.0000 |
| | | | | 7403.4554 |
| So the sine of the second angle | A D B | 58. | 0′ | 9928.4204 |
| to his opposite side | A B | 334. | 937 | 2524.9650 |
| And the sine of the third angle | D A B | 43. | 20′ | 9836.4770 |
| to his opposite side | D B | 271. | 032 | 2433.0216 |

## PROP. II.

### *Hauing two sides and one angle opposite to either of those sides to find the other two angles and the third side.*

As in the triangle A B D, hauing the two sides A B 335 paces and A D 100 paces, and knowing the angle A D B which opposite to the side A B, to be 122 *gr.* or the outward angle B D C to be 58 *gr.* if it were required to find the other two angles at A and B, and the third side B D. I may first find an angle A B D opposite to the other knowne side A D.

| | | | |
|---|---|---|---|
| As the opposite side | A B | 335 $\frac{000}{}$ | 2525, 0448 |
| to the sine of the angle giuen | A D B | 58. 0′ | 9928, 4204 |
| | | | 7403, 3756 |
| So is the next side | A D | 100 $\frac{000}{}$ | 2000, 0000 |
| to the sine of his opp. angle | A B D | 14. 59 $\frac{5}{6}$ | 9403, 3756 |

Then knowing these two angles at D and B, I take the inward angle ABD 14 59′ 50″ *s.* out of the outward angle BDC 58 0′ and so find the thrid angle B A D, to bee 43 20′ 10 *s.* So hauing three angles, and 2 sides I may well find the third side B D by the former Proportion.

| | | | |
|---|---|---|---|
| As the sine of the first angle | A D B | 58 *gr.* 0 *m.* | 9928, 4204 |
| is to his opposite side | A B | 335 $\frac{000}{}$ | 2525, 0448 |
| | | | 7403, 3756 |
| So the sine of the last angle | D A B | 43. 20 $\frac{1}{6}$ | 9836, 5033 |
| to his opposite side | D B | 271 $\frac{850}{}$ | 2433, 1277 |

PROP.

# PROP. III.

## *Hauing two sides and the angle betweene them to finde the other two angles and the third side.*

If the angle conteined betweene the two sides giuen bee a right angle, the other two angles will be found readily by tangents and Logarithmes. As in the rectangle A I B hauing the side A I 244 and the side I B to find the angles at A and B.

| | | | |
|---|---|---|---|
| As the greater side | A I | 244 | 2387,3898 |
| is to the lesser side | I B | 230 | 2361,7278 |
| So the *Radius* the tangent of | | 45 gr. 0' | 10000,0000 |
| to the tangent of the lesser angle | | 43 18½ | 9974,3380 |

But if it be an oblique angle that is conteined betweene the two sides giuen, the triangle may be reduced into two rectangle triangles, and then resolued as before.

As, in the triangle A D B, hauing the sides A B 335 A D, 100 and the angle B A D 43 20', to finde the angles at B and D, and the third side B D. First, I would suppose a perpendicular D H to bee let downe from D, the end of the lesser side, vpon the greater side A B; so shall I haue two rectangle triangles D H A and D H B. And in the rectangle A H D, the angle at *A* being 43 20' the other angle *A D H* will be 46. 40' by complement and with these angles and the side *A D*, I may find both *A H* and *D H* by the first proportion. Then taking *A H* out of *A B*, there remaines *H B* for the side of the Rectangle *D H B*, and therefore with this side *H B* and the other side *D H*, I may finde the angle at *B*, by the former part of this proportion. And with this angle and the perpendicular *D H*, I may finde the third side *D B*, by the first proposition.

Or hauing two sides and the angle betweene them, wee may finde the other two angles without letting downe any perpendicular, in this manner.

As the summe of the two sides giuen
is to the difference of these sides
So the tangent of halfe the sum of the two opposite angles to the tangent of halfe the difference betweene those angles.

| | | | |
|---|---|---|---|
| So here hauing the side | *AB* | 335 | |
| and the other side | *AD* | 100 | |
| the summe of these sides is | | 435 | 2638,4892 |
| and the difference of these sides | | 235 | 2371,9678 |
| The angle conteined *BAD* is | | 43 20' | 267,4214 |
| the summe of the two opposite angles | | 136 40' | |
| the halfe summe of these angles | | 68 20 | 10400,9092 |
| and by proportion and halfe difference | | 53 40$\frac{1}{5}$ | 10133,4878 |

This halfe sum & halfe differẽce mak 122 0$\frac{1}{5}$ the greater angle
and the difference betweene them 14 19$\frac{4}{5}$ the lesser angle

## PROP. IV.

### *Hauing three sides, to finde the three angles.*

Let one of the three sides giuen be the Base, (but rather the greater side) that the perpendicular may fall within the triangle. Then gather the summe and the difference of the two sides, and the proportion will hold.

As the Base of the Triangle
to the summe of the sides.
So the difference of the sides
to the alternate Base. This alternate Base being taken forth of the true base, if wee let downe a perpendicular from the opposite angle, it shall fall vpon the middle of the remainder. As in the triangle ADB.

The

| | | | |
|---|---|---|---|
| The lesser side is | *A D* | 100 | |
| The other side | *B D* | 271 | |
| The Base of the triangle | *A B* | 335 | 2525,0448 |
| The summe of the sides | | 371 | 2569,3739 |
| | | | 44,3291 |
| The difference betweene these sides | | 171 | 2232,9961 |
| and so the alternate Base is | | 189 $\frac{376}{}$ | 2277,3252 |
| This taken out of 335 leaues | | 145 $\frac{624}{}$ | |

the halfe whereof is—— 72 812. And such is the segment *A H*, the distance betweene the angle at *A* and the perpendicular *D H*. So that hauing drawne this perpendicular, wee haue two rectangle triangles *D H A* and *D H B* in which hauing two sides and the right angle, wee may find the other angles by the second proposition.

These foure propositions may suffice for the resolution of the sides and angles in all right lined Triangles.

## PRPOP. V.

*Hauing the Base and Perpendicular in a right-lined Triangle, to finde the superficiall content.*

The perpendicular may bee found, by one or other of the former proposition S, and that being known we may find the superficiall content. As in the Triangle A D B, hauing the Base A B 335, and the perpendicular D H 68.545.

| | | |
|---|---|---|
| As the number of | 2 | 0301,0700 |
| to the perpendicular | 68. 545 | 1835,9757 |
| | | 1534,9457 |
| So the Base | 335 | 2525,0448 |
| to the content | 11 481 $\frac{221}{}$ | 4059,9905 |

 Or,

Or, if we would find the content without knowing the perpendicular, we may put two or more operations into one, as in the proportion following.

## PROP. VI.

### *Hauing two sides of a right-lined Triangle, and the angle betweene them, to find the content.*

Adde the sine of the Angle, and the Logarithmes of both the sides, from the summe of these subtract —— 10301,0300 so the Remainder shall be the Logarithme of the content.

As, in the triangle A D B, hauing the sides A B 335, A D 100, and the angle B A D 43 *gr.* 20 *m.*

| | |
|---|---|
| The sine of the angle 43 *gr.* 20 *m.* is | 9836,4770 |
| the Logarithme of the side A B 335 | 2525,0448 |
| the Logarithme of the side A D 100 | 2000,0000 |
| The summe of these make | 14361,5218 |
| from which subtract the solemne Logarithme | 10301,0300 |
| the Remainder will be | 4060,4918 |

the Logarithme of 11494 the content required.

## PROP. VII.

### *Hauing three Angles, and one side of a right-lined Triangle, to finde the content.*

Adde the double of the Logarithme of the side giuen, and the sines of the two next angles; from the summe of these subtract the summe of 10301,0300, and the sine of the opposite angle, so the Remainder shall bee the Logarithme of the content.

As

As in the Triangle A D B supposing the angles B A C to be 34 D. 20 *m.* B D A 122. D. 0 *m.* A B D 14 *gr.* 40 *m*; and the side A D to be 100 parts.

| | | |
|---|---|---|
| The Logarithme of the side A C | 100 is | 2000, 0000 |
| the same againe | | 2000, 0000 |
| The sine of the angle B A C | 43 *gr.* 20 | 9836, 4770 |
| The sine of the angle B D A | 58 0 | 9928, 4204 |
| The summe of these foure make | | 23764, 8974 |
| Againe if we adde the solemne Logarithme | | 10301, 0300 |
| to the sine of the opposite angle | 14 *gr.* 40 | 9403, 4554 |
| The summe of both will make | | 19704, 4854 |
| Which subtracted from 23764. 8974 leave | | 4060, 4120 |

the Logarithme of 11492 the content required.

# PROP. VIII.

## *Hauing the third sides of a right-lined triangle, to finde the content.*

First set downe the three sides, the summe of them, and the halfe summe. Then from this halfe-summe subtract each side seuerally, and note the differences. That done, adde the Logarithmes of the halfe-summe, and these differences; the halfe thereof shall be the Logarithme of the content.

Thus in the triangle A D B, the three sides are { *A B.* 335, *D B.* 271, *A D.* 100 }

| | | |
|---|---|---|
| the summe of these sides is | 706 | |
| the halfe summe | 353 | 2547, 7747 |
| the difference from A B | 18 | 1255, 2725 |
| the difference from D B | 82 | 1913, 8138 |
| the difference from A D | 253 | 2403, 1205 |
| The summe of their Logarithmes | | 8119, 9815 |
| and the halfe thereof is | | 4059, 9907 |

the Logarithme of 11482 [illegible] the content required.

PROP.

## PROP. IX.

### Hauing the three sides of a right-lined triangle, to finde the Perpendicular.

As, in the former triangle A D B, to finde the perpendicular D H. First, find the content of the Triangle by the former proportion, then may the perpendicular bee found by the conuerse of the V. Proposition.

| | | |
|---|---|---|
| As the Base of the triangle | 335 | 2525,0448 |
| to the superficiall content. | 11481 $\frac{12}{}$ | 4059,9907 |
| | | 1534,9459 |
| So alwayes the number of | 2 | 0301,0300 |
| to the perpendicular. | 68 $\frac{545}{}$ | 1835,9759 |

## PROP. X.

### Hauing the Semidiameter of a Circle to finde the Chord for any Arke proposed.

As if in protracting the former triangle A D B it were required to find length of a Chord of 43 *gr.* 20 *m.* agreeing to the Semidiameter A E, which wee suppose to be 3 inches. This might be done by the first proportion for, if the chord were drawne from E to F we should haue a triangle E A F of three angles and two sides knowne. But, more generally comparing the sine of 30 *gr.* with the sine of halfe, the arke proposed, the proportion will hold.

| | | |
|---|---|---|
| As the sine of the *Semiradius* | 30 *gr.* 0 *m.* | 9698,9700 |
| to the Semidiameter | 3 $\frac{000}{}$ | 0477,1212 |
| | | 9221,8488 |
| So the sine of halfe the arke | 21 *gr.* 40 *m.* | 9567,2689 |
| to the Chord required. | 2 $\frac{215}{}$ | 0345,4201 |

So

So that hauing drawne the line A E, and described an occult arke of a Circle vpon the center A, and semidiameter A E at the distance of three inches, if we take out two inches, and 215 parts of 1000, and inscribe them into that arke from E to F, the line A F shall make the angle F A E to be 43 20 *m.* as was required.

Thus hauing applyed that to the Canon and table of Logarithmes which I had set downe before for the generall vse of the lines of numbers, sines, and tangent, it may appeare sufficiently, that, if we obserue the rules of proportion set forth by others, and worke by these Tables; we may vse addition insteed of their multiplication, and subtraction insteed of their diuision, and so apply these generall rules to infinite particulars.

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# CHAP. IV.

## *Containing some vse of right-lined triangles, in the practise of Fortification.*

IN the late manner of Fortification the ordinary care is.

1 That the angle of the Bulwarke may be either a right angle, or neere vnto it.

2 That this angle may be defended from the flanque and cortin on either side.

3 That the lines of defense may not exceed the reach of a musket, which is said to bee xij. score yards and those make 720 foot.

4 That the depth of the flanques and bredth of the rampart be sufficient to resist a battery; and that may be about 100 foot at the ground.

Vpon these considerations depend the rest of lines and angles: whereof I will set downe some Propositions, beginning with that which may resolue the works of others.

## PROP. I.

*Hauing the side of a Regular Fort, with the length of the Gorge, the Flanque and the Face of the Bulwarke, to find the rest of the lines and angles.*

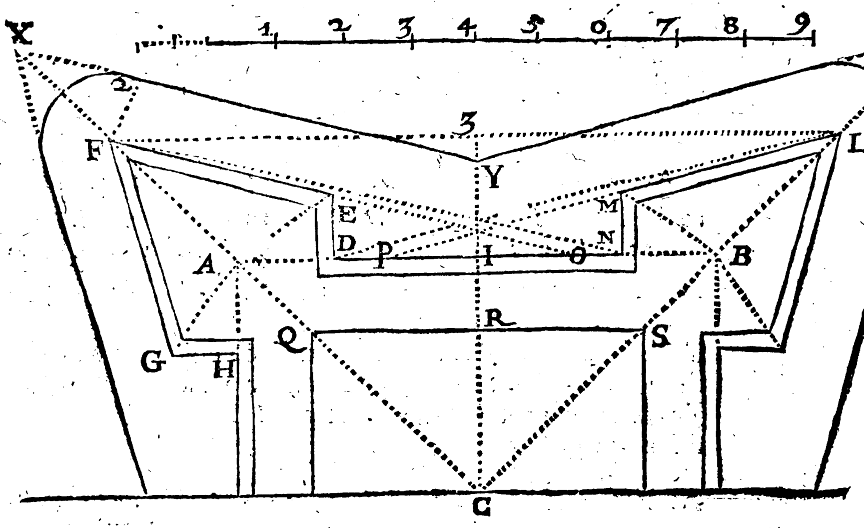
A regular Fort is that, which is made with equall sides and angles, each Bulwarke like vnto other.

Suppose that, by obseruation or otherwise we haue found, that in a square fort, the side was 700 foot, the Gorge 140, the Flanque 100, and the Face 335: In a Pentagonall, hexagonall, heptagonall, as in this table.

| | | Quadr | Pentag | Hexag | Heptag | Octag. |
|---|---|---|---|---|---|---|
| *The side* | AB | 700 | 800 | 900 | 950 | 1000 |
| *The gorge* | AD | 140 | 180 | 190 | 200 | 230 |
| *The flanque* | DE | 100 | 120 | 140 | 150 | 140 |
| *The face* | EF | 335 | 352 | 370 | 360 | 420 |

And that it were required to find the rest of the lines, and the quantity of the angles belonging to each Fort, beginning with the quadrate.

First,




First we may protract this Fort, by making a square whose side A B shall bee 700 foot by the scale: then take but 140 for the gorge, and set them of from A vnto D, and from A vnto H. At D and H raise 2, flanques perpendicular to the sides of the fort and there pricke downe 100 from D vnto E, and and from H vnto G. That done, take 335 out of the same scale, and setting one foot of the compasses in the point E, make an occult arke of a circle. Againe, setting one foote of the compasses in the point G, make another occult arke, crossing the former in the point F; So the lines, E F, F G shall represent the face of the Bulwarke.

In like manner, for the Bulwarke at B, wee may set of the gorge from B vnto N, &c. So haue wee diuerse triangles, which may be resolued by the first 3. Propositions of right-lined triangles. And the manner of it shall be so set downe, as that the Precept may be easily distinguished from the example, and applied to any other, not onely by this canon and table of Logarithmes, but by the old Canon of sines and tan-

 gents,

gents, and by the lines of sines and tangents both vpon the Sector and the crosse-staffe.

1 In the Rectangle A D E, hauing the sides A D, A E, we may find the angles at A and E, and the third side A E, by the former part of the third Proportion of Right-lined triangles.

| | | | |
|---|---|---|---|
| As the gorge | *A D* | 140 | 2146. 1280 |
| to the Flanque | *D E* | 100 | 2000. 0000 |
| So the *Radius* | | 90.0'.0" | 10000. 0000 |
| to the the tangent of | *D A E* | 35. 32 ¼ | 9853. 8720 |

Take the angle *D A E* out of 90 *gr.* the complement will giue the angle *D E A*: and then, hauing two sides and three angles, we may well find the third side *A E* by the first Proposition of right-lined triangles

| | | | |
|---|---|---|---|
| As the sine of | *D A E* | 35. 32 ¼ | 9764. 3542 |
| to the side | *D E* | 100. | 2000. 0000 |
| So the sine of | *A D E* | 90. 0'. 0" | 10000. 0000 |
| to the side | *A E* | 172 $\frac{047}{}$ | 2235. 6458 |

2 Because the fort is supposed to bee square, the angle *H A D*, must be 98 *gr.* and the halfe angle *C A D* 45 *gr.* if wee adde this angle C A D vnto the angle *D A E* and take the summe out of 180 *gr.* the remainder 99. 2 $\frac{13}{74}$ shall be the angle *E A F*. Then in the triangle *E A* F, hauing the angle at *A*, and the two sides F E, A E, wee may finde the other angles at E and F, by the III. Proposition of right-lined triangles.

| | | | |
|---|---|---|---|
| As the face | E F | 335 | 2525. 0448 |
| to the sine of | E A F | 99. 27 ¾ | 9994. 0502 |
| | | | 7469. 0054 |
| So the line | A E | 172 $\frac{047}{}$ | 2235. 6459 |
| to the sine of | A F E | 30. 26 ⅕ | 9704. 6513 |

Adde

Adde this angle A F E to the angle E A F, and take the summe out of 180 *gr.* the Remainder 50. 6.4″ shall be the angle A E F. And then we haue two sides and three angles, to finde the head-line A F.

| | | | |
|---|---|---|---|
| As the sine of | E A F | 99. 27 $\frac{3}{4}$ | 9964.0502 |
| to the face | E F | 335. | 2525.0448 |
| | | | 7469.0054 |
| So the sine of | A E F | 50. 6. $\frac{1}{15}$ | 9884. 8958 |
| to the headline | A F | 260 $\frac{55}{}$ | 2415. 8904 |

3 If we produce the face F E vntill it meet the cortin in O; we shall haue the triangle A F O: wherein, knowing the side A F, and the three angles (for, knowing two angles, the third is alwayes knowne by complement vnto 180 *gr.*) wee may finde the other two sides F O, A O.

| | | | |
|---|---|---|---|
| As the sine of | A O F | 14. 33′. 48″ | 9400. 4548 |
| to the head-line | A F | 260 $\frac{55}{}$ | 2415. 8904 |
| | | | 6984. 5644 |
| So the sine of | F A O | 45. 0′. 0″ | 9849. 4850 |
| to the line | F O | 732 $\frac{60}{}$ | 2864. 9206 |
| and the sine of | A F O | 30. 26. 12″ | 9704. 6513 |
| to the line | A O | 524 $\frac{912}{}$ | 2720. 0869 |

Take the gorge N B 140, out of the side A B 700. there remaines 560 for the line A N. Take this line A O out of A N, and there remaines 35 $\frac{081}{}$ for O N that part of the cortin from whence the face of the Bulwarke may be defended.

4 In the triangle A F N hauing two sides A F, A N, and the angle betweene them F A N, we may finde the other two angles at F and N, by the later part of the third Proposition of right-lined triangles.

| | | |
|---|---|---|
| As the summe of the sides *A* F, *A* N. | $810^{\underline{55}}$ | 2914.1050 |
| is to the difference of those sides | $299^{\underline{45}}$ | 2476.3245 |
| So the tangent of the halfe summe of the | | 437.7805 |
| opposite angles at F and N. | 22. 30′ | 9617.6153 |
| to the tangent of halfe the difference between those angles. | 8. 36$\frac{1}{5}$ | 9179.8348 |

This halfe difference added to the halfe sum, giues the greater angle. *A* F N 31. 6$\frac{1}{5}$.
and subtracted, the lesser A N F 13. 53$\frac{4}{5}$.

| | | | |
|---|---|---|---|
| As the sine of *A* N F | | 13. 53. 48′ | 9380.5157 |
| to the headline *A* F | | $260^{\underline{550}}$ | 2415.8904 |
| | | | 6964.6253 |
| So the Sine of | F *A* N | 45. 0. 0 | 9849.4850 |
| to the line of defence F N | | $767^{\underline{113}}$ | 2884.8597 |

5 In the triangle A B C we haue the side A B, and the 3. angles, to finde the side C A or C B, from the center to the angles of the Fort.

| | | | |
|---|---|---|---|
| *As* the sine of | *A* C B | 90. 0. 0 | 10000.0000 |
| to the side | *A* B | 700. | 2845.0980 |
| So the sine of | A B C | 45. 0. 0 | 9849.4850 |
| to the line | *A* C | $494^{\underline{975}}$ | 2694.5830 |

This line *A* C added to the headline *A* F, giues the whole C F, from the center of the Fort to the vttermost point of the Bulwark to be $755^{\underline{525}}$

6 In the triangle C F L (the side F L being parallel to A B the side of the Fort) we haue the three angles and the side C F; by which we may finde F L the distance between the points of the two next Bulwarks.

| | | | |
|---|---|---|---|
| As the sine of | C L F | 45. 0 0 | 9849.4850 |
| to the line | C F | 755. $\underline{525}$ | 2878.2498 |
| So the sine of | F C L | 90. 0 0 | 10000.0000 |
| to the sine | F L | 1068. 464 | 3028.7648 |

Thus

Thus by resoluing of six triangles we haue found

| | | | | |
|---|---|---|---|---|
| The angle at the gorge | D A E | 35. | 32′ | 15″ |
| the angle of the Bulwark | G F E | 60. | 52 | 24 |
| the angle | F E D | 104. | 33 | 48 |
| the angle | A N F | 13. | 53 | 48 |

| | | Foote |
|---|---|---|
| The length of the line | A E | 172. 047 |
| the Headline | A F | 260. 550 |
| the Line on the Cortin | O N | 35. 088 |
| the Line of defence | F N | 767. 113 |
| the semidiameter | C A | 494. 975 |
| the line frō the center to the Bulw. | C F | 755. 525 |
| the distance betweene the Bulw. | F L | 1068. 464 |

the principall Lines and Angles belonging to the Bulwark at A.

The rest of the lines are either parallell vnto these, or else they may be found in the same manner.

And all these may be vnderstood to be the same in the rest of the *Bulwarkes* belonging to this Fort.

Againe, what is said of a square Fort, the same may be applyed to all regular Forts.

And so, resoluing the workes of other men, it may appeare how neere they haue come to the former grounds.

But that wee may not altogether insist vpon examples, I will set downe some profitable suppositions, and from them proceed to finde the rest of the lines and angles belonging to any Regular Fort.

1 The angle at the center A C B, betweene the lines C A, C B, drawne from the Center to each Bulwarke, is found by dividing 360 *gr.* by the number of the sides. *So* in a square Fort, this angle will be *90 gr.* In a Pentagonall Fort, where there are fiue sides, it will be 72 *gr.* &c.

2 Take this angle at the center, out of 180 *gr.* there remaines the angle of the Fort H A D.

3 The

3 The angle *ADE* between the Flanque and the Cortin, may be alway 90 *gr.*

4 The vttermost angle of the Bulwarke EFG, must be lesse then the angle of the Fort, yet not lesse then 60 *gr.* nor doth it need to be much more then 90 *gr.* If we allow it to be $\frac{2}{3}$. of the angle of the Fort, it may be defended from the Flanque and Cortin on either side.

5 The angle at the Gorge DAE, which formes the Flanque DE, may be allowed betweene 35 and 40 *gr.* For in small regular Forts, it may be 40 *gr.* but where the angle of the Fort is great, it may be lesse.

These 5. angles being first settled, the most of the other angles will depend vpon them, as in the Table following.

Or howsoeuer there may bee other angles found to bee more convenient, yet these are sufficient to explane the vse of triangles.

| *In a Regular Fort.* | | Quadr. | | Pentag. | | Hexag. | | Heptag. | | Octag. | | Cortin. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. | Gr. | M. |
| *Angle at the Center* | *ACB* | 90 | 0 | 72 | 0 | 60 | 0 | 51 | 25 | 45 | 0 | 0 | 0 |
| *Angle of the Fort* | *HAD* | 90 | 0 | 108 | 0 | 120 | 0 | 128 | 34 | 135 | 0 | 180 | 0 |
| *Angle of the Flanque* | *ADE* | 90 | 0 | 90 | 0 | 90 | 0 | 90 | 0 | 90 | 0 | 90 | 0 |
| *Angle of the Bulwarke* | *GFE* | 60 | 0 | 72 | 0 | 80 | 0 | 85 | 42 | 90 | 0 | 90 | 0 |
| *Angle of the Gorge* | *DAE* | 40 | 0 | 39 | 0 | 38 | 0 | 37 | 0 | 36 | 0 | 35 | 0 |
| *The halfe of HAD is* | *CAD* | 45 | 0 | 54 | 0 | 60 | 0 | 64 | 17 | 67 | 30 | 90 | 0 |
| *Halfe of GFE is* | *AFE* | 30 | 0 | 36 | 0 | 40 | 0 | 42 | 51 | 45 | 0 | 45 | 0 |
| *Complement of CAD is* | *DAF* | 135 | 0 | 126 | 0 | 120 | 0 | 115 | 43 | 112 | 30 | 90 | 0 |
| *AFE out of CAD leaues* | *AOF* | 15 | 0 | 18 | 0 | 20 | 0 | 21 | 25 | 22 | 30 | 45 | 0 |
| *Complement of AOF is* | *OED* | 75 | 0 | 72 | 0 | 70 | 0 | 68 | 35 | 67 | 30 | 45 | 0 |
| *Complement of OED is* | *DEF* | 105 | 0 | 108 | 0 | 110 | 0 | 111 | 26 | 112 | 30 | 135 | 0 |
| *Complement of DAE is* | *AED* | 50 | 0 | 51 | 0 | 52 | 0 | 53 | 0 | 54 | 0 | 55 | 0 |
| *AED out of DEF leaues* | *AEF* | 55 | 0 | 57 | 0 | 58 | 0 | 58 | 26 | 58 | 30 | 80 | 0 |
| *AEF and AFE giue* | *FAE* | 95 | 0 | 87 | 0 | 82 | 0 | 78 | 43 | 76 | 30 | 55 | 0 |

II. *Hauing*

# PROP. II.

## *Hauing the ordinary angles, with the Flanque and line of Defense, to finde the rest of the lines and angles, in a regular Fort.*

SVppose the angles to be such, as in the former table, the depth of the flanque DE 100. foot, and the line of defense FN 720. foote; and that it were required, to find the rest of the lines and angles belonging to a Pantagonall fort.

1 In the triangle ADE hauing the three angles and the flanque DE, we may find the length of the gorge AD, and the line AE. The angle ADE is alway 90 *gr.* but, the fort being Pentagonall, and with fiue Bulwarkes at the fiue angles, the table giues the angle DAE to bee 39 *gr.* and the angle AED 51 *gr.* wherefore

| | | | |
|---|---|---|---|
| As the sine of | DAE | 39.0′.0″ | 9798.8718 |
| to the flanque | DE | 100 | 2000.0000 |
| | | | 7798.8718 |
| So the sine of | AED | 51.0′.0″ | 9890.5026 |
| to the gorge | AD | 123 $\frac{49}{}$ | 2091.6308 |
| And the whole sine | *ADE* | 90.0.0. | 10000.0000 |
| to the line | *AE* | 158 $\frac{9}{}$ | 2201.1282 |

2 In the triangle AFE, hauing the three angles and the side AE, we may find the face of the Bulwarke FE, and the head-line AF.

| | | | |
|---|---|---|---|
| As the sine of | A F E | 36. 0. 0. | 9769.2186 |
| to the line | A E | $158^{90}$ | 2291.1282 |
| | | | 7568.0904 |
| So the sine of | F A E | 87. 0. 0. | 9999.4044 |
| to the face | F E | $269^{97}$ | 2431.3140 |
| And the sine of | A E F | 57. 0. 0. | 9923.5914 |
| to the head-line | A F | $226^{725}$ | 2355.5010 |

3 In the triangle A F O, hauing the three angles and the side A F, we may find the other two sides F O and A O.

| | | | |
|---|---|---|---|
| As the sine of | A O F | 18. 0. 0. | 9489.9823 |
| to the headline | A F | $226^{72}$ | 2355.5010 |
| | | | 7134.4813 |
| So the sine of | F A O | 126. 0. 0. | 9907.4576 |
| to the line | F O | $593^{57}$ | 2773.4763 |
| And the sine of | A F O | 36. 6. 0. | 9769.2186 |
| to the line | A O | $431^{26}$ | 2634.7373 |

4 In the triangle A F N, hauing the headline A F the line of defense F N, and the angle F A N, wee may find the other two angles at N and F, and the third side A N.

| | | | |
|---|---|---|---|
| As the line of defense | F N | 720. | 2857.3325 |
| to the sine of | F A N | 126.0.0″. | 9907.9576 |
| | | | 7050.6252 |
| So the headline | A F | $226^{72}$ | 2355.5010 |
| to the sine of | A N F | 14. 45. 33. | 9406.1261 |

This angle A N F added to the angle F A N, and the summe of both taken out of 180 *gr.* will giue the third angle A F N.

| | | | |
|---|---|---|---|
| As the sine of | F A N | 126 *gr.* 0. 0. | 9907.9576 |
| to the line of defense | F N | 720. | 2857.3325 |
| | | | 7050.6252 |
| So the sine of | A F N | 39. 14′ 27″ | 9801.1178 |
| to the line | A N | $562^{90}$ | 2750.4927 |

Hauing

Hauing this line A N if we adde the gorge N B, or A D, the summe of both shall be the side of the fort A B.

If wee take the gorge A D, out of this line A N, the remainder shall be the cortin D N.

Againe if we take the line A O, out of this line A N, the remainder shall be O N, that part of the cortin from whence the face of the Bulwarke may be defended. And so here

| | | |
|---|---|---|
| The length of this line | A N being | 562. 98 |
| the gorge | A D | 123. 49 |
| the side of the fort | A B shall be | 686. 47 |
| the cortin | D N | 439. 49 |
| Againe taking the line | A O | 431. 26 |
| from A N, there remaines | O N | 131. 72 |

5 In the triangle A I C, hauing the three angles, and the side A I, the one halfe of A B the side of the fort, wee may find both O I, the semidiameter of the circle inscribed, and C A, the semidiameter of the circle circumscribed about the fort.

| | | | |
|---|---|---|---|
| As the sine of | A C I | 36. 0'. 0''. | 9769.2186 |
| to the line | A I | 343 $\frac{235}{}$ | 2535.5915 |
| | | | 7233.6271 |
| So the sine of | C A I | 54.0.0. | 9907.9576 |
| to the line | C I | 472.4225. | 2674.3305 |
| And the whole sine | C I A | 90.0.0. | 10000.0000 |
| to the line | C A | 583.9466. | 2766.3729 |

This line C A added to the head-line A F, giues the distance C F betweene the center of the fort, and the vttermost point of the Bulwarke.

6 If this fort shall be incompassed with a dith, whose vttermost sides shall bee parallell to the face of the Bulwarke; supposing this ditch to be of a known bredth (and that may be about 100 foot) we haue the triangle F 2 X; wherein, knowing the three angles, & the side F 2, we may find the line FX.

| | | | |
|---|---|---|---|
| As the sine of | F X 2 | 36. 0. 0. | 9769. 2186 |
| to the bredth-line | F 2 | 100. | 2000. 0000 |
| So the whole sine | F 2 X | 90. 0. 0. | 10000. 0000 |
| to the line | F X | $170\frac{13}{}$ | 2230. 7814 |

This line F X added to the line C F, giues the distance C X, betweene the center of the fort, and the vttermost corner of the ditch. And so here,

| | | |
|---|---|---|
| The length of the head-line | A F is | 226. 72 |
| the semidiameter | C A | 583. 95 |
| Both these make the line | C F | 810. 67 |
| Adde vnto this the line | F X | 170. 13 |
| So, C A, A F, F X make | C X | 980. 80 |

7 In the triangle C Y X, hauing the three angles and the side C X, we may finde the two other sides C Y and X Y.

| | | | |
|---|---|---|---|
| As the sine of | C Y X | 108. 0′. 0″. | 9978. 2063 |
| to the line | C X | $980^{80}$ | 2991. 5815 |
| | | | 6986. 6248 |
| So the sine of | C X Y | 36. 0. 0. | 9769. 2186 |
| to the line | C Y | $606\frac{169}{}$ | 2782. 5938 |
| And the sine | X C Y | 36. 0. 0. | 9769. 2186 |
| to the line | X Y | $606\frac{169}{}$ | 2782. 5938 |

Take the line C I, from this line C Y, there remaines I Y, the bredth of the ditch from the middle of the cortin.

8 Then, for the lines F L, X Z, and such other parallels to the side of the fort A B,

| | | | |
|---|---|---|---|
| As the semidiameter | C A | 583. 95 | 2766. 3729 |
| to the side of the fort | A B | 686. 47 | 2836. 6215 |
| | | | 7074. 2486 |
| So the length of | C F | 810. 67 | 2908. 8444 |
| to the distance | F L | 953. 00 | 2979. 0930 |
| And the length of | C X | 980. 80 | 2991. 5815 |
| to the distance | X Z | 1152. 97 | 3061. 8201 |

9 The

9 The Perpendiculars C 3, C 4, and such others, let downe from the center vpon the former parallels may bee found in the same sort;

| | | | |
|---|---|---|---|
| As the semidiameter | C A | 583. 95 | 2766. 3729 |
| to the Perpendicular | C I | 472. 42 | 2674. 3305 |
| | | | 92. 0424 |
| So the length of | C F | 810. 67 | 2908. 8444 |
| to the Perpendicular | C 3 | 655. 84 | 2816. 8020 |
| And the length of | C X | 980. 80 | 2991. 5815 |
| to the Perpendicular | C 4 | 793. 48 | 2899. 5391 |

10 If wee take I R the bredth of the Rampart, out of the Perpendicular C I, supposing the bredth of the Rampart to be 100. foote, there remaines 372. 42 for the Perpendicular C R.

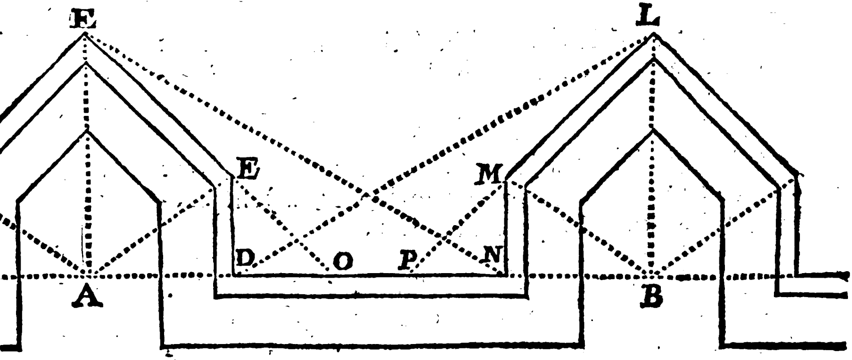
If wee take out I T, the bredth of the Rampart and street adioining (the street being supposed 30. foot broad) there remaines 342. 42 for the Perpendicular C T.

| | | | |
|---|---|---|---|
| As the Perpendicular | C I | 472. 42 | 2674. 3305 |
| to the side of the fort | A B | 686. 47 | 2836. 6215 |
| | | | 162. 2910 |
| So the Perpendicular | C R | 372. 42 | 2571. 0358 |
| to the side of the Rampart | Q S | 541. 16 | 2733. 3268 |
| And the Perpendicular | C T | 342. 42 | 2534. 5622 |
| to the inner side of the street | V W | 497. 57 | 2696. 8532 |

| | | | |
|---|---|---|---|
| As the Perpendicular | C I | 472. 42 | 2674. 3305 |
| to the semidiameter | C A | 583. 95 | 2766. 3729 |
| | | | 92. 0424 |
| So the Perpendicular | C R | 372. 42 | 2571. 0378 |
| to the line | C Q | 460. 34 | 2663. 0802 |
| And the Perpendicular | C T | 342. 42 | 2534. 5622 |
| to the line | C V | 423. 25 | 2626. 6046 |

# PROP. III.

*Hauing the ordinary angles with the line of defense and face of the Bulwarke, to finde the rest of the lines and angles.*




SVppose a long cortin to be fortified with Bulwarkes, the angle of each Bulwarke to bee 90 *gr.* the angle at the gorge forming the flanque 35 *gr.* the rest, as in the former table, the line of defense, 720 foote, and the face of the Bulwarke 300 foote.

1 In the triangle A E F, hauing the three angles and the face F E, wee may finde the headline A F, and the line *A E*.

As

| | | | |
|---|---|---|---|
| As the fine of | F A E | 55. 0. 0. | 9913. 3645 |
| to the face | F E | 300. | 2477. 1212 |
| | | | 7436. 2433 |
| So the fine of | A E F | 80. 0. 0. | 9993. 3514 |
| to the head-line | A F | 360. 668 | 2557. 1081 |
| And the fine of | A F E | 45. 0. 0. | 9849. 4850 |
| to the line | A E | 258. 965 | 2413. 2417 |

2 In the triangle A D E hauing the three angles and the line A E, we may find both the flanque D E, and the gorge A D.

| | | | |
|---|---|---|---|
| As the fine of | A D E | 90. 0. 0. | 10000. 0000 |
| to the line | A E | 258. 96. | 2413. 2417 |
| | | | 7586. 7583 |
| So the fine of | D A E | 35. 0. 0. | 9758. 5913 |
| to the flanque | D E | 148. 53 | 2171. 8330 |
| And the fine of | A E D | 55. 0. 0 | 9913. 3645 |
| to the gorge | A D | 212. 132 | 2326. 6062 |

3 In the triangle F A O, hauing the three angles, and the two equall fides A F, A O, we may finde the length of of F O, the face produced vnto the cortin.

| | | | |
|---|---|---|---|
| As the fine of | A O F | 45. 0. 0" | 9849. 4850 |
| to the headline. | A F | 360. 66 | 2557. 1081 |
| So the whole fine of | F A O | 90. 0. 0 | 10000. 0000 |
| to the face produced | F O | 510. | 2707. 6231 |

4 In the triangle F A N, hauing the headline A F, the line of defenfe F N, and the right angle F A N, wee may finde the other two angles at F and N, and the third fide A N.

As

| | | | |
|---|---|---|---|
| As the line of defence | F N | 720 | 2857, 3325 |
| to the whole sine of | F A N | 90. 0. 0 | 10000.0000 |
| So the head line | A F | 360. 66 | 2557 1081 |
| to the sine of | A N F | 30. 3⅔ | 9699. 7756 |

| | | | |
|---|---|---|---|
| As the sine of | F A N | 90. 0. 0 | 10000.0000 |
| to the line | F N | 720. | 2857. 3325 |
| So the sine of | A F N | 59. 56⅓ | 9937. 2735 |
| to the line | A N | 623. 1697 | 2794. 6060 |

Hauing the line A N, if we adde the Gorge N B, or A D, the summe of both shall be the line A B or F L, the distance betweene both Bulwarks.

If we take the Gorge A D out of this line A N, the remainder shall be the Cortin D N.

Againe, if we take the line A O out of this line A N, the remainder shall be O N, that part of the cortin from whence the face of the Bulwark may be defended.

| | |
|---|---|
| Thus the length of A N being | 623 169 |
| the Gorge N B, or A D | 212. 132 |
| the distance F L or A B shall be | 835. 301 |
| the Cortin D N | 41. 037 |
| Againe taking the line A O | 360. 668 |
| from A N, there remaine O N | 262. 501 |

PROP.

eA

# PROP. IIII.

## *Hauing the Angles of an irregular Fort, with the side betweene them, and the face of the Bulwark, to find the rest of the Lines and Angles.*

Suppose the angles of an old walled Towne were to bee fortified with new Bulwarks. The angles of the Bulwarke to be either ⅔. of the angle at the wall, or (if ⅔. of the angle be more then 90 *gr.*) it may suffice, that they be 90 *gr.* The Flanques perpendicular to the Cortin, to be formed by an angle betweene 35 and 40 *gr.* as shall be found more conuenient. And the face of each Bulwarke to be 300 foot.

Let the angle at A be 126 *gr.* then may EFG, the angle of the Bulwark be 84 *gr.* and the angle DAE may be allowed to be 38 *gr.* Let the angle at B be 140 *gr.* then because ⅔. of this angle are aboue 93 *gr.* the angle of this Bulwarke may well be 90 *gr.* and the angle at the Gorge NBM. 36 *gr.* And let AB, the distance betweene these angles be 750 foot.

In regular Forts the Bulwarkes may be made one like the other, so the head-lines being produced will all meet in the same center. In irregular (such as this) there will bee some difference, yet the worke though somewhat longer will bee still the same.

At the Bulwarke A in the triangle AFE, because the angle of the Fort HAD is 126 *gr.* the halfe angle QAD 63 *gr.* and the angle at the Gorge DAE supposed to be 38 *gr.* the angle EAF will bee 79 *gr.* Againe the angle AFE (the halfe of GFE the angle of the Bulwarke) being 42 *gr.* the angle AEF will be 59 *gr.* by complement.

| | | | |
|---|---|---|---|
| As the sine of | FAE | 79. 0. 0 | 9991.9465 |
| to the face | FE | 300. | 2477.1212 |
| | | | 7514.8253 |
| So the sine of | AEF | 59. 0. 0 | 9933.0656 |
| to the head-line | AF | 261.963. | 2418.2403 |
| And the sine of | AFE | 42. 0. 0 | 9825.5109 |
| to the line | AE. | 204.496. | 2310.6856 |

In the rectangle ADE the angle, at the Gorge DAE being 38 *gr.* the other angle DEA must bee 52 *gr.* by complement.

| | | | |
|---|---|---|---|
| As the whole sine of | ADE | 90. 0. 0. | 10000.0000 |
| to the line | AE | 204.496 | 2310.6856 |
| | | | 7689.3144 |
| So the sine of | DAE | 38. 0. 0. | 9789.3419 |
| to the flanque | DE | 125.900. | 2100.0275 |
| And the sine of | AED | 52. 0. 0" | 9896.5341 |
| to the Gorge | AD | 161.145. | 2207.2137 |

In like manner at the Bulwarke B in the triangle BLM, because the angle of the fort is 140 *gr.* the halfe thereof SBN 70 *gr.* and the angle at the Gorge NBM supposed to be 36 *gr.* the angle MBL will be 74 *gr.* And then the angle BLM (the halfe of the angle of the Bulwarke) being 45 *gr.* the third angle BML, must be 61 *gr.* by complement.

| | | | |
|---|---|---|---|
| As the sine of | MBL | 74. 0'. 0". | 9982.8416 |
| to the face | ML | 300. | 2477.121 |
| | | | 7505.7204 |
| So the sine of | BML | 61. 0. 0. | 9941.8192 |
| to the head-line | BL | 272.960 | 2436.0988 |
| And the sine of | BLM | 45. 0. 0. | 9849.4850 |
| to the line | BM | 220.681. | 2343.7646 |

And

And in the rectangle triangle B N M, allowing N B M, the angle at the Gorge to be 36 *gr.* the other angle B M N must be 54 *gr.* by complement.

| | | |
|---|---|---|
| As the whole sine B N M | 90. 0. 0. | 10000.0000 |
| to the line B M | 220. 681 | 2343.7646 |
| | | 7656.2354 |
| So the sine of N B M | 36. 0. 0 | 9769,2186 |
| to the flanque N M | 129. 713 | 2112,9832 |
| And the sine of B M N | 54. 0. 0 | 9907,9576 |
| to the Gorge B N | 178. 534 | 2251,7222 |

3. In the triangle A F O, taking the angle A F O 42 *gr.* out of the angle Q A O 63 *gr.* there remaines 21 *gr.* for the angle A O F.

| | | |
|---|---|---|
| As the sine of A O F | 21. 0'. 0" | 9554,3291 |
| to the headline A F | 261. 963 | 2418,2403 |
| | | 7136,0888 |
| So the sine of A F O | 42. 0. 0 | 9825,5109 |
| to the line A O | 489. 127 | 2689,4221 |
| And the sine of F A O | 63. 0. 0 | 9949,8808 |
| to the face produced F O | 651, 316 | 2813,7920 |

And so in the like triangle B L P, taking the angle B L P, 45 *gr.* out of the angle S B P 70 *gr.* there remaines 25 *gr.* for the third angle B P L.

| | | |
|---|---|---|
| As the sine of B P L | 25. 0. 0 | 9625,9482 |
| to the headline *B L* | 272. 960 | 2436,0988 |
| | | 7189,8494 |
| So the sine of B L P | 45. 0. 0 | 9849,4850 |
| to the line *B P* | 456.704 | 2659,6356 |
| And the sine of *L B P* | 110. 0' 0" | 9972,9858 |
| to the face produced L P | 606. 927 | 2783,1364 |

| | | | |
|---|---|---|---|
| Thus the length of the side | A B | being | 750. |
| the length of the Gorge | B N | | 178, 534 |
| the length of the line | A N | | 571, 466 |
| Take from this the line | A O | | 489. 127 |
| there remaines for the line | O N | | 82, 339 |
| Againe taking the Gorge | A D | | 161, 145 |
| out of the side A B there remaines | B D | | 588,855 |
| Take from this the line | B P | | 456,704 |
| there remaines for the line | D P | | 132,151 |
| Take A D out of A N the cortin D N | | is | 410,321 |

4 In the triangle A F N, hauing two sides A F, A N, and F A N the angle betweene them, we may finde the other two angles at N and F, and the line of defence F N.

| | | | |
|---|---|---|---|
| As the summe of the sides A F, A N, | | 833. 429 | 2920.8684 |
| is to the difference of those sides | | 309. 503 | 2490.6536 |
| So the tangent of halfe the summe of the two | | | 430. 2048 |
| opposite angles at F and N | | 31.30. 0 | 9787.3193 |
| to the tangent of | | 12. 49 ¼ | 9357.1145 |
| the halfe difference betweene those angles. | | | |
| This halfe difference added to the halfe summe giues | | | |
| the greater angle | A F N. | 44. 19 ¼. | |
| and subtracted the lesser | A N F | 18. 40 ¾. | |
| As the sine of | A N F | 18, 40′ ¾ | 9505.5225 |
| to the headline | A F | 261.963 | 2418.2403 |
| | | | 7087.2822 |
| So the sine of | F A N | 63. 0. 0 | 9949.8808 |
| to the line of defence | F N | 728, 783 | 2862.5986 |
| And the sine of | A F N | 44. 19 ¼ | 9844. 2725 |
| to the line | A N | 571. 465 | 2756.9903 |

And in the like triangle B D L, hauing two sides B L, B D, and the angle betweene them L B D, we may finde the other two angles at D and L, and the line of defence L D.

As

| | | | |
|---|---|---|---|
| As the summe of B L and B D | | 861.815 | 2935.4138 |
| to the difference of these sides | | 315.895 | 2499.5421 |
| | | | 435.8717 |
| So the tangent of halfe the summe of the two opposite angles at L and D, | | 35.0.0. | 9845.2267 |
| to the tangent of | | 14.23.$\frac{1}{3}$ | 9409.3550 |

This halfe difference added to the halfe summe giues

| | | | |
|---|---|---|---|
| the greater angle | B L D | | 49.23′$\frac{1}{3}$. |
| and subtracted the lesser | B D L | | 20.36.$\frac{1}{3}$. |
| As the sine of | B L D | 20.36$\frac{1}{3}$ | 9546.4542 |
| to the headline | B L | 272.960 | 2436.0988 |
| | | | 7110.3544 |
| So the sine of | L B D | 70.0.0 | 9972.9858 |
| to the line of defence | L D | 728.838 | 2862.6314 |
| And the sine of | B L D | 49.23$\frac{1}{3}$. | 9880.3627 |
| to the line | B D | 588.855 | 2770.0083 |

## PROP. V.

### *Hauing the Lines and Angles of a regular Fort, to find the content in feet and acres.*

The content of a Fort may be taken seuerall wayes: either from within the Rampert, or from within the outside of the ditch, or else we may take in the Out-workes: And those may be of seuerall sorts, such as are here represented, or the like.

If we consider the content within the Rampart, we haue the triangle Q C S, wherein knowing the Perpendicular C R and the Base Q S, we may finde the content of the triangle. And this content multiplyed by the number of the like triangles belonging to the Fort, shall bee the whole content required.

Thus, in the *Pentagonall* Fort before described, where the

Perpendicular CR was found to be in feet 372. 42. and the Base QS 541.16.

| | | | |
|---|---|---|---|
| As the solemne number | | 2. | 0301,0300 |
| is to the Base | QS | 541.16 | 2733.3268 |
| | | | 2432.2968 |
| So the Perpendicular | CR | 372.42 | 2571.0358 |
| to the content of the triangle | | 100773.25 | 5003.3326 |
| Adde (for 5. triangles) the logarithme of | | 5 | 0698.9700 |
| The content in feet comes to | | 503866. | 5702.3026 |

Then to reduce this *content* into *acres*, we may either divide the number of feet by 43560, (the number of feet contained in an *acre*) or working by Logarithmes, we may subtract this solemne Logarithme 4639.08787.

| | | |
|---|---|---|
| Thus, from the Logarithme of | 503866.25. | 5702.3026 |
| subtract the solemne Logari. of | 43560. | 4639.0878 |
| there remaines the Logarith. of | 11.56. | 1063.2148 |

the content in acres contained within the Rampert.

If it be required to finde the content of this *Pentagonall Fort* within the outward side of the Ditch, we have 10 such triangles as *XCY*, wherein knowing the two sides *CX*, *CY*, and the angle betweene them *XCY*, we may let down a Perpendiculer from the angle at *Y*, upon the Base *CX*; and then with the Perpendicular and the Base, we may finde the content of the triangle as before.

Thus the side *CX* being 980.80, the side *CY* 606.17, and the angle betweene them *XCY*, 36. 0'. 0''

| | | | |
|---|---|---|---|
| As the whole sine of | | 90. 0. 0 | 10000,0000 |
| to the lesser side | *CY* | 607. 17 | 2782,5938 |
| So the sine of | *XCY* | 36. 0. 0 | 9769,2186 |
| to the Perpendicular | | | 2551,8124 |

| | | | |
|---|---|---|---|
| 2 | *As* the solemne number | 2 | 0301,0300 |
| | to the Base CX | 980, 80 | 2991,5819 |
| | | | 2690,5515 |
| | So the Perpendicular | | 2551,8124 |
| | to the content of the triangle | 174728,60 | 5242,3639 |
| | *A*dde (for ten triangles) the Logari, of | 10 | 1000,0000 |
| | the content in feet comes to | 1747286 | 6242,3639 |
| | *A*gaine subtract the Logarithme of | 43560 | 4639,0878 |
| | the content in acres comes to | 40, 11 | 1603,2761 |

By the same reason resoluing all into triangles, wee may take in the Counterscarp, and the rest of the Out-workes, *A*nd so finde the content, not onely of a Regular Fort, but of any other piece of ground.

---

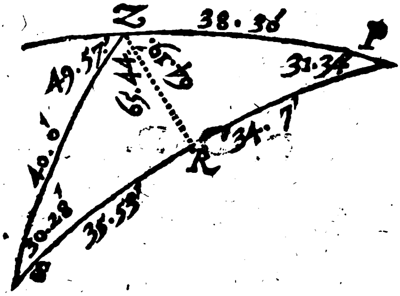
*FINIS.*

---

# CANON TRIANGVLORVM,

Or Tables of *Artificiall* SINES and TANGENTS, to a *Radius* of 10000, 0000 parts, and each minute of the Quadrant.

By EDM. GUNTER Professor of Astronomie in *Gresham Colledge*.




LONDON,
Printed by *William Iones*, for *Iames Bowler*, and are to be sold at the *Marigold* in *Pauls* Church-yard.
1636.

# HONORATISSIMO

DOMINO Dn. JOHANNI

COMITI de BRIDGEWATER,

VICECOMITI de BRACKLEY,

BARONI de ELLESMERE,

Hunc suum Canonem
Triangulorum

D. D. D.

EDM. GUNTER.

# The description of the Canon.

THis *Canon* hath six columnes. The first is of degrees and minutes, from the beginning of the Quadrant unto 45 *gr.* the sixt of degrees and minuts, from 45 *gr.* vnto the end of the quadrant; the other foure containe the *Sines* and *Tangents* belonging to each of these degrees and minutes, after the manner of other *Canons*. The difference is in the numbers. For these *Sines* are not such as halfe the chords of the double arke, nor these *Tangents* perpendiculars at the end of the Diameter: but other numbers substituted in their place, for attaining the same end, by a more easie way, such as the *Logarithmes* of the Lord of *Merchiston*, and thereupon I call them *Artificiall Sines* and *Tangents*. So the second and fourth columnes containe the *Sines* and *Tangents* of the degrees and minutes in the first columne: the third and fift containe the *Sines* and *Tangents* of the sixt columne.

As if it were required to finde the artificiall *Sine* belonging to our latitude, which here at *London* is 51 *gr.* 32 *m.* you may find *Sine* 51 in the lower part of the page, and *M.* 32 in the sixt columne, the common angle will giue 9893,7452 for the *Sine* required. And in the same line you haue 9793,8317 for the *Sine* of the complement of this latitude, which in one word may be called the *cosine*. In like maner the *Tangent* of 51 *gr.* 32 *m.* will be found to be 10099,9134, and the *co-tangent* 9900,0865.

The *Secants* (if there were vse of them) may easily be supplied, by taking the *co-sine* out of the double of the *Radius*.

| | |
|---|---|
| As the double of the *Radius* being | 20000,0000 |
| Take hence the *co-sine* of 51 *gr.* 32 *m.* | 9793,8317 |
| The *Secant* of 51 *gr.* 32 *m.* will be | 10206,1683 |

The *versed Sines* may also bee supplied by adding 301,0300 vnto the double of the *sine* of halfe the arke, and subtracting the *Radius*. As the halfe of 51 *gr.* 32 *m.* being 25 *gr.* 46 *m.*

| | |
|---|---|
| Adde to the *Sine* of 25 *gr.* 46 *m.* | 9638,1968 |
| The same againe, and the former | 9638,1968 |
| number, for the *Radius* being subtracted, | 301,0300 |
| the *versed sine* of 51 *gr.* 32 *m.* will be | 9577,4236 |

| M | Sin. 0. | | Tan. 0. | | |
|---|---|---|---|---|---|
| 0 | 0 | 10000,0000 | 0 | Infinitum. | 60 |
| 1 | 6463,7260 | 9999,9999 | 6463,7260 | 13536,2739 | 59 |
| 2 | 6764,7560 | 9999,9999 | 6764,7561 | 13235,2438 | 58 |
| 3 | 6940,8473 | 9999,9998 | 6940,8474 | 13059,1525 | 57 |
| 4 | 7065,7860 | 9999,9997 | 7065,7863 | 12934,2136 | 56 |
| 5 | 7162,6959 | 9999,9995 | 7162,6964 | 12837,3035 | 55 |
| 6 | 7241,8771 | 9999,9993 | 7241,8778 | 12758,1221 | 54 |
| 7 | 7308,8238 | 9999,9991 | 7308,8247 | 12691,1752 | 53 |
| 8 | 7366,8157 | 9999,9988 | 7366,8169 | 12633,1831 | 52 |
| 9 | 7417,9681 | 9999,9985 | 7417,9696 | 12582,0303 | 51 |
| 10 | 7463,7255 | 9999,9981 | 7463,7273 | 12536,2726 | 50 |
| 11 | 7505,1180 | 9999,9977 | 7505,1202 | 12494,8797 | 49 |
| 12 | 7542,9064 | 9999,9973 | 7542,9091 | 12457,0908 | 48 |
| 13 | 7577,6684 | 9999,9969 | 7577,6715 | 12422,3284 | 47 |
| 14 | 7609,8529 | 9999,9964 | 7609,8565 | 12390,1434 | 46 |
| 15 | 7639,8160 | 9999,9958 | 7639,8201 | 12360,1798 | 45 |
| 16 | 7667,8445 | 9999,9953 | 7667,8492 | 12332,1507 | 44 |
| 17 | 7694,1713 | 9999,9947 | 7694,1785 | 12305,8214 | 43 |
| 18 | 7718,9966 | 9999,9940 | 7718,0026 | 12281,9974 | 42 |
| 19 | 7742,4175 | 9999,9933 | 7742,4841 | 12257,5158 | 41 |
| 20 | 7764,7536 | 9999,9926 | 7764,7610 | 12235,2389 | 40 |
| 21 | 7785,9427 | 9999,9919 | 7785,9508 | 12214,0491 | 39 |
| 22 | 7806,1458 | 9999,9911 | 7806,1547 | 12193,8452 | 38 |
| 23 | 7825,4507 | 9999,9902 | 7825,4604 | 12174,5395 | 37 |
| 24 | 7843,9338 | 9999,9894 | 7843,9444 | 12156,0555 | 36 |
| 25 | 7861,6623 | 9999,9885 | 7861,6738 | 12138,3262 | 35 |
| 26 | 7878,6953 | 9999,9875 | 7878,7077 | 12121,2922 | 34 |
| 27 | 7895,0854 | 9999,9866 | 7895,0988 | 12104,9012 | 33 |
| 28 | 7910,8793 | 9999,9856 | 7910,8937 | 12089,1062 | 32 |
| 29 | 7926,1189 | 9999,9845 | 7926,1344 | 12073,8656 | 31 |
| 30 | 7940,8418 | 9999,9834 | 7940,8584 | 12059,1416 | 30 |
| | | Sin. 89. | | Tan. 89. | M |

| M | Sin. 0. | | Tan. 0. | | |
|---|---|---|---|---|---|
| 30 | 7940,8418 | 9999,9834 | 7940,8584 | 12059,1416 | 30 |
| 31 | 7955,081[illegible] | 9999,9823 | 7955,0996 | 12044,9004 | 29 |
| 32 | 7968,8698 | 9999,9812 | 7968,8886 | 12031,1113 | 28 |
| 33 | 7982,2333 | 9999,9800 | 7982,2534 | 12017,7466 | 27 |
| 34 | 7995,1979 | 9999,9787 | 7995,2192 | 12004,7808 | 26 |
| 35 | 8007,7866 | 9999,9774 | 8007,8091 | 11992,1908 | 25 |
| 36 | 8020,0206 | 9999,9761 | 8020,0445 | 11979,9555 | 24 |
| 37 | 8031,9194 | 9999,9748 | 8031,9446 | 11968,0553 | 23 |
| 38 | 8043,5008 | 9999,9734 | 8043,5274 | 11956,4726 | 22 |
| 39 | 8054,7814 | 9999,9720 | 8054,8193 | 11945,1806 | 21 |
| 40 | 8065,7763 | 9999,9706 | 8065,8057 | 11934,1942 | 20 |
| 41 | 8076,4996 | 9999,9691 | 8076,5305 | 11923,4694 | 19 |
| 42 | 8086,9646 | 9999,9675 | 8086,9970 | 11913,0029 | 18 |
| 43 | 8097,1832 | 9999,9660 | 8097,2172 | 11902,7827 | 17 |
| 44 | 8107,1669 | 9999,9644 | 8107,2025 | 11892,7975 | 16 |
| 45 | 8116,9262 | 9999,9628 | 8116,9634 | 11883,0365 | 15 |
| 46 | 8126,4709 | 9999,9611 | 8126,5098 | 11873,4901 | 14 |
| 47 | 8135,8104 | 9999,9594 | 8135,8510 | 11864,1489 | 13 |
| 48 | 8144,9532 | 9999,9576 | 8144,9955 | 11855,0044 | 12 |
| 49 | 8153,9075 | 9999,9558 | 8153,9516 | 11846,0483 | 11 |
| 50 | 8162,6808 | 9999,9540 | 8162,7367 | 11837,2632 | 10 |
| 51 | 8171,2808 | 9999,9522 | 8171,3281 | 11828,6718 | 9 |
| 52 | 8179,7129 | 9999,9503 | 8179,7626 | 11820,2374 | 8 |
| 53 | 8187,9847 | 9999,9484 | 8188,0363 | 11811,9636 | 7 |
| 54 | 8196,1020 | 9999,9464 | 8196,1555 | 11803,8444 | 6 |
| 55 | 8204,0702 | 9999,9444 | 8204,1258 | 11795,8741 | 5 |
| 56 | 8211,8949 | 9999,9423 | 8211,9525 | 11788,0474 | 4 |
| 57 | 8219,5810 | 9999,9403 | 8219,6407 | 11780,3592 | 3 |
| 58 | 8227,1335 | 9999,9382 | 8227,1953 | 11772,8046 | 2 |
| 59 | 8234,5568 | 9999,9360 | 8234,6207 | 11765,3792 | 1 |
| 60 | 8241,8553 | 9999,9338 | 8241,9214 | 11758,0785 | 0 |
| | | Sin. 89. | | Tan. 89. | M |

| M | Sin. 1. | | Tan. 1. | | |
|---|---|---|---|---|---|
| 0 | 8241,8553 | 9999,9338 | 8241,9214 | 11758,0785 | 60 |
| 1 | 8249,0331 | 9999,9316 | 8249,1015 | 11750,8984 | 59 |
| 2 | 8256,0942 | 9999,9293 | 8256,1649 | 11743,8351 | 58 |
| 3 | 8263,0423 | 9999,9270 | 8263,1152 | 11736,8847 | 57 |
| 4 | 8269,8819 | 9999,9247 | 8269,9562 | 11730,0437 | 56 |
| 5 | 8276,[illegible]36 | 9999,9223 | 8276,6912 | 11723,3087 | 55 |
| 6 | 8283,2433 | 9999,9199 | 8283,3234 | 11716,6765 | 54 |
| 7 | 8289,7734 | 9999,9175 | 8289,8559 | 11710,1440 | 53 |
| 8 | 8296,2067 | 9999,9150 | 8296,2916 | 11703,7083 | 52 |
| 9 | 8302,5460 | 9999,9125 | 8302,6335 | 11697,3664 | 51 |
| 10 | 8308,7941 | 9999,9099 | 8308,8842 | 11691,1158 | 50 |
| 11 | 8314,9535 | 9999,9073 | 8315,0462 | 11684,9537 | 49 |
| 12 | 8321,0268 | 9999,9047 | 8321,1221 | 11678,8778 | 48 |
| 13 | 8327,0163 | 9999,9020 | 8327,1142 | 11672,8857 | 47 |
| 14 | 8332,9243 | 9999,8993 | 8333,0249 | 11666,9750 | 46 |
| 15 | 8338,7529 | 9999,8966 | 8338,8563 | 11661,1437 | 45 |
| 16 | 8344,5043 | 9999,8938 | 8344,6104 | 11655,3895 | 44 |
| 17 | 8350,1805 | 9999,8910 | 8350,2894 | 11649,7105 | 43 |
| 18 | 8355,7834 | 9999,8882 | 8355,8952 | 11644,1047 | 42 |
| 19 | 8361,3149 | 9999,8853 | 8361,4296 | 11638,5703 | 41 |
| 20 | 8366,7769 | 9999,8823 | 8366,8945 | 11633,1054 | 40 |
| 21 | 8372,1709 | 9999,8794 | 8372,2915 | 11627,7084 | 39 |
| 22 | 8377,4988 | 9999,8764 | 8377,6223 | 11622,3776 | 38 |
| 23 | 8382,7620 | 9999,8734 | 8382,8886 | 11617,1113 | 37 |
| 24 | 8387,9621 | 9999,8703 | 8388,0918 | 11611,9081 | 36 |
| 25 | 8393,1007 | 9999,8672 | 8393,2335 | 11606,7664 | 35 |
| 26 | 8398,1792 | 9999,8641 | 8398,3151 | 11601,6848 | 34 |
| 27 | 8403,1990 | 9999,8609 | 8403,3381 | 11596,6619 | 33 |
| 28 | 8408,1613 | 9999,8576 | 8408,3036 | 11591,6963 | 32 |
| 29 | 8413,0676 | 9999,8544 | 8413,2131 | 11586,7868 | 31 |
| 30 | 8417,9190 | 9999,8511 | 8418,0678 | 11581,9321 | 30 |
| | | Sin. 88. | | Tan. 88. | M |

| M | Sin. 1. | | Tan. 1. | | |
|---|---|---|---|---|---|
| 30 | 8417,9190 | 9999,8511 | 8418,0678 | 11581,9321 | 30 |
| 31 | 8422,7168 | 9999,8478 | 8422,8689 | 11577,1310 | 29 |
| 32 | 8427,4621 | 9999,8444 | 8427,6176 | 11572,3823 | 28 |
| 33 | 8432,1561 | 9999,8410 | 8432,3150 | 11567,6849 | 27 |
| 34 | 8436,7998 | 9999,8376 | 8436,9622 | 11563,0377 | 26 |
| 35 | 8441,3944 | 9999,8341 | 8441,5603 | 11558,4397 | 25 |
| 36 | 8445,9409 | 9999,8306 | 8446,1102 | 11553,8897 | 24 |
| 37 | 8450,4402 | 9999,8271 | 8450,6131 | 11549,3868 | 23 |
| 38 | 8454,8933 | 9999,8235 | 8455,0698 | 11544,9301 | 22 |
| 39 | 8459,3012 | 9999,8199 | 8459,4814 | 11540,5186 | 21 |
| 40 | 8463,6648 | 9999,8162 | 8463,8486 | 11536,1513 | 20 |
| 41 | 8467,9850 | 9999,8125 | 8468,1724 | 11531,8275 | 19 |
| 42 | 8472,2625 | 9999,8088 | 8472,4537 | 11527,5462 | 18 |
| 43 | 8476,4983 | 9999,8050 | 8476,6933 | 11523,3066 | 17 |
| 44 | 8480,6932 | 9999,8012 | 8480,8919 | 11519,1080 | 16 |
| 45 | 8484,8478 | 9999,7974 | 8485,0505 | 11514,9485 | 15 |
| 46 | 8488,9634 | 9999,7935 | 8489,1696 | 11510,8303 | 14 |
| 47 | 8493,0397 | 9999,7896 | 8493,2502 | 11506,7498 | 13 |
| 48 | 8497,0784 | 9999,7856 | 8497,2927 | 11502,7072 | 12 |
| 49 | 8501,0798 | 9999,7816 | 8501,2981 | 11498,7018 | 11 |
| 50 | 8505,0446 | 9999,7776 | 8505,2670 | 11494,7329 | 10 |
| 51 | 8508,9736 | 9999,7735 | 8509,2000 | 11490,7999 | 9 |
| 52 | 8512,8673 | 9999,7694 | 8513,0978 | 11486,9021 | 8 |
| 53 | 8516,7263 | 9999,7653 | 8516,9610 | 11483,0389 | 7 |
| 54 | 8520,5513 | 9999,7611 | 8520,7902 | 11479,2098 | 6 |
| 55 | 8524,3429 | 9999,7569 | 8524,5860 | 11475,4140 | 5 |
| 56 | 8528,1016 | 9999,7527 | 8528,3489 | 11471,6510 | 4 |
| 57 | 8531,8281 | 9999,7484 | 8532,0797 | 11467,9203 | 3 |
| 58 | 8535,5228 | 9999,7441 | 8535,7787 | 11464,2212 | 2 |
| 59 | 8539,1863 | 9999,7397 | 8539,4466 | 11460,5534 | 1 |
| 60 | 8542,8191 | 9999,7353 | 8543,0838 | 11456,9162 | 0 |
| | [illegible] | Sin. 88. | [illegible] | Tan. 88. | M |

| M | Sin. 2. | | Tan. 2. | | |
|---|---|---|---|---|---|
| 0 | 8542,8191 | 9999,7353 | 8543,0838 | 11456,9162 | 60 |
| 1 | 8546,4217 | 9999,7309 | 8546,6908 | 11453,3092 | 59 |
| 2 | 8549,9947 | 9999,7264 | 8550,2683 | 11449,7317 | 58 |
| 3 | 8553,5385 | 9999,7219 | 8553,8166 | 11446,1834 | 57 |
| 4 | 8557,0536 | 9999,7174 | 8557,3362 | 11442,6637 | 56 |
| 5 | 8560,5404 | 9999,7128 | 8560,8276 | 11439,1724 | 55 |
| 6 | 8563,9994 | 9999,7082 | 8564,2912 | 11435,7088 | 54 |
| 7 | 8567,4310 | 9999,7035 | 8567,7274 | 11432,2725 | 53 |
| 8 | 8570,8357 | 9999,6988 | 8571,1368 | 11428,8631 | 52 |
| 9 | 8574,2139 | 9999,6941 | 8574,5197 | 11425,4802 | 51 |
| 10 | 8577,5659 | 9999,6894 | 8577,8765 | 11422,1234 | 50 |
| 11 | 8580,8923 | 9999,6846 | 8581,2076 | 11418,7923 | 49 |
| 12 | 8584,1933 | 9999,6797 | 8584,5135 | 11415,4864 | 48 |
| 13 | 8587,4694 | 9999,6749 | 8587,7945 | 11412,2054 | 47 |
| 14 | 8590,7209 | 9999,6700 | 8591,0509 | 11408,9490 | 46 |
| 15 | 8593,9482 | 9999,6650 | 8594,2832 | 11405,7167 | 45 |
| 16 | 8597,1517 | 9999,6600 | 8597,4916 | 11402,5083 | 44 |
| 17 | 8600,3317 | 9999,6550 | 8600,6766 | 11399,3233 | 43 |
| 18 | 8603,4885 | 9999,6499 | 8603,8385 | 11396,1614 | 42 |
| 19 | 8606,6225 | 9999,6449 | 8606,9776 | 11393,0223 | 41 |
| 20 | 8609,7341 | 9999,6397 | 8610,0943 | 11389,9056 | 40 |
| 21 | 8612,8234 | 9999,6346 | 8613,1888 | 11386,8111 | 39 |
| 22 | 8615,8909 | 9999,6294 | 8616,2615 | 11383,7384 | 38 |
| 23 | 8618,9369 | 9999,6241 | 8619,3127 | 11380,6872 | 37 |
| 24 | 8621,9616 | 9999,6188 | 8622,3427 | 11377,6572 | 36 |
| 25 | 8624,9653 | 9999,6135 | 8625,3517 | 11374,6482 | 35 |
| 26 | 8627,9484 | 9999,6082 | 8628,3402 | 11371,6598 | 34 |
| 27 | 8630,9111 | 9999,6028 | 8631,3082 | 11368,6917 | 33 |
| 28 | 8633,8536 | 9999,5974 | 8634,2562 | 11365,7437 | 32 |
| 29 | 8636,7764 | 9999,5919 | 8637,1844 | 11362,8155 | 31 |
| 30 | 8639,6795 | 9999,5864 | 8640,0931 | 11359,9068 | 30 |
| | | Sin. 87 | | Tang. 87 | M |

| M | Sin. 2. | | Tan. 2. | | |
|---|---|---|---|---|---|
| 30 | 8639,6795 | 9999,5864 | 8640,0931 | 11359,9068 | 30 |
| 31 | 8642,5634 | 9999,5809 | 8642,9825 | 11357,0175 | 29 |
| 32 | 8645,4282 | 9999,5753 | 8645,8528 | 11354,1471 | 28 |
| 33 | 8648,2741 | 9999,5697 | 8648,7044 | 11351,2955 | 27 |
| 34 | 8651,1015 | 9999,5640 | 8651,5375 | 11348,4625 | 26 |
| 35 | 8653,9106 | 9999,5584 | 8654,3522 | 11345,6477 | 25 |
| 36 | 8656,7016 | 9999,5527 | 8657,1489 | 11342,8510 | 24 |
| 37 | 8659,4748 | 9999,5469 | 8659,9278 | 11340,0721 | 23 |
| 38 | 8662,2303 | 9999,5411 | 8662,6891 | 11337,3108 | 22 |
| 39 | 8664,9684 | 9999,5353 | 8665,4330 | 11334,5669 | 21 |
| 40 | 8667,6893 | 9999,5294 | 8668,1598 | 11331,8401 | 20 |
| 41 | 8670,3932 | 9999,5235 | 8670,8696 | 11329,1303 | 19 |
| 42 | 8673,0803 | 9999,5176 | 8673,5627 | 11326,4372 | 18 |
| 43 | 8675,7510 | 9999,5116 | 8676,2393 | 11323,7606 | 17 |
| 44 | 8678,4052 | 9999,5056 | 8678,8996 | 11321,1003 | 16 |
| 45 | 8681,0433 | 9999,4995 | 8681,5437 | 11318,4562 | 15 |
| 46 | 8683,6654 | 9999,4934 | 8684,1719 | 11315,8280 | 14 |
| 47 | 8686,2717 | 9999,4873 | 8686,7844 | 11313,2155 | 13 |
| 48 | 8688,8625 | 9999,4812 | 8689,3813 | 11310,6186 | 12 |
| 49 | 8691,4378 | 9999,4750 | 8691,9628 | 11308,0371 | 11 |
| 50 | 8693,9980 | 9999,4687 | 8694,5292 | 11305,4707 | 10 |
| 51 | 8696,5431 | 9999,4625 | 8697,0806 | 11302,9193 | 9 |
| 52 | 8699,0733 | 9999,4561 | 8699,6171 | 11300,3828 | 8 |
| 53 | 8701,5889 | 9999,4498 | 8702,1390 | 11297,8609 | 7 |
| 54 | 8704,0899 | 9999,4434 | 8704,6464 | 11295,3535 | 6 |
| 55 | 8706,5765 | 9999,4370 | 8707,1395 | 11292,8604 | 5 |
| 56 | 8709,0490 | 9999,4306 | 8709,6184 | 11290,3815 | 4 |
| 57 | 8711,5074 | 9999,4242 | 8712,0833 | 11287,9166 | 3 |
| 58 | 8713,9520 | 9999,4175 | 8714,5345 | 11285,4655 | 2 |
| 59 | 8716,3829 | 9999,4110 | 8716,9719 | 11283.0281 | 1 |
| 60 | 8718,8001 | 9999,4044 | 8719,3957 | 11280,6042 | 0 |
| | | Sin. 87. | | Tan. 87. | M |

| M | Sin. 3. | | Tan. 3. | | |
|---|---|---|---|---|---|
| 0 | 8718,8001 | 9999,4044 | 8719,3957 | 11280,6042 | 60 |
| 1 | 8721,2040 | 9999,3977 | 8721,8062 | 11278,1937 | 59 |
| 2 | 8723,5946 | 9999,3910 | 8724,2035 | 11275,7964 | 58 |
| 3 | 8725,9720 | 9999,3843 | 8726,5877 | 11273,4123 | 57 |
| 4 | 8728,3365 | 9999,3776 | 8728,9589 | 11271,0410 | 56 |
| 5 | 8730,6882 | 9999,3708 | 8731,3173 | 11268,6826 | 55 |
| 6 | 8733,0271 | 9999,3640 | 8733,6631 | 11266,3368 | 54 |
| 7 | 8735,3535 | 9999,3571 | 8735,9964 | 11264,0036 | 53 |
| 8 | 8737,6674 | 9999,3502 | 8738,3172 | 11261,6827 | 52 |
| 9 | 8739,9691 | 9999,3433 | 8740,6258 | 11259,3742 | 51 |
| 10 | 8742,2586 | 9999,3363 | 8742,9222 | 11257,0777 | 50 |
| 11 | 8744,5360 | 9999,3293 | 8745,2066 | 11254,7933 | 49 |
| 12 | 8746,8015 | 9999,3223 | 8747,4792 | 11252,5207 | 48 |
| 13 | 8749,0552 | 9999,3152 | 8749,7400 | 11250,2599 | 47 |
| 14 | 8751,2973 | 9999,3081 | 8751,9892 | 11248,0107 | 46 |
| 15 | 8753,5278 | 9999,3009 | 8754,2268 | 11245,7731 | 45 |
| 16 | 8755,7468 | 9999,2937 | 8756,4531 | 11243,5468 | 44 |
| 17 | 8757,6546 | 9999,2865 | 8758,6681 | 11241,3319 | 43 |
| 18 | 8760,1511 | 9999,2792 | 8760,8719 | 11239,1280 | 42 |
| 19 | 8762,3366 | 9999,2719 | 8763,0646 | 11236,9353 | 41 |
| 20 | 8764,5111 | 9999,2646 | 8765,2464 | 11234,7535 | 40 |
| 21 | 8766,6747 | 9999,2572 | 8767,4174 | 11232,5825 | 39 |
| 22 | 8768,8275 | 9999,2498 | 8769,5777 | 11230,4222 | 38 |
| 23 | 8770,9697 | 9999,2423 | 8771,7273 | 11228,2726 | 37 |
| 24 | 8773,1013 | 9999,2349 | 8773,8664 | 11226,1335 | 36 |
| 25 | 8775,2225 | 9999,2273 | 8775,9952 | 11224,0048 | 35 |
| 26 | 8777,3334 | 9999,2198 | 8778,1135 | 11221,8864 | 34 |
| 27 | 8779,4340 | 9999,2122 | 8780,2217 | 11219,7782 | 33 |
| 28 | 8781,5244 | 9999,2045 | 8782,3198 | 11217,6801 | 32 |
| 29 | 8783,6048 | 9999,1969 | 8784,4079 | 11215,5920 | 31 |
| 30 | 8785,6752 | 9999,1892 | 8786,4860 | 11213,5139 | 30 |
| | | Sin. 86. | | Tan. 86. | M |

| M | Sin. 3. | | Tan. 3. | | M |
|---|---|---|---|---|---|
| 30 | 8785,6752 | 9999,1892 | 8786,4860 | 11213,5139 | 30 |
| 31 | 8787,7358 | 9999,1814 | 8788,5544 | 11211,4455 | 29 |
| 32 | 8789,7866 | 9999,1736 | 8790,6130 | 11209,3869 | 28 |
| 33 | 8791,8278 | 9999,1658 | 8792,6619 | 11207,3380 | 27 |
| 34 | 8793,8593 | 9999,1580 | 8794,7013 | 11205,2986 | 26 |
| 35 | 8795,8814 | 9999,1501 | 8796,7313 | 11203,2686 | 25 |
| 36 | 8797,8940 | 9999,1421 | 1798,7519 | 11201,2480 | 24 |
| 37 | 8799,8974 | 9999,1342 | 8800,7632 | 11199,2368 | 23 |
| 38 | 8801,8915 | 9999,1262 | 8802,7653 | 11197,2347 | 22 |
| 39 | 8803,8764 | 9999,1181 | 8804,7582 | 11195,2417 | 21 |
| 40 | 8805,8523 | 9999,1100 | 8806,7422 | 11193,2577 | 20 |
| 41 | 8807,8192 | 9999,1019 | 8808,7172 | 11191,2827 | 19 |
| 42 | 8809,7772 | 9999,0938 | 8810,6834 | 11189,3166 | 18 |
| 43 | 8811,7263 | 9999,0856 | 8812,6407 | 11187,3592 | 17 |
| 44 | 8813,6667 | 9999,8774 | 8814,5893 | 11185,4106 | 16 |
| 45 | 8815,5985 | 9999,0691 | 8816,5293 | 11183,4706 | 15 |
| 46 | 8817,5216 | 9999,0608 | 8818,4608 | 11181,5391 | 14 |
| 47 | 8819,4363 | 9999,0525 | 8820,3838 | 11179,6161 | 13 |
| 48 | 8821,3425 | 9999,0441 | 8822,2984 | 11177,7016 | 12 |
| 49 | 8823,2403 | 9999,0357 | 8824,2046 | 11175,7953 | 11 |
| 50 | 8825,1299 | 9999,0272 | 8826,1026 | 11173,8973 | 10 |
| 51 | 8827,0112 | 9999,0188 | 8827,9924 | 11172,0075 | 9 |
| 52 | 8828,8843 | 9999,0102 | 8829,8741 | 11170,1258 | 8 |
| 53 | 8830,7494 | 9999,0017 | 8831,7477 | 11168,2522 | 7 |
| 54 | 8832,6065 | 9998,9931 | 8833,6134 | 11166,3865 | 6 |
| 55 | 8834,4557 | 9998,9844 | 8835,4712 | 11164,5287 | 5 |
| 56 | 8836,2969 | 9998,9758 | 8837,3211 | 11162,6788 | 4 |
| 57 | 8838,1304 | 9998,9671 | 8839,1632 | 11160,8367 | 3 |
| 58 | 8839,9560 | 9998,9583 | 8840,9977 | 11159,0022 | 2 |
| 59 | 8841,7741 | 9998,9496 | 8842,8245 | 11157,1754 | 1 |
| 60 | 8843,5845 | 9998,9407 | 8844,6437 | 11155,3562 | 0 |
| | | Sin. 86. | | Tan. 86. | M |

| M | Sin. 4. | | Tan. 4. | | |
|---|---|---|---|---|---|
| 0 | 8843,5845 | 9998,9408 | 8844,6437 | 11155,3562 | 60 |
| 1 | 8845,3873 | 9998,9319 | 8846,455[illegible] | 11153,5445 | 59 |
| 2 | 8847,1827 | 9998,9230 | 8848,259[illegible] | 11151,7403 | 58 |
| 3 | 8848,9706 | 9998,9141 | 8850,0565 | 11149,9434 | 57 |
| 4 | 8850,7512 | 9998,9051 | 8851,8460 | 11148,1539 | 56 |
| 5 | 8852,5245 | 9998,8961 | 8853,6283 | 11146,3716 | 55 |
| 6 | 8854,2905 | 9998,8871 | 8855,4034 | 11144,5966 | 54 |
| 7 | 8856,0493 | 9998,8780 | 8857,1713 | 11142,8286 | 53 |
| 8 | 8857,8010 | 9998,8689 | 8858,9321 | 11141,0678 | 52 |
| 9 | 8859,5456 | 9998,8597 | 8860,6858 | 11139,3141 | 51 |
| 10 | 8861,2832 | 9998,8506 | 8862,4326 | 11137,5673 | 50 |
| 11 | 8863,0139 | 9998,8413 | 8864,1725 | 11135,8274 | 49 |
| 12 | 8864,7376 | 9998,8321 | 8865,9055 | 11134,0944 | 48 |
| 13 | 8866,4545 | 9998,8228 | 8867,6317 | 11132,3682 | 47 |
| 14 | 8868,1646 | 9998,8135 | 8869,3511 | 11130,6488 | 46 |
| 15 | 8869,8679 | 9998,8041 | 8871,0638 | 11128 9361 | 45 |
| 16 | 8871,5646 | 9998,7947 | 8872,7699 | 11127,2300 | 44 |
| 17 | 8873,2546 | 9998,7852 | 8874,4693 | 11125,5306 | 43 |
| 18 | 8874,9380 | 9998,7758 | 8876,1622 | 11123,8377 | 42 |
| 19 | 8876,6149 | 9998,7662 | 8877,8487 | 11122,1513 | 41 |
| 20 | 8878,2853 | 9998,7567 | 8879,5286 | 11120,4713 | 40 |
| 21 | 8879,9493 | 9998,7471 | 8881,2022 | 11118,7978 | 39 |
| 22 | 8881,6069 | 9998,7375 | 8882,8694 | 11117,1305 | 38 |
| 23 | 8883,2581 | 9998,7278 | 8884,5303 | 11115,4696 | 37 |
| 24 | 8884,9031 | 9998,7181 | 8886,1849 | 11113,8150 | 36 |
| 25 | 8886,5418 | 9998,7083 | 8887,8334 | 11112,1665 | 35 |
| 26 | 8888,1743 | 9998,6986 | 8889,4756 | 11110,5243 | 34 |
| 27 | 8889,8006 | 9998,6888 | 8891,1118 | 11108,8881 | 33 |
| 28 | 8891,4209 | 9998,6789 | 8892,7420 | 11107,2580 | 32 |
| 29 | 8893,0351 | 9998,6690 | 8894,3660 | 11105,6339 | 31 |
| 30 | 8894,6433 | 9998,6591 | 8895,9841 | 11104,0158 | 30 |
| | | Sin. 85. | | Tan. 85. | M |

| M | Sin. 4. | | Tan. 4. | | M |
|---|---|---|---|---|---|
| 30 | 8894,6433 | 9998,6591 | 8895,9841 | 11104,0158 | 30 |
| 31 | 8896,2455 | 9998,6492 | 8897,5963 | 11102,4036 | 29 |
| 32 | 8897,8417 | 9998,6391 | 8899,2026 | 11100,7973 | 28 |
| 33 | 8899,4322 | 9998,6291 | 8900,8030 | 11099,1969 | 27 |
| 34 | 8901,0167 | 9998,6190 | 8902,3977 | 11097,6022 | 26 |
| 35 | 8902,5955 | 9998,6089 | 8903,9866 | 11096,0134 | 25 |
| 36 | 8904,1685 | 9998,5988 | 8905,5697 | 11094,4302 | 24 |
| 37 | 8905,7358 | 9998,5886 | 8907,1472 | 11092,8527 | 23 |
| 38 | 8907,2974 | 9998,5784 | 8908,7190 | 11091,2809 | 22 |
| 39 | 8908,8534 | 9998,5681 | 8910,2853 | 11089,7146 | 21 |
| 40 | 8910,4038 | 9998,5578 | 8911,8460 | 11088,1539 | 20 |
| 41 | 8911,9487 | 9998,5475 | 8913,4012 | 11086,5988 | 19 |
| 42 | 8913,4880 | 9998,5371 | 8914,9508 | 11085,0491 | 18 |
| 43 | 8915,0219 | 9998,5267 | 8916,4951 | 11083,5048 | 17 |
| 44 | 8916,5503 | 9998,5163 | 8918,0340 | 11081,9659 | 16 |
| 45 | 8918,0733 | 9998,5058 | 8919,5675 | 11080,4324 | 15 |
| 46 | 8919,5910 | 9998,4953 | 8921,0957 | 11078,9042 | 14 |
| 47 | 8921,1034 | 9998,4847 | 8922,6186 | 11077,3813 | 13 |
| 48 | 8922,6104 | 9998,4742 | 8924,1362 | 11075,8637 | 12 |
| 49 | 8924,1122 | 9998,4635 | 8925,6487 | 11074,3512 | 11 |
| 50 | 8925,6089 | 9998,4528 | 8927,1561 | 11072,8439 | 10 |
| 51 | 8927,1003 | 9998,4422 | 8928,6581 | 11071,3418 | 9 |
| 52 | 8928,5866 | 9998,4314 | 8930,1551 | 11069,8448 | 8 |
| 53 | 8930,0678 | 9998,4206 | 8931,6471 | 11068,3528 | 7 |
| 54 | 8931,5439 | 9998,4098 | 8933,1340 | 11066,8659 | 6 |
| 55 | 8933,0150 | 9998,3990 | 8934,6160 | 11065,3840 | 5 |
| 56 | 8934,4810 | 9998,3881 | 8936,0929 | 11063,9070 | 4 |
| 57 | 8935,9421 | 9998,3772 | 8937,5649 | 11062,4350 | 3 |
| 58 | 8937,3983 | 9998,3662 | 8939,0321 | 11060,9678 | 2 |
| 59 | 8938,8496 | 9998,3552 | 8940,4943 | 11059,5056 | 1 |
| 60 | 8940,2960 | 9998,3442 | 8941,9517 | 11058,0482 | 0 |
| | | Sin. 85. | | Tan. 85. | M |

| M | Sin. 5. | | Tan. 5. | | |
|---|---|---|---|---|---|
| 0 | 8940,2960 | 9998,3442 | 8941,9517 | 11058,0482 | 60 |
| 1 | 8941,7375 | 9998,3331 | 8943,4044 | 11056,5955 | 59 |
| 2 | 8943,1743 | 9998,3220 | 8944,8522 | 11055,1477 | 58 |
| 3 | 8944,6063 | 9998,3109 | 8945,2954 | 11053,7046 | 57 |
| 4 | 8946,0335 | 9998,2997 | 8947,7338 | 11052,2661 | 56 |
| 5 | 8947,4560 | 9998,2885 | 8949,1675 | 11050,8324 | 55 |
| 6 | 8948,8739 | 9998,2772 | 8950,5966 | 11049,4033 | 54 |
| 7 | 8950,2871 | 9998,2659 | 8952,0211 | 11047,9788 | 53 |
| 8 | 8951,6956 | 9998,2546 | 8953,4410 | 11046,5589 | 52 |
| 9 | 8953,0996 | 9998,2432 | 8954,8564 | 11045,1436 | 51 |
| 10 | 8954,4990 | 9998,2318 | 8956,2672 | 11043,7327 | 50 |
| 11 | 8955,8939 | 9998,2204 | 8957,6735 | 11042,3264 | 49 |
| 12 | 8957,2843 | 9998,2089 | 8959,0754 | 11040,9245 | 48 |
| 13 | 8958,6702 | 9998,1974 | 8960,4728 | 11039,5271 | 47 |
| 14 | 8960,0517 | 9998,1858 | 8961,8658 | 11038,1341 | 46 |
| 15 | 8961,4287 | 9998,1742 | 8963,2544 | 11036,7455 | 45 |
| 16 | 8962,8013 | 9998,1626 | 8964,6387 | 11035,3612 | 44 |
| 17 | 8964,1696 | 9998,1509 | 8966,0187 | 11033,9812 | 43 |
| 18 | 8965,5337 | 9998,1392 | 8967,3944 | 11032,6055 | 42 |
| 19 | 8966,8934 | 9998,1275 | 8968,7658 | 11031,2341 | 41 |
| 20 | 8968,2488 | 9998,1157 | 8970,1330 | 11029,8669 | 40 |
| 21 | 8969,5998 | 9998,1039 | 8971,4949 | 11028,5050 | 39 |
| 22 | 8970,9467 | 9998,0921 | 8972,8546 | 11027,1453 | 38 |
| 23 | 8972,2894 | 9998,0802 | 8974,2092 | 11025,7907 | 37 |
| 24 | 8973,6280 | 9998,0683 | 8975,5597 | 11024,4402 | 36 |
| 25 | 8974,9624 | 9998,0563 | 8976,9060 | 11023,0939 | 35 |
| 26 | 8976,2926 | 9998,0443 | 8978,2483 | 11021,7516 | 34 |
| 27 | 8977,6187 | 9998,0323 | 8979,5864 | 11020,4135 | 33 |
| 28 | 8978,9408 | 9998,0202 | 8980,9206 | 11019,0793 | 32 |
| 29 | 8980,2588 | 9998,0081 | 8982,2507 | 11017,7492 | 31 |
| 30 | 8981,5728 | 9997,9959 | 8983,5769 | 11016,4230 | 30 |
| | | Sin. 84. | | Tan. 84. | M |

| M | Sin. 5. | | Tan. 5. | | |
|---|---|---|---|---|---|
| 30 | 8981,5728 | 9997,9959 | 8983,5769 | 11016,4230 | 30 |
| 31 | 8982,8829 | 9997,9838 | 8984,8991 | 11015,[illegible]08 | 29 |
| 32 | 8984,1889 | 9997,9715 | 8986,2173 | 11013,7826 | 28 |
| 33 | 8985,4909 | 9997,9593 | 8987,5316 | 11012,4683 | 27 |
| 34 | 8986,7890 | 9997,9470 | 8988,8420 | 11011,1579 | 26 |
| 35 | 8988,0833 | 9997,9347 | 8990,1486 | 11009,8513 | 25 |
| 36 | 8989,3737 | 9997,9223 | 8991,4513 | 11008,5486 | 24 |
| 37 | 8990,6602 | 9997,9099 | 8992,7503 | 11007,2496 | 23 |
| 38 | 8991,9429 | 9997,8974 | 8994,0454 | 11005,9545 | 22 |
| 39 | 8993,2217 | 9997,8850 | 8995,3367 | 11004,6632 | 21 |
| 40 | 8994,4967 | 9997,8725 | 8996,6243 | 11003,3757 | 20 |
| 41 | 8995,7680 | 9997,8599 | 8997,9081 | 11002,0918 | 19 |
| 42 | 8997,0356 | 9997,8473 | 8999,1883 | 11000,8117 | 18 |
| 43 | 8998,2994 | 9997,8347 | 9000,4648 | 10999,5352 | 17 |
| 44 | 8999,5595 | 9997,8220 | 9001,7375 | 10998,2624 | 16 |
| 45 | 9000,8159 | 9997,8093 | 9003,0066 | 10996,9933 | 15 |
| 46 | 9002,0687 | 9997,7965 | 9004,2721 | 10995,7278 | 14 |
| 47 | 9003,3178 | 9997,7838 | 9005,5340 | 10994,4659 | 13 |
| 48 | 9004,5633 | 9997,7710 | 9006,7923 | 10993,2076 | 12 |
| 49 | 9005,8053 | 9997,7581 | 6008,0472 | 10991,9528 | 11 |
| 50 | 9007,0436 | 9997,7452 | 9009,2984 | 10990,7016 | 10 |
| 51 | 9008,2784 | 9997,7323 | 9010,5461 | 10989,4539 | 9 |
| 52 | 9009,5096 | 9997,7193 | 9011,7902 | 10988,2097 | 8 |
| 53 | 9010,7373 | 9997,7063 | 9013,0310 | 10986,9690 | 7 |
| 54 | 9011,9615 | 9997,6933 | 9014,2682 | 10985,7317 | 6 |
| 55 | 9013,1823 | 9997,6802 | 9015,5021 | 10984,4979 | 5 |
| 56 | 9014,3996 | 9997,6671 | 9016,7325 | 10983,2675 | 4 |
| 57 | 9015,6134 | 9997,6540 | 9017,9594 | 10982,0405 | 3 |
| 58 | 9016,8238 | 9997,6408 | 9019,1830 | 10980,8169 | 2 |
| 59 | 9018,0309 | 9997,6276 | 9020,4033 | 10979,5967 | 1 |
| 60 | 9019,2345 | 9997,6143 | 9021,6202 | 10978,3797 | 0 |
| | | Sin. 84. | | Tan. 84. | M |

| M | Sin. 6. | | Tan. 6. | | |
|---|---|---|---|---|---|
| 0 | 9019,2345 | 9997,6143 | 9021,6202 | 10978,3797 | 60 |
| 1 | 9020,4348 | 9997,6010 | 9022,8338 | 10977,1662 | 59 |
| 2 | 9021,6317 | 9997,5877 | 9024,0440 | 10975,9559 | 58 |
| 3 | 9022,8254 | 9997,5743 | 9025,2510 | 10974,7489 | 57 |
| 4 | 9024,0157 | 9997,5609 | 9026,4548 | 10973,5452 | 56 |
| 5 | 9025,2027 | 9997,5475 | 9027,6552 | 10972,3447 | 55 |
| 6 | 9026,3864 | 9997,5340 | 9028,8524 | 10971,1475 | 54 |
| 7 | 9027,5669 | 9997,5204 | 9030,0464 | 10969,9535 | 53 |
| 8 | 9028,7441 | 9997,5069 | 9031,2372 | 10968,7627 | 52 |
| 9 | 9029,9182 | 9997,4933 | 9032,4249 | 10967,5751 | 51 |
| 10 | 9031,0890 | 9997,4797 | 9033,6094 | 10966,3906 | 50 |
| 11 | 9032,2567 | 9997,4660 | 9034,7906 | 10965,2093 | 49 |
| 12 | 9033,4211 | 9997,4523 | 9035,9688 | 10964,0311 | 48 |
| 13 | 9034,5824 | 9997,4386 | 9037,1439 | 10962,8561 | 47 |
| 14 | 9035,7406 | 9997,4248 | 9038,3158 | 10961,6841 | 46 |
| 15 | 9036,8957 | 9997,4110 | 9039,4848 | 10960,5152 | 45 |
| 16 | 9038,0477 | 9997,3971 | 9040,6506 | 10959,3493 | 44 |
| 17 | 9039,1966 | 9997,3832 | 9041,8134 | 10958,1866 | 43 |
| 18 | 9040,3424 | 9997,3693 | 9042,9731 | 10957,0268 | 42 |
| 19 | 9041,4852 | 9997,3553 | 9044,1298 | 10955,8701 | 41 |
| 20 | 9042,6249 | 9997,3413 | 9045,2836 | 10954,7164 | 40 |
| 21 | 9043,7616 | 9997,3273 | 9046,4343 | 10953,5656 | 39 |
| 22 | 9044,8954 | 9997,3132 | 9047,5821 | 10952,4178 | 38 |
| 23 | 9046,0261 | 9997,2991 | 9048,7270 | 10951,2730 | 37 |
| 24 | 9047,1538 | 9997,2849 | 9049,8689 | 10950,1311 | 36 |
| 25 | 9048,2786 | 9997,2707 | 9051,0078 | 10948,9921 | 35 |
| 26 | 9049,4004 | 9997,2565 | 9052,1439 | 10947,8560 | 34 |
| 27 | 9050,5194 | 9997,2423 | 9053,2771 | 10946,7228 | 33 |
| 28 | 9051,6354 | 9997,2279 | 9054,4075 | 10945,5925 | 32 |
| 29 | 9052,7485 | 9997,2136 | 9055,5349 | 10944,4651 | 31 |
| 30 | 9053,8587 | 9997,1992 | 9056,6595 | 10943,3405 | 30 |
| | | Sin. 83. | | Tan. 83. | M |

| M | Sin. 6. | | Tan. 6. | | |
|---|---|---|---|---|---|
| 30 | 9053,8587 | 9997,1992 | 9056,6594 | 10943,3405 | 30 |
| 31 | 9054,9661 | 9997,1848 | 9057,7812 | 10942,2187 | 29 |
| 32 | 9056,0706 | 9997,1704 | 9058,9002 | 10941,0998 | 28 |
| 33 | 9057,1723 | 9997,1559 | 9060,0164 | 10939,9836 | 27 |
| 34 | 9058,2711 | 9997,1414 | )061,1297 | 10938,8702 | 26 |
| 35 | 9059,3672 | 9997,1268 | 9062,2404 | 10937,7596 | 25 |
| 36 | 9060,4604 | 9997,1122 | 9063,3482 | 10936,6518 | 24 |
| 37 | 9061,5508 | 9997,0976 | 9064,4532 | 10935,5467 | 23 |
| 38 | 9062,6385 | 9997,0829 | 9065,5556 | 10934,4444 | 22 |
| 39 | 9063,7235 | 9997,0682 | 9066,6553 | 10933,3447 | 21 |
| 40 | 9064,8057 | 9997,0534 | 9067,7522 | 10932,2477 | 20 |
| 41 | 9065,8852 | 9997,0387 | 9068,8465 | 10931,1534 | 19 |
| 42 | 9066,9619 | 9997,0238 | 9069,9381 | 10930,0619 | 18 |
| 43 | 9068,0359 | 9997,0090 | 9071,0269 | 10928,9730 | 17 |
| 44 | 9069,1073 | 9996,9941 | 9072,1132 | 10927,8867 | 16 |
| 45 | 9070,1760 | 9996,9791 | 9073,1969 | 10926,8031 | 15 |
| 46 | 9071,2421 | 9996,9642 | 9074,2779 | 10925,7220 | 14 |
| 47 | 9072,3055 | 9996,9492 | 9075,3563 | 10924,6436 | 13 |
| 48 | 9073,3662 | 9996,9341 | 9076,4321 | 10923,5679 | 12 |
| 49 | 9074,4243 | 9996,9191 | 9077,5053 | 10922,4947 | 11 |
| 50 | 9075,4799 | 9996,9039 | 9078,5759 | 10921,4240 | 10 |
| 51 | 9076,5328 | 9996,8888 | 9079,6440 | 10920,3559 | 9 |
| 52 | 9077,5832 | 9996,8736 | 9080,7096 | 10919,2903 | 8 |
| 53 | 9078,6310 | 9996,8583 | 9081,7726 | 10918,2273 | 7 |
| 54 | 9079,6762 | 9996,8431 | 9082,8331 | 10917,1669 | 6 |
| 55 | 9080,7188 | 9996,8278 | 9083,8910 | 10916,1089 | 5 |
| 56 | 9081,7590 | 9996,8124 | 9084,9466 | 10915,0534 | 4 |
| 57 | 9082,7966 | 9996,7970 | 9085,9995 | 10914,0004 | 3 |
| 58 | 9083,8317 | 9996,7816 | 9087,0500 | 10912,9499 | 2 |
| 59 | 9084,8643 | 9996,7662 | 9088,0981 | 10911,9018 | 1 |
| 60 | 9085,8944 | 9996,7507 | 9089,1437 | 10910,8562 | 0 |
| | | Sin. 85. | | Tan. 83. | M |

| M | Sin. 7 | | Tan. 7. | | |
|---|---|---|---|---|---|
| 0 | 9085,8944 | 9996,7507 | 9089,1437 | 10910,8562 | 60 |
| 1 | 9086,9221 | 9996,7351 | 9090,1869 | 10909,8130 | 59 |
| 2 | 9087,9473 | 9966,7196 | 9091,2277 | 10908,7723 | 58 |
| 3 | 9088,9700 | 9996,7040 | 9092,2660 | 10907,7339 | 57 |
| 4 | 9089,9903 | 9996,6883 | 9093,3020 | 10906,6980 | 56 |
| 5 | 9091,0082 | 9996,6727 | 9094,3355 | 10905,6644 | 55 |
| 6 | 9092,0236 | 9996,6569 | 9095,3667 | 10904,6333 | 54 |
| 7 | 9093,0367 | 9996,6412 | 9096,3955 | 10903,9045 | 53 |
| 8 | 6094,0473 | 9996,6254 | 9097,4219 | 10902,5780 | 52 |
| 9 | 9095,0556 | 9996,6096 | 9098,4460 | 10901,5539 | 51 |
| 10 | 9096,0615 | 9996,5937 | 9099,4678 | 10900,5322 | 50 |
| 11 | 9097,0650 | 9996,5778 | 9100,4872 | 10899,5127 | 49 |
| 12 | 9098,0662 | 9996,5619 | 9101,5043 | 10898,4956 | 48 |
| 13 | 9099,0651 | 9996,5459 | 9102,5192 | 10897,4808 | 47 |
| 14 | 9100,0616 | 9996,5299 | 9103,5317 | 10896,4682 | 46 |
| 15 | 9101,0558 | 9996,5138 | 9104,5420 | 10895,4580 | 45 |
| 16 | 9102,0477 | 9996,4977 | 9105,5500 | 10894,4500 | 44 |
| 17 | 9103,0378 | 9996,4816 | 9106,5557 | 10893,4443 | 43 |
| 18 | 9104,0246 | 9996,4654 | 9107,5591 | 10892,4408 | 42 |
| 19 | 9105,0096 | 9996,4492 | 9108,5604 | 10891,4395 | 41 |
| 20 | 9105,9924 | 9996,4330 | 9109,5594 | 10890,4405 | 40 |
| 21 | 9106,9729 | 9996,4167 | 9110,5562 | 10889,4438 | 39 |
| 22 | 9107,9511 | 9996,4004 | 9111,5507 | 10888,4492 | 38 |
| 23 | 9108,9272 | 9996,3840 | 9112,5431 | 10887,4568 | 37 |
| 24 | 9109,9010 | 9996,3677 | 9113,5333 | 10886,4666 | 36 |
| 25 | 9110,8726 | 9996,3512 | 9114,5214 | 10885,4786 | 35 |
| 26 | 9111,8420 | 9996,3348 | 9115,5072 | 10884,4928 | 34 |
| 27 | 9112,8091 | 9996,3183 | 9116,4908 | 10883,5091 | 33 |
| 28 | 9113,7741 | 9996,3017 | 9117,4724 | 10882,5275 | 32 |
| 29 | 9114,7370 | 9996,2851 | 9118,4518 | 10881,5481 | 31 |
| 30 | 9115,6976 | 9996,2685 | 9119,4291 | 10880,5709 | 30 |
| | | Sin. 82. | | Tan. 82. | M |

| M | Sin. 7. | | Tan. 7. | | |
|---|---|---|---|---|---|
| 30 | 9115,6976 | 9996,2685 | 9119,4291 | 10880,5709 | 30 |
| 31 | 9116,6561 | 9996,2519 | 9120,4042 | 10879,5957 | 29 |
| 32 | 9117,6125 | 9996,2352 | 9121,3773 | 10878,6227 | 28 |
| 33 | 9118,5667 | 9996,2185 | 9122,3482 | 10877,6517 | 27 |
| 34 | 9119,5188 | 9996,2017 | 9123,3171 | 10876,6829 | 26 |
| 35 | 9120,4688 | 9996,1849 | 9124,2838 | 10875,7161 | 25 |
| 36 | 9121,4166 | 9996,1681 | 9125,2485 | 10874,7514 | 24 |
| 37 | 9122,3624 | 9996,1512 | 9126,2112 | 10873,7888 | 23 |
| 38 | 9123,3061 | 9996,1343 | 9127,1717 | 10872,8282 | 22 |
| 39 | 6124,2476 | 9996,1173 | 9128,1303 | 10871,8696 | 21 |
| 40 | 9125,1871 | 9996,1003 | 9129,0868 | 10870,9131 | 20 |
| 41 | 9126,1246 | 9996,0833 | 9130,0412 | 10869,9587 | 19 |
| 42 | 9127,0606 | 9996,0663 | 9130,9937 | 10869,0062 | 18 |
| 43 | 9127,9933 | 9996,0492 | 9131,9441 | 10868,0558 | 17 |
| 44 | 6128,9246 | 9996,0320 | 9132,8926 | 10867,1073 | 16 |
| 45 | 9129,8539 | 9996,0148 | 9133,8390 | 10866,1609 | 15 |
| 46 | 9130,7812 | 9995,9976 | 9134,7835 | 10865,2164 | 14 |
| 47 | 9131,7064 | 9995,9804 | 9135,7260 | 10864,2739 | 13 |
| 48 | 9132,6296 | 9995,9631 | 9136,6665 | 10863,3334 | 12 |
| 49 | 9133,5509 | 9965,9458 | 9137,6051 | 10862,3948 | 11 |
| 50 | 9134,4702 | 9995,9284 | 9138,5417 | 10861,4582 | 10 |
| 51 | 9135,3874 | 9995,9110 | 9139,4764 | 10860,5235 | 9 |
| 52 | 9136,3027 | 9995,8936 | 9140,4091 | 10859,5908 | 8 |
| 53 | 9137,2161 | 9995,8761 | 9141,3399 | 10858,6600 | 7 |
| 54 | 9138,1275 | 9995,8586 | 9142,2688 | 10857,7311 | 6 |
| 55 | 9139,0369 | 9995,8410 | 9143,1959 | 10856,8040 | 5 |
| 56 | 9139,9445 | 9995,8235 | 9144,1210 | 10855,8790 | 4 |
| 57 | 9140,8500 | 9995,8058 | 9145,0441 | 10854,9558 | 3 |
| 58 | 9141,7537 | 9995,7882 | 9145,9654 | 10854,0345 | 2 |
| 59 | 9142,6554 | 9995,7705 | 9146,8849 | 10853,1150 | 1 |
| 60 | 9143,5553 | 9995,7527 | 9047,8025 | 10852,1974 | 0 |
| | | Sin. 82. | | Tan. 82. | M |

| M | Sin. 8. | | Tan. 8. | | |
|---|---|---|---|---|---|
| 0 | 9143,5553 | 9995,7527 | 9147,8025 | 10852,1974 | 60 |
| 1 | 9144,4532 | 9995,7350 | 9148,7182 | 10851,2817 | 59 |
| 2 | 9145,3493 | 9995,7172 | 9149,6321 | 10850,3679 | 58 |
| 3 | 9146,2434 | 9995,6993 | 9150,5441 | 10849,4558 | 57 |
| 4 | 9147,1358 | 9995,6814 | 9151,4543 | 10848,5456 | 56 |
| 5 | 9148,0262 | 9995,6635 | 9152,3627 | 10847,6373 | 55 |
| 6 | 9148,9148 | 9995,6455 | 9153,2692 | 10846,7307 | 54 |
| 7 | 9149,8015 | 9995,6275 | 9154,1739 | 10845,8260 | 53 |
| 8 | 9150,6863 | 9995,6095 | 9155,0768 | 10844,9231 | 52 |
| 9 | 9151,5694 | 9995,5914 | 9155,9779 | 10844,0220 | 51 |
| 10 | 9152,4506 | 9995,5733 | 9156,8773 | 10843,1227 | 50 |
| 11 | 9153,3300 | 9995,5552 | 9157,7748 | 10842,2251 | 49 |
| 12 | 9154,2076 | 9995,5370 | 9158,6706 | 10841,3293 | 48 |
| 13 | 9155,0834 | 9995,5188 | 9159,5646 | 10840,4353 | 47 |
| 14 | 9155,9574 | 9995,5005 | 9160,4568 | 10839,5431 | 46 |
| 15 | 9156,8295 | 9995,4822 | 9161,3473 | 10838,6526 | 45 |
| 16 | 9157,6999 | 9995,4639 | 9162,2361 | 10837,7639 | 44 |
| 17 | 9158,5686 | 9995,4455 | 9163,1230 | 10836,8769 | 43 |
| 18 | 9159,4354 | 9995,4271 | 9164,0083 | 10835,9916 | 42 |
| 19 | 9160,3005 | 9995,4086 | 9164,8918 | 10835,1081 | 41 |
| 20 | 9161,1638 | 9995,3901 | 9165,7732 | 10834,2263 | 40 |
| 21 | 9162,0254 | 9995,3716 | 9166,6537 | 10833,3462 | 39 |
| 22 | 9162,8852 | 9995,3531 | 9167,5321 | 10832,4678 | 38 |
| 23 | 9163,7433 | 9995,3345 | 9168,4088 | 10831,5911 | 37 |
| 24 | 9164,5997 | 9995,3158 | 9169,2839 | 10830,7161 | 36 |
| 25 | 9165,4544 | 9995,2972 | 9170,1572 | 10829,8427 | 35 |
| 26 | 9166,3073 | 9995,2784 | 9171,0288 | 10828,9711 | 34 |
| 27 | 9167,1585 | 9995,2597 | 9171,8988 | 10828,1011 | 33 |
| 28 | 9168,0081 | 9995,2409 | 9172,7671 | 10827,2328 | 32 |
| 29 | 9168,8559 | 9995,2221 | 9173,6338 | 10826,3661 | 31 |
| 30 | 9169,7020 | 9995,2032 | 9174,4988 | 10825,5011 | 30 |
| | | Sin. 81. | | Tan. 81. | M |

| M | Sin. 8. | | Tan. 8. | | |
|---|---|---|---|---|---|
| 30 | 9169,7020 | 9995,2032 | 9174,4988 | 10825,5011 | 30 |
| 31 | 9170,5465 | 9995,1843 | 9175,3622 | 10824,6377 | 29 |
| 32 | 9171,3893 | 9995,1654 | 9176,2239 | 10823,7760 | 28 |
| 33 | 9172,2304 | 9995,1464 | 9177,0840 | 10822,9159 | 27 |
| 34 | 9173,0699 | 9995,1274 | 9177,9424 | 10822,0575 | 26 |
| 35 | 9173,9077 | 9995,1084 | 9178,7993 | 10821,2006 | 25 |
| 36 | 9174,7438 | 9995,0893 | 9179,6545 | 10820,3454 | 24 |
| 37 | 9175,5783 | 9995,0702 | 9180,5081 | 10819,4918 | 23 |
| 38 | 9176,4112 | 9995,0510 | 9181,3602 | 10818,6398 | 22 |
| 39 | 9177,2424 | 9995,0318 | 9182,2106 | 10817,7893 | 21 |
| 40 | 9178,0721 | 9995,0125 | 9183,0595 | 10816,9404 | 20 |
| 41 | 9178,9000 | 9994,9933 | 9183,9068 | 10816,0932 | 19 |
| 42 | 9179,7264 | 9994,9739 | 9184,7524 | 10815,2475 | 18 |
| 43 | 9180,5512 | 9994,9546 | 9185,5965 | 10814,4034 | 17 |
| 44 | 9181,3744 | 9994,9352 | 9186,4391 | 10813,5608 | 16 |
| 45 | 9182,1959 | 9994,9158 | 9187,2801 | 10812,7198 | 15 |
| 46 | 9183,0160 | 9994,8963 | 9188,1196 | 10811,8803 | 14 |
| 47 | 9183,8344 | 9994,8768 | 9188,9575 | 10811,0424 | 13 |
| 48 | 9184,6512 | 9994,8573 | 9189,7939 | 10810,2061 | 12 |
| 49 | 6185,4664 | 9994,8377 | 9190,6287 | 10809,3712 | 11 |
| 50 | 9186,2801 | 9994,8181 | 9191,4620 | 10808,5379 | 10 |
| 51 | 9187,0923 | 9994,7984 | 9192,2938 | 10807,7061 | 9 |
| 52 | 9187,9029 | 9994,7787 | 9193,1241 | 10806,8758 | 8 |
| 53 | 9188,7119 | 9994,7590 | 9193,9529 | 10806,0470 | 7 |
| 54 | 9189,5194 | 9994,7393 | 9194,7801 | 10805,2198 | 6 |
| 55 | 9190,3254 | 9994,7195 | 9195,6059 | 10804,3940 | 5 |
| 56 | 9191,1398 | 9994,6996 | 9196,4402 | 10803,5597 | 4 |
| 57 | 9191,9327 | 9994,6797 | 9197,2530 | 10802,7470 | 3 |
| 58 | 9192,7341 | 9994,6598 | 9198,0743 | 10801,9256 | 2 |
| 59 | 9193,5340 | 9994,6399 | 9198,8941 | 10801,1058 | 1 |
| 60 | 9194,3324 | 9994,6199 | 9199,7125 | 10800,2874 | 0 |
| | | Sin. 81. | | Tan. 81. | M |

| M | Sin. 9. | | Tan. 9. | | |
|---|---|---|---|---|---|
| 0 | 9194,3324 | 9994,6199 | 9199,7125 | 10800,2874 | 60 |
| 1 | 9195,1293 | 9994,5998 | 9200,5294 | 10799,4705 | 59 |
| 2 | 9195,9246 | 9994,5798 | 9201,3448 | 10798,6551 | 58 |
| 3 | 9196,7185 | 9994,5597 | 9202,1588 | 10797,8411 | 57 |
| 4 | 9197,5109 | 9994,5396 | 9202,9713 | 10797,0286 | 56 |
| 5 | 9198,3019 | 9994,5194 | 9203,7825 | 10796,2175 | 55 |
| 6 | 9199,0913 | 9994,4992 | 9204,5921 | 10795,4078 | 54 |
| 7 | 9199,8793 | 9994,4789 | 9205,4004 | 10794,5996 | 53 |
| 8 | 9200,6658 | 9994,4586 | 9206,2072 | 10793,7928 | 52 |
| 9 | 9201,4509 | 9994,4383 | 9207,0125 | 10792,9874 | 51 |
| 10 | 9202,2345 | 9994,4179 | 9207,8165 | 10792,1834 | 50 |
| 11 | 9203,0166 | 9994,3975 | 9208,6191 | 10791,3809 | 49 |
| 12 | 9203,7973 | 9994,3771 | 9209,4202 | 10790,5797 | 48 |
| 13 | 9204,5766 | 9994,3566 | 9210,2200 | 10789,7799 | 47 |
| 14 | 9205,3544 | 9994,3361 | 9211,0183 | 10788,9816 | 46 |
| 15 | 9206,1309 | 9994,3155 | 9211,8153 | 10788,1846 | 45 |
| 16 | 9206,9058 | 9994,2949 | 9212,6109 | 10787,3890 | 44 |
| 17 | 9207,6794 | 9994,2743 | 9213,4051 | 10786,5948 | 43 |
| 18 | 9208,4516 | 9994,2536 | 9214,1979 | 10785,8020 | 42 |
| 19 | 9209,2224 | 9994,2329 | 9214,9894 | 10785,0105 | 41 |
| 20 | 9209,9917 | 9994,2121 | 9215,7795 | 10784,2204 | 40 |
| 21 | 9210,7597 | 9994,1914 | 9216,5682 | 10783,4317 | 39 |
| 22 | 9211,5262 | 9994,1706 | 9217,3556 | 10782,6443 | 38 |
| 23 | 9212,2914 | 9994,1497 | 9218,1416 | 10781,8583 | 37 |
| 24 | 9213,0552 | 9994,1288 | 9218,9263 | 10781,0736 | 36 |
| 25 | 9213,8176 | 9994,1079 | 9219,7097 | 10780,2902 | 35 |
| 26 | 9214,5787 | 9994,0869 | 9220,4917 | 10779,5082 | 34 |
| 27 | 9215,3383 | 9994,0659 | 9221,2724 | 10778,7275 | 33 |
| 28 | 9216,0966 | 9994,0449 | 9222,0518 | 10777,9482 | 32 |
| 29 | 9216,8536 | 9994,0238 | 9222,8298 | 10777,1701 | 31 |
| 30 | 9217,6092 | 9994,0027 | 9223,6065 | 10776,3934 | 30 |
| | | Sin. 80. | | Tan. 80. | M |

| M | Sin 9. | | Tan. 9. | | |
|---|---|---|---|---|---|
| 30 | 9217,6092 | 9994,0027 | 9223,6065 | 10776,3934 | 30 |
| 31 | 9218,3634 | 9993,9815 | 9224,3819 | 10775,6180 | 29 |
| 32 | 9219,1163 | 9993,9603 | 9225,1560 | 10774,8439 | 28 |
| 33 | 9219,8679 | 9993,9391 | 9225,9288 | 10774,0711 | 27 |
| 34 | 9220,6182 | 9993,9178 | 9226,7003 | 10773,2996 | 26 |
| 35 | 9221,3671 | 9993,8965 | 9227,4705 | 10772,5294 | 25 |
| 36 | 9222,1146 | 9993,8751 | 9228,2395 | 10771,7605 | 24 |
| 37 | 9222,8609 | 9993,8537 | 9229,0071 | 10770,9928 | 23 |
| 38 | 9223,6058 | 9993,8323 | 9229,7735 | 10770,2265 | 22 |
| 39 | 9224,3494 | 9993,8109 | 9230,5386 | 10769,4614 | 21 |
| 40 | 9225,0918 | 9993,7893 | 9231,3024 | 10768,6975 | 20 |
| 41 | 9225,8328 | 9993,7678 | 9232,0649 | 10767,9350 | 19 |
| 42 | 9226,5725 | 9993,7462 | 9232,8262 | 10767,1737 | 18 |
| 43 | 9227,3109 | 9993,7246 | 9233,5862 | 10766,4137 | 17 |
| 44 | 9228,0480 | 9993,7030 | 9234,3450 | 10765,6549 | 16 |
| 45 | 9228,7839 | 9993,6813 | 9235,1026 | 10764,8974 | 15 |
| 46 | 9229,5184 | 9993,6596 | 9235,8588 | 10764,1411 | 14 |
| 47 | 9230,2517 | 9993,6378 | 9236,6139 | 10763,3860 | 13 |
| 48 | 9230,9838 | 9993,6160 | 9237,3677 | 10762,6322 | 12 |
| 49 | 9231,7145 | 9993,5942 | 9238,1203 | 10761,8796 | 11 |
| 50 | 9232,4440 | 9993,5723 | 9238,8717 | 10761,1283 | 10 |
| 51 | 9233,1722 | 9993,5504 | 9239,6218 | 10760,3781 | 9 |
| 52 | 9233,8992 | 9993,5284 | 9240,3707 | 10759,6292 | 8 |
| 53 | 9234,6249 | 9993,5064 | 9241,1184 | 10758,8815 | 7 |
| 54 | 9235,3494 | 9993,4844 | 9241,8649 | 10758,1350 | 6 |
| 55 | 9236,0725 | 9993,4623 | 9242,6102 | 10757,3897 | 5 |
| 56 | 9236,7946 | 9993,4402 | 9243,3543 | 10756,6456 | 4 |
| 57 | 9237,5153 | 9993,4181 | 9244,0972 | 10755,9027 | 3 |
| 58 | 9138,8348 | 9993,3959 | 9244,8389 | 10755,1610 | 2 |
| 59 | 9238,9531 | 9993,3737 | 9245,5794 | 10754,4205 | 1 |
| 60 | 9239,6702 | 9993,3514 | 9246,3187 | 10753,6812 | 0 |
| | | Sin. 80. | | Tan. 80. | M |

| M | Sin. 10. | | Tan. 10. | | |
|---|---|---|---|---|---|
| 0 | 9239,6702 | 9993,351. | 9246,3187 | 10753,6812 | 60 |
| 1 | 9240,3861 | 9993,3291 | 9247,0569 | 10752,9430 | 59 |
| 2 | 9241,1007 | 9993,3068 | 9247,7939 | 10752,2061 | 58 |
| 3 | 9241,8141 | 9993,2844 | 9248,5296 | 10751,4703 | 57 |
| 4 | 9242,5263 | 9993,2620 | 9249,2643 | 10750,7356 | 56 |
| 5 | 9243,2373 | 9993,2396 | 9249,9977 | 10750,0022 | 55 |
| 6 | 9243,9472 | 9993,2171 | 9250,7300 | 10749,2699 | 54 |
| 7 | 9244,6558 | 9993,1946 | 9251,4612 | 10748,5387 | 53 |
| 8 | 9245,3632 | 9993,1720 | 9252,1912 | 10747,8087 | 52 |
| 9 | 9246,0695 | 9993,1494 | [illegible]2,920[illegible] | 10747,0799 | 51 |
| 10 | 9246,7745 | 9993,1268 | 9253,6477 | 10746,3522 | 50 |
| 11 | 9247,4784 | 9993,1041 | 9254,3743 | 10745,6257 | 49 |
| 12 | 9248,1811 | 9993,0814 | 9255,0997 | 10744,9002 | 48 |
| 13 | 9248,8826 | 9993,0586 | 9255,8240 | 10744,1759 | 47 |
| 14 | 9249,5830 | 9993,0358 | 9256,5471 | 10743,4528 | 46 |
| 15 | 9250,2822 | 9993,0130 | 9257,2691 | 10742,7308 | 45 |
| 16 | 9250,9802 | 9992,9902 | 9257,9900 | 10742,0099 | 44 |
| 17 | 9251,6771 | 9992,9673 | 9258,7098 | 10741,2901 | 43 |
| 18 | 9252,3729 | 9992,9443 | 9259,4285 | 10740,5714 | 42 |
| 19 | 9253,0674 | 9992,9213 | 9260,1461 | 10739,8538 | 41 |
| 20 | 9253,7609 | 9992,8983 | 9260,8625 | 10739,1374 | 40 |
| 21 | 9254,4532 | 9992,8753 | 9261,5779 | 10738,4221 | 39 |
| 22 | 9255,1443 | 9992,8522 | 9262,2921 | 10737,7078 | 38 |
| 23 | 9255,8343 | 9992,8290 | 9263,0053 | 10736,9947 | 37 |
| 24 | 9256,5232 | 9992,8059 | 9263,7173 | 10736,2826 | 36 |
| 25 | 9257,2110 | 9992,7827 | 9264,4283 | 10735,5716 | 35 |
| 26 | 9257,8976 | 9992,7594 | 9265,1382 | 10734,8618 | 34 |
| 27 | 9258,5831 | 9992,7362 | 9265,8469 | 10734,1530 | 33 |
| 28 | 9259,2675 | 9992,7128 | 9266,5547 | 10733,4452 | 32 |
| 29 | 9259,9508 | 9992,6895 | 9267,2613 | 10732,7386 | 31 |
| 30 | 9260,6330 | 9992,6661 | 9267,9669 | 10732,0330 | 30 |
| | | Sin. 79. | | Tan. 79. | M |

| M | Sin.10. | [illegible] | Tan.10. | [illegible] | |
|---|---|---|---|---|---|
| 30 | 9260,6330 | 9992,6661 | 9267,96[illegible] | 10732,0339 | 30 |
| 31 | 9261,3141 | 9992,6427 | 9268,6714 | 10731,3385 | 29 |
| 32 | 9261,9920 | 9992,6192 | 9269,3748 | 10730,6251 | 28 |
| 33 | 9262,6729 | 9992,5957 | 9270,0772 | 10729,9227 | 27 |
| 34 | 9263,3507 | 9992,5721 | 9270,7785 | 10729,2214 | 26 |
| 35 | 9264,0274 | 9992,5485 | 9271,4788 | 10728,5211 | 25 |
| 36 | 9264,7029 | 9992,5249 | 9272,1780 | 10727,8219 | 24 |
| 37 | 9265,3775 | 9992,5013 | 9272,8762 | 10727,1238 | 23 |
| 38 | 9266,0509 | 9992,4776 | 9273,5733 | 10726,4266 | 22 |
| 39 | 9266,7232 | 9992,4538 | 9274,2694 | 10725,7306 | 21 |
| 40 | 9267,3945 | 9992,4300 | 9274,9644 | 10725,0355 | 20 |
| 41 | 9268,0646 | 9992,4062 | 9275,6584 | 10724,3415 | 19 |
| 42 | 9268,7338 | 9992,3824 | 9276,3514 | 10723,6485 | 18 |
| 43 | 9269,4019 | 9992,3585 | 9277,0433 | 10722,9566 | 17 |
| 44 | 9270,0689 | 9992,3346 | 9277,7343 | 10722,2657 | 16 |
| 45 | 9270,7348 | 9992,3106 | 9278,4241 | 10721,5758 | 15 |
| 46 | 9271,3996 | 9992,2866 | 9279,1130 | 10720,8869 | 14 |
| 47 | 9272,0634 | 9992,2625 | 9279,8009 | 10720,1991 | 13 |
| 48 | 9272,7262 | 9992,2385 | 9280,4877 | 10719,5122 | 12 |
| 49 | 9273,3880 | 9992,2143 | 9281,1736 | 10718,8263 | 11 |
| 50 | 9274,0487 | 9992,1902 | 9281,8584 | 10718,1415 | 10 |
| 51 | 9274,7083 | 9992,1660 | 9282,5423 | 10717,4577 | 9 |
| 52 | 9275,3669 | 9992,1418 | 9283,2251 | 10716,7748 | 8 |
| 53 | 9276,0245 | 9992,1175 | 9283,9070 | 10716,0930 | 7 |
| 54 | 9276,6810 | 9992,0932 | 9284,5878 | 10715,4121 | 6 |
| 55 | 9277,3365 | 9992,0688 | 9285,2677 | 10714,7322 | 5 |
| 56 | 9277,9910 | 9992,0445 | 9285,9465 | 10714,0534 | 4 |
| 57 | 9278,6445 | 9992,0200 | 9286,6244 | 10713,3755 | 3 |
| 58 | 9279,2969 | 9991,9956 | 9287,3013 | 10712,6986 | 2 |
| 59 | 9279,9484 | 9991,9711 | 9287,9773 | 10712,0227 | 1 |
| 60 | 9280,5988 | 9991,9465 | 9288,6522 | 10711,3477 | 0 |
| | | Sin.79. | | Tan.79. | M |

D

| M | Sin. 11. | | Tan. 11. | | |
|---|---|---|---|---|---|
| 0 | 9280,5988 | 9991,9465 | 9288,6522 | 10711,3477 | 60 |
| 1 | 9281,2482 | 9991,9220 | 9289,3262 | 10710,6737 | 59 |
| 2 | 9281,8966 | 9991,8973 | 9289,9992 | 10710,0007 | 58 |
| 3 | 9282,5440 | 9991,8727 | 9290,6713 | 10709,3286 | 57 |
| 4 | 9283,1904 | 9991,8480 | 9291,3424 | 10708,6575 | 56 |
| 5 | 9283,8359 | 9991,8233 | 9292,0125 | 10707,9874 | 55 |
| 6 | 9284,4803 | 9991,7985 | 9292,6817 | 10707,3182 | 54 |
| 7 | 9285,1237 | 9991,7737 | 9293,3499 | 10706,6500 | 53 |
| 8 | 9285,7661 | 9991,7489 | 9294,0172 | 10705,9827 | 52 |
| 9 | 9286,4075 | 9991,7240 | 9294,6835 | 10705,3164 | 51 |
| 10 | 9287,0480 | 9991,6991 | 9295,3489 | 10704,6510 | 50 |
| 11 | 9287,6875 | 9991,6741 | 9296,0134 | 10703,9866 | 49 |
| 12 | 9288,3260 | 9991,6491 | 9296,6768 | 10703,3231 | 48 |
| 13 | 9288,9635 | 9991,6241 | 9297,3394 | 10702,6605 | 47 |
| 14 | 9289,6001 | 9991,5990 | 9298,0010 | 10701,9989 | 46 |
| 15 | 9290,2357 | 9991,5739 | 9298,6617 | 10701,3382 | 45 |
| 16 | 9290,8703 | 9991,5487 | 9299,3215 | 10700,6784 | 44 |
| 17 | 9291,5040 | 9991,5236 | 9299,9804 | 10700,0195 | 43 |
| 18 | 9292,1367 | 9991,4983 | 9300,6383 | 10699,3616 | 42 |
| 19 | 9292,7684 | 9991,4731 | 9301,2953 | 10698,7046 | 41 |
| 20 | 9293,3992 | 9991,4478 | 9301,9514 | 10698,0485 | 40 |
| 21 | 9294,0291 | 9991,4224 | 9302,6066 | 10697,3933 | 39 |
| 22 | 9294,6580 | 9991,3971 | 9303,2609 | 10696,7390 | 38 |
| 23 | 9295,2859 | 9991,3716 | 9303,9142 | 10696,0857 | 37 |
| 24 | 9295,9129 | 9991,3462 | 9304,5667 | 10695,4332 | 36 |
| 25 | 9296,5390 | 9991,3207 | 9305,2182 | 10694,7817 | 35 |
| 26 | 9297,1641 | 9991,2952 | 9305,8689 | 10694,1310 | 34 |
| 27 | 9297,7883 | 9991,2696 | 9306,5186 | 10693,4813 | 33 |
| 28 | 9298,4116 | 9991,2440 | 9307,1675 | 10692,8324 | 32 |
| 29 | 9299,0339 | 9991,2183 | 9307,8155 | 10692,1844 | 31 |
| 30 | 9299,6553 | 9991,1927 | 9308,4626 | 10691,5374 | 30 |
| | | Sin. 78. | | Tang. 78. | M |

| M | Sin. 11. | | Tan. 11. | | |
|---|---|---|---|---|---|
| 30 | 9299,6553 | 9991,1927 | 9308,4626 | 10691,5374 | 30 |
| 31 | 9300,2757 | 9991,1669 | 9309,1088 | 10690,8912 | 29 |
| 32 | 9300,8953 | 9991,1412 | 9309,7541 | 10690,2459 | 28 |
| 33 | 9301,5139 | 9991,1154 | 9310,3985 | 10689,6014 | 27 |
| 34 | 9302,1317 | 9991,0895 | 9311,0421 | 10688,9578 | 26 |
| 35 | 9302,7485 | 9991,0637 | 9311,6847 | 10688,3152 | 25 |
| 36 | 9303,3643 | 9991,0378 | 9312,3265 | 10687,6734 | 24 |
| 37 | 9303,9793 | 9991,0118 | 9312,9679 | 10687,0324 | 23 |
| 38 | 9304,5934 | 9990,9858 | 9313,6076 | 10686,3924 | 22 |
| 39 | 9305,2066 | 9990,9598 | 9314,2468 | 10685,7532 | 21 |
| 40 | 9305,8189 | 9990,9337 | 9314,8851 | 10685,1148 | 20 |
| 41 | 9306,4302 | 9990,9076 | 9315,5126 | 10684,4874 | 19 |
| 42 | 9307,0407 | 9990,8815 | 9316,1592 | 10683,8407 | 18 |
| 43 | 9307,6503 | 9990,8553 | 9316,7950 | 10683,2050 | 17 |
| 44 | 9308,2590 | 9990,8291 | 9317,4299 | 10682,5701 | 16 |
| 45 | 9308,8668 | 9990,8028 | 9318,0639 | 10681,9360 | 15 |
| 46 | 9309,4737 | 9990,7765 | 9318,6971 | 10681,3028 | 14 |
| 47 | 9310,0797 | 9990,7502 | 9319,3295 | 10680,6704 | 13 |
| 48 | 9310,6849 | 9990,7238 | 9319,9610 | 10680,0389 | 12 |
| 49 | 9311,2892 | 9990,6974 | 9320,5917 | 10679,4082 | 11 |
| 50 | 9311,8926 | 9990,6710 | 9321,2216 | 10678,7784 | 10 |
| 51 | 9312,4951 | 9990,6445 | 9321,8506 | 10678,1493 | 9 |
| 52 | 9313,0967 | 9990,6179 | 9322,4788 | 10677,5212 | 8 |
| 53 | 9313,6975 | 9990,5914 | 9323,1061 | 10676,8938 | 7 |
| 54 | 9314,2974 | 9990,5648 | 9323,7326 | 10676,2673 | 6 |
| 55 | 9314,8965 | 9990,5381 | 9324,3583 | 10675,6418 | 5 |
| 56 | 9315,4947 | 9990,5115 | 9324,9832 | 10675,0169 | 4 |
| 57 | 9316,0920 | 9990,4847 | 9325,6072 | 10674,3927 | 3 |
| 58 | 9316,6885 | 9990,4580 | 9326,2305 | 10673,7694 | 2 |
| 59 | 9317,2841 | 9990,4312 | 9326,8529 | 10673,1470 | 1 |
| 60 | 9317,8789 | 9990,4044 | 9327,4745 | 10672,5254 | 0 |
| | | Sin. 78. | | Tan. 78. | M |

| M | Sin. 12 | | Tan. 12. | | |
|---|---|---|---|---|---|
| 0 | 9317,8789 | 9990,4044 | 9327,4745 | 10672,5254 | 60 |
| 1 | 9318,4728 | 9990,3775 | 9328,0955 | 10671,9046 | 59 |
| 2 | 9319,0699 | 9990,3506 | 9328,7155 | 10671,2847 | 58 |
| 3 | 9319,6581 | 9990,3236 | 9329,3344 | 10670,6655 | 57 |
| 4 | 9320,2495 | 9990,2966 | 9329,9528 | 10670,0471 | 56 |
| 5 | 9320,8400 | 9990,2696 | 9330,5704 | 10669,4296 | 55 |
| 6 | 9321,4297 | 9990,2425 | 9331,1871 | 10668,8128 | 54 |
| 7 | 9322,0186 | 9990,2154 | 9331,8032 | 10668,1968 | 53 |
| 8 | 9322,6066 | 9990,1883 | 9332,4183 | 10667,5817 | 52 |
| 9 | 9323,1938 | 9990,1611 | 9333,0326 | 10666,9673 | 51 |
| 10 | 9323,7802 | 9990,1339 | 9333,6462 | 10666,3537 | 50 |
| 11 | 9324,3657 | 9990,1066 | 9334,2590 | 10665,7409 | 49 |
| 12 | 9324,9504 | 9990,0794 | 9334,8710 | 10665,1289 | 48 |
| 13 | 9325,5343 | 9990,0520 | 9335,4823 | 10664,5177 | 47 |
| 14 | 9326,1174 | 9990,0247 | 9336,0927 | 10663,9072 | 46 |
| 15 | 9326,6995 | 9989,9972 | 9336,7024 | 10663,2976 | 45 |
| 16 | 9327,2811 | 9989,9698 | 9337,3112 | 10662,6887 | 44 |
| 17 | 9327,8617 | 9989,9423 | 9337,9194 | 10662,0806 | 43 |
| 18 | 9328,4415 | 9989,9148 | 9338,5267 | 10661,4732 | 42 |
| 19 | 9329,0205 | 9989,8872 | 9339,1333 | 10660,8666 | 41 |
| 20 | 9329,5987 | 9989,8596 | 9339,7391 | 10660,2608 | 40 |
| 21 | 9330,1761 | 9989,8320 | 9340,3441 | 10659,6558 | 39 |
| 22 | 9330,7527 | 9989,8043 | 9340,9483 | 10659,0516 | 38 |
| 23 | 9331,3285 | 9989,7766 | 9341,5518 | 10658,4481 | 37 |
| 24 | 9321,9035 | 9989,7488 | 9342,1546 | 10657,8453 | 36 |
| 25 | 9332,4777 | 9989,7210 | 9342,7566 | 10657,2433 | 35 |
| 26 | 9333,0511 | 9989,6932 | 9343,3578 | 10656,6421 | 34 |
| 27 | 9333,6236 | 9989,6653 | 9343,9583 | 10656,0416 | 33 |
| 28 | 9334,1955 | 9989,6374 | 9344,5580 | 10655,4419 | 32 |
| 29 | 9334,7665 | 9989,6095 | 9345,1570 | 10654,8429 | 31 |
| 30 | 9335,3367 | 9989,5815 | 9345,7552 | 10654,2447 | 30 |
| | | Sin. 77. | | Tang. 77 | M |

| M | Sin. 12. | | Tan. 12. | | |
|---|---|---|---|---|---|
| 30 | 9335,3367 | 9989,5815 | 9345,7552 | 10654,2447 | 30 |
| 31 | 9335,9061 | 9989,5534 | 9346,3527 | 10653,6472 | 29 |
| 32 | 9336,4748 | 9989,5254 | 9346,9494 | 10653,0505 | 28 |
| 33 | 9337,0427 | 9989,4973 | 9347,5454 | 10652,4545 | 27 |
| 34 | 9337,6098 | 9989,4691 | 9348,1407 | 10651,8593 | 26 |
| 35 | 9338,1762 | 9989,4410 | 9348,7352 | 10651,2647 | 25 |
| 36 | 9338,7417 | 9989,4127 | 9349,3290 | 10650,6710 | 24 |
| 37 | 9339,3065 | 9989,3845 | 9349,9220 | 10650,0779 | 23 |
| 38 | 9339,8705 | 9989,3562 | 9350,5143 | 10649,4856 | 22 |
| 39 | 9340,4338 | 9989,3278 | 9351,1059 | 10648,8940 | 21 |
| 40 | 9340,9963 | 9989,2995 | 9351,6968 | 10648,3032 | 20 |
| 41 | 9341,5580 | 9989,2711 | 9352,2869 | 10647,7130 | 19 |
| 42 | 9342,1189 | 9989,2426 | 9352,8763 | 10647,1236 | 18 |
| 43 | 9342,6791 | 9989,2141 | 9353,4650 | 10646,5349 | 17 |
| 44 | 9343,2386 | 9989,1856 | 9354,0529 | 10645,9470 | 16 |
| 45 | 9343,7972 | 9989,1570 | 9354,6402 | 10645,3597 | 15 |
| 46 | 9344,3551 | 9989,1284 | 9355,2267 | 10644,7732 | 14 |
| 47 | 9344,9123 | 9989,0998 | 9355,8125 | 10644,1874 | 13 |
| 48 | 9345,4688 | 9989,0711 | 9356,3976 | 10643,6023 | 12 |
| 49 | 9346,0244 | 9989,0424 | 9356,9820 | 10643,0179 | 11 |
| 50 | 9346,5794 | 9989,0136 | 9357,5657 | 10642,4342 | 10 |
| 51 | 9347,1336 | 9988,9848 | 9358,1487 | 10641,8512 | 9 |
| 52 | 9347,6870 | 9988,9560 | 9358,7310 | 10641,2689 | 8 |
| 53 | 9348,2397 | 9988,9272 | 9359,3126 | 10640,6874 | 7 |
| 54 | 9348,7917 | 9988,8982 | 9359,8934 | 10640,1065 | 6 |
| 55 | 9349,3429 | 9988,8692 | 9360,4736 | 10639,5263 | 5 |
| 56 | 9349,8934 | 9988,8402 | 9361,0532 | 10638,9448 | 4 |
| 57 | 9350,4431 | 9988,8112 | 9361,6319 | 10638,3681 | 3 |
| 58 | 9350,9921 | 9988,7821 | 9362,2100 | 10637,7900 | 2 |
| 59 | 9351,5404 | 9988,7580 | 9362,7874 | 10637,2126 | 1 |
| 60 | 9352,0880 | 9988,7239 | 9363,3641 | 10636,6358 | 0 |
| | | Sin. 77. | | Tan. 77. | M |

| M | Sin. 13. | | Tan. 13. | | |
|---|---|---|---|---|---|
| 0 | 9352,0880 | 9988,7239 | 9363,3641 | 10636,6359 | 60 |
| 1 | 9352,6348 | 9988,6947 | 9363,9401 | 10636,0598 | 59 |
| 2 | 9353,1809 | 9988,6655 | 9364,5154 | 10635,4845 | 58 |
| 3 | 9353,7263 | 9988,6362 | 9365,0901 | 10634,9098 | 57 |
| 4 | 9354,2710 | 9988,6069 | 9365,6640 | 10634,3359 | 56 |
| 5 | 9354,8150 | 9988,5776 | 9366,2373 | 10633,7626 | 55 |
| 6 | 9355,3582 | 9988,5482 | 9366,8099 | 10633,1900 | 54 |
| 7 | 9355,9007 | 9988,5188 | 9367,3819 | 10632,6180 | 53 |
| 8 | 9356,4425 | 9988,4893 | 9367,9532 | 10632,0468 | 52 |
| 9 | 9356,9836 | 9988,4598 | 9368,5237 | 10631,4762 | 51 |
| 10 | 9357,5240 | 9988,4303 | 9369,0937 | 10630,9063 | 50 |
| 11 | 9358,0637 | 9988,4007 | 9369,6629 | 10630,3370 | 49 |
| 12 | 9358,6026 | 9988,3711 | 9370,2315 | 10629,7684 | 48 |
| 13 | 9359,1409 | 9988,3415 | 9370,7994 | 10629,2005 | 47 |
| 14 | 9359,6785 | 9988,3118 | 9371,3666 | 10628,6333 | 46 |
| 15 | 9360,2153 | 9988,2820 | 9371,9332 | 10628,0667 | 45 |
| 16 | 9360,7515 | 9988,2523 | 9372,4992 | 10627,5008 | 44 |
| 17 | 9361,2869 | 9988,2225 | 9373,0644 | 10626,9355 | 43 |
| 18 | 9361,8217 | 9988,1926 | 9373,6290 | 10626,3709 | 42 |
| 19 | 9362,3558 | 9988,1627 | 9374,1930 | 10625,8069 | 41 |
| 20 | 9362,8892 | 9988,1328 | 9374,7563 | 10625,2436 | 40 |
| 21 | 9363,4218 | 9988,1029 | 9375,3182 | 10624,6810 | 39 |
| 22 | 9363,9538 | 9988,0729 | 9375,8809 | 10624,1190 | 38 |
| 23 | 9364,4852 | 9988,0428 | 9376,4423 | 10623,5576 | 37 |
| 24 | 9365,0158 | 9988,0128 | 9377,0030 | 10622,9969 | 36 |
| 25 | 9365,5457 | 9987,9826 | 9377,5631 | 10622,4369 | 35 |
| 26 | 9366,0750 | 9987,9525 | 9378,1225 | 10621,8775 | 34 |
| 27 | 9366,6036 | 9987,9223 | 9378,6812 | 10621,3187 | 33 |
| 28 | 9367,1315 | 9987,8921 | 9379,2394 | 10620,7605 | 32 |
| 29 | 9367,6587 | 9987,8618 | 9379,7969 | 10620,2031 | 31 |
| 30 | 9368,1852 | 9987,8315 | 9380,3537 | 10619,6462 | 30 |
| | | Sin. 76 | | Tan. 76. | M |

| M | Sin. 13. | | Tan. 13. | | |
|---|---|---|---|---|---|
| 30 | 9368,1852 | 9987,8315 | 9380,3537 | 10619,6462 | 30 |
| 31 | 9368,7111 | 9987,8011 | 9380,9099 | 10619,0900 | 29 |
| 32 | 9369,2363 | 9987,7707 | 9381,4655 | 10618,5344 | 28 |
| 33 | 9369,7608 | 9987,7403 | 9382,0205 | 10617,9795 | 27 |
| 34 | 9370,2847 | 9987,7098 | 9382,5748 | 10617,4251 | 26 |
| 35 | 9370,8079 | 9987.6793 | 9383,1285 | 10616,8714 | 25 |
| 36 | 9371,3304 | 9987,6488 | 9383,6815 | 10616,3184 | 24 |
| 37 | 9371,8522 | 9987,6182 | 9384,2340 | 10615,7659 | 23 |
| 38 | 9372,3734 | 9987,5876 | 9384,7858 | 10615,2141 | 22 |
| 39 | 9372.8940 | 9987.5569 | 9385,3370 | 10614,6629 | 21 |
| 40 | 9373,4138 | 9987,5262 | 9385,8876 | 10614,1124 | 20 |
| 41 | 9373,9331 | 9987,4955 | 9386,4375 | 10613,5624 | 19 |
| 42 | 9374,4516 | 9987,4647 | 9386,9869 | 10613,0131 | 18 |
| 43 | 9374.9695 | 9987,4339 | 9387,5356 | 10612,4643 | 17 |
| 44 | 9375,4868 | 9987,4031 | 9388,0837 | 10611,9162 | 16 |
| 45 | 9376,0034 | 9987,3722 | 9388,6312 | 10611,3687 | 15 |
| 46 | 9376,5193 | 9987,3412 | 9389,1781 | 10610,8219 | 14 |
| 47 | 9377.0346 | 9987.3103 | 9389.7243 | 10610,2756 | 13 |
| 48 | 9377,5493 | 9987,2792 | 9390,2700 | 10609,7299 | 12 |
| 49 | 9378,0633 | 9987,2482 | 9390,8150 | 10609,1849 | 11 |
| 50 | 9378,5766 | 9987,2171 | 9391,3595 | 10608,6404 | 10 |
| 51 | 9379,0893 | 9987,1860 | 9391,9033 | 10608.0966 | 9 |
| 52 | 9379,6014 | 9987,1548 | 9392,4466 | 10607.5533 | 8 |
| 53 | 9380,1129 | 9987,1236 | 9392,9892 | 10607,0107 | 7 |
| 54 | 9380,6237 | 9987,0924 | 9393,5313 | 10606.4687 | 6 |
| 55 | 9381,1338 | 9987,0611 | 9394,0727 | 10605,9272 | 5 |
| 56 | 9381,6434 | 9987,0298 | 9394,6136 | 10605,3863 | 4 |
| 57 | 9382,1522 | 9986,9984 | 9395,1538 | 10604,8461 | 3 |
| 58 | 9382,6605 | 9986,9670 | 9395,6935 | 10604,3064 | 2 |
| 59 | 9383,1681 | 9986,9356 | 9396,2325 | 10603,7674 | 1 |
| 60 | 9383,6751 | 9986.9041 | 9396,7710 | 10603,2289 | 0 |
| | | Sin. 76. | | Tan. 76. | M |

| M | Sin. 14. | | Tan. 14. | | |
|---|---|---|---|---|---|
| 0 | 9383,6751 | 9986,9041 | 9396,7710 | 10603,2289 | 60 |
| 1 | 9384,1815 | 9986,8726 | 9397,3089 | 10602,6910 | 59 |
| 2 | 9384,6873 | 9986,8410 | 9397,8462 | 10602,1537 | 58 |
| 3 | 9385,1924 | 9986,8094 | 9398,3829 | 10601,6170 | 57 |
| 4 | 9385,6969 | 9986,7778 | 9398,9191 | 10601,0808 | 56 |
| 5 | 9386,2008 | 9986,7461 | 9399,4546 | 10600,5453 | 55 |
| 6 | 9386,7040 | 9986,7144 | 9399,9896 | 10600,0103 | 54 |
| 7 | 9387,2066 | 9986,6826 | 9400,5240 | 10599,4760 | 53 |
| 8 | 9387,7087 | 9986,6508 | 9401,0578 | 10598,9421 | 52 |
| 9 | 9388,2101 | 9986,6190 | 9401,5910 | 10598,4089 | 51 |
| 10 | 9388,7108 | 9986,5872 | 9402,1237 | 10597,8763 | 50 |
| 11 | 9389,2110 | 9986,5552 | 9402,6557 | 10597,3442 | 49 |
| 12 | 9389,7106 | 9986,5233 | 9403,1873 | 10596,8127 | 48 |
| 13 | 9390,2095 | 9986,4913 | 9403,7182 | 10596,2817 | 47 |
| 14 | 9390,7079 | 9986,4593 | 9404,2486 | 10595,7514 | 46 |
| 15 | 9391,2056 | 9986,4272 | 9404,7784 | 10595,2216 | 45 |
| 16 | 9391,7027 | 9986,3951 | 9405,3076 | 10594,6923 | 44 |
| 17 | 9392,1993 | 9986,3630 | 9405,8363 | 10594,1637 | 43 |
| 18 | 9392,6952 | 9986,3308 | 9406,3644 | 10593,6356 | 42 |
| 19 | 9393,1905 | 9986,2986 | 9406,8919 | 10593,1080 | 41 |
| 20 | 9393,6852 | 9986,2663 | 9407,4189 | 10592,5810 | 40 |
| 21 | 9394,1793 | 9986,2340 | 9407,9453 | 10592,0546 | 39 |
| 22 | 9394,6728 | 9986,2017 | 9408,4711 | 10591,5288 | 38 |
| 23 | 9395,1658 | 9986,1693 | 9408,9964 | 10591,0035 | 37 |
| 24 | 9395,6581 | 9986,1369 | 9409,5212 | 10590,4787 | 36 |
| 25 | 9396,1498 | 9986,1044 | 9410,0454 | 10589,9545 | 35 |
| 26 | 9396,6410 | 9986,0719 | 9410,5690 | 10589,4309 | 34 |
| 27 | 9397,1315 | 9986,0394 | 9411,0921 | 10588,9078 | 33 |
| 28 | 9397,6215 | 9986,0068 | 9411,6146 | 10588,3853 | 32 |
| 29 | 9398,1108 | 9985,9742 | 9412,1366 | 10587,8633 | 31 |
| 30 | 9398,5996 | 9985,9416 | 9412,6580 | 10587,3419 | 30 |
| | | Sin. 75. | | Tan. 75. | M |

| M | Sin. 14. | | Tan. 14. | | |
|---|---|---|---|---|---|
| 30 | 9398,5996 | 9985,9416 | 9412,6580 | 90587,3419 | 30 |
| 31 | 9399,0878 | 9985,9089 | 9413,1789 | 10586,8210 | 29 |
| 32 | 9399,5754 | 9985,8761 | 9413,6992 | 10586,3007 | 28 |
| 33 | 9400,0624 | 9985,8434 | 9414,2190 | 10585,7809 | 27 |
| 34 | 9400,5489 | 9985,8106 | 9414,7383 | 10585,2616 | 26 |
| 35 | 9401,0347 | 9985,7777 | 9415,2570 | 10584,7429 | 25 |
| 36 | 9401,5200 | 9985,7448 | 9415,7752 | 10584,2248 | 24 |
| 37 | 9402,0047 | 9985,7119 | 9416,2928 | 10583,7071 | 23 |
| 38 | 9402,4889 | 9985,6789 | 9416,8099 | 10583,1900 | 22 |
| 39 | 9402,9724 | 9985,6459 | 9417,3264 | 10582,6735 | 21 |
| 40 | 9403,4554 | 9985,6129 | 9417,8425 | 10582,1575 | 20 |
| 41 | 9403,9378 | 9985,5798 | 9418,3579 | 10581,6420 | 19 |
| 42 | 9404,4196 | 9985,5467 | 9418,8729 | 10581,1270 | 18 |
| 43 | 9404,9009 | 9985,5135 | 9419,3873 | 10580,6126 | 17 |
| 44 | 9405,3816 | 9985,4803 | 9419,9012 | 10580,0987 | 16 |
| 45 | 9405,8617 | 9985,4471 | 9420,4146 | 10579,5853 | 15 |
| 46 | 9406,3412 | 9985,4138 | 9420,9274 | 10579,0725 | 14 |
| 47 | 9406,8202 | 9985,3805 | 9421,4397 | 10578,5602 | 13 |
| 48 | 9407,2987 | 9985,3471 | 9421,9515 | 10578,0484 | 12 |
| 49 | 9407,7765 | 9985,3137 | 9422,4628 | 10577,5372 | 11 |
| 50 | 9408,2538 | 9985,2803 | 9422,9735 | 10577,0264 | 10 |
| 51 | 9408,7306 | 9985,2468 | 9423,4837 | 10576,5162 | 9 |
| 52 | 9409,2067 | 9985,2133 | 9423,9934 | 10576,0065 | 8 |
| 53 | 9409,6824 | 9985,1797 | 9424,5026 | 10575,4973 | 7 |
| 54 | 9410,1574 | 9985,1461 | 9425,0113 | 10574,9887 | 6 |
| 55 | 9410,6319 | 9985,1125 | 9425,5194 | 10574,4805 | 5 |
| 56 | 9411,1059 | 9985,0788 | 9426,0270 | 10573,9729 | 4 |
| 57 | 9411,5793 | 9985,0451 | 9426,5341 | 10573,4658 | 3 |
| 58 | 9412,0521 | 9985,0114 | 9427,0408 | 10572,9592 | 2 |
| 59 | 9412,5244 | 9984,9776 | 9427,5468 | 10572,4531 | 1 |
| 60 | 9412,9962 | 9984,9437 | 9428,0524 | 10571,9475 | 0 |
| | | Sin. 75. | | Tan. 75. | M |

| M | Sin. 15. | | Tan. 15. | | |
|---|---|---|---|---|---|
| 0 | 9412,9962 | 9984,9437 | 9428,0524 | 10571,9475 | 60 |
| 1 | 9413,4674 | 9984,9099 | 9428,5575 | 10571,4424 | 59 |
| 2 | 9413,9380 | 9984,8760 | 9429,0620 | 10570,9379 | 58 |
| 3 | 9414,4082 | 9984,8420 | 9429,5661 | 10570,4338 | 57 |
| 4 | 9414,8777 | 9984,8080 | 9430,0697 | 10569,9303 | 56 |
| 5 | 9415,3467 | 9984,7740 | 9430,5727 | 10569,4272 | 55 |
| 6 | 9415,8152 | 9984,7399 | 9431,0752 | 10568,9247 | 54 |
| 7 | 9416,2831 | 9984,7058 | 9431,5773 | 10568,4226 | 53 |
| 8 | 9416,7505 | 9984,6717 | 9432,0788 | 10567,9211 | 52 |
| 9 | 9417,2174 | 9984,6375 | 9432,5799 | 10567,4201 | 51 |
| 10 | 9417,6837 | 9984,6033 | 9433,0804 | 10566,9195 | 50 |
| 11 | 9418,1495 | 9984,5690 | 9433,5805 | 10566,4195 | 49 |
| 12 | 9418,6147 | 9984,5347 | 9434,0800 | 10565,9199 | 48 |
| 13 | 9419,0794 | 9984,5003 | 9434,5791 | 10565,4209 | 47 |
| 14 | 9419,5436 | 9984,4660 | 9435,0776 | 10564,9223 | 46 |
| 15 | 9420,0073 | 9984,4315 | 9435,5757 | 10564,4242 | 45 |
| 16 | 9420,4704 | 9984,3971 | 9436,0732 | 10563,9267 | 44 |
| 17 | 9420,9329 | 9984,3626 | 9436,5703 | 10563,4296 | 43 |
| 18 | 9421,3950 | 9984,3280 | 9437,0669 | 10562,9330 | 42 |
| 19 | 9421,8565 | 9984,2935 | 9437,5630 | 10562,4369 | 41 |
| 20 | 9422,3175 | 9984,2588 | 9438,0586 | 10561,9413 | 40 |
| 21 | 9422,7780 | 9984,2242 | 9438,5538 | 10561,4461 | 39 |
| 22 | 9423,2380 | 9984,1895 | 9439,0484 | 10560,9515 | 38 |
| 23 | 9423,6974 | 9984,1548 | 9439,5426 | 10560,4573 | 37 |
| 24 | 9424,1563 | 9984,1200 | 9440,0363 | 10559,9637 | 36 |
| 25 | 9424,6147 | 9984,0852 | 9440,5295 | 10559,4705 | 35 |
| 26 | 9425,0725 | 9984,0503 | 9441,0222 | 10558,9777 | 34 |
| 27 | 9425,5299 | 9984,0154 | 9441,5144 | 10558,4855 | 33 |
| 28 | 9425,9867 | 9983,9805 | 9442,0062 | 10557,9937 | 32 |
| 29 | 9426,4430 | 9983,9455 | 9442,4975 | 10557,5024 | 31 |
| 30 | 9426,8988 | 9983,9105 | 9442,9883 | 10557,0116 | 30 |
| | | Sin. 74. | | Tan. 74. | M |

| M | Sin. 9. | | Tan. 15. | | |
|---|---|---|---|---|---|
| 30 | 9426,8988 | 9983,9105 | 9442,9883 | 10557,0116 | 30 |
| 31 | 9427,3541 | 9983,8754 | 9443,4786 | 10556,5213 | 29 |
| 32 | 9427,8088 | 9983,8403 | 9443,9685 | 10556,0314 | 28 |
| 33 | 9428,2631 | 9983,8052 | 9444,4579 | 10555,5421 | 27 |
| 34 | 9428,7168 | 9983,7700 | 9444,9468 | 10555,0531 | 26 |
| 35 | 9429,1701 | 9983,7348 | 9445,4352 | 10554,5647 | 25 |
| 36 | 9429,6228 | 9983,6996 | 9445,9232 | 10554,0767 | 24 |
| 37 | 9430,0750 | 9983,6643 | 9446,4107 | 10553,5892 | 23 |
| 38 | 9430,5267 | 9983,6289 | 9446,8977 | 10553,1022 | 22 |
| 39 | 9430,9779 | 9983,5936 | 9447,3843 | 10552,6156 | 21 |
| 40 | 9431,4286 | 9983,5581 | 9447,8704 | 10552,1295 | 20 |
| 41 | 9431,8788 | 9983,5227 | 9448,3561 | 10551,6439 | 19 |
| 42 | 9432,3285 | 9983,4872 | 9448,8412 | 10551,1587 | 18 |
| 43 | 9432,7777 | 9983,4517 | 9449,3259 | 10550,6740 | 17 |
| 44 | 9433,2263 | 9983,4161 | 9449,8102 | 10550,1897 | 16 |
| 45 | 9433,6745 | 9983,3805 | 9450,2940 | 10549,7059 | 15 |
| 46 | 9434,1222 | 9983,3449 | 9450,7773 | 10549,2226 | 14 |
| 47 | 9434,5694 | 9983,3092 | 9451,2602 | 10548,7397 | 13 |
| 48 | 9435,0162 | 9983,2734 | 9451,7426 | 10548,2573 | 12 |
| 49 | 9435,4623 | 9983,2377 | 9452,2246 | 10547,7753 | 11 |
| 50 | 9435,9080 | 9983,2019 | 9452,7061 | 10547,2938 | 10 |
| 51 | 9436,3532 | 9983,1660 | 9453,1872 | 10546,8128 | 9 |
| 52 | 9436,7979 | 9983,1301 | 9453,6677 | 10546,3322 | 8 |
| 53 | 9437,2421 | 9983,0942 | 9454,1479 | 10545,8520 | 7 |
| 54 | 9437,6859 | 9983,0582 | 9454,6276 | 10545,3723 | 6 |
| 55 | 9438,1291 | 9983,0222 | 9455,1069 | 10544,8930 | 5 |
| 56 | 9438,5719 | 9982,9862 | 9455,5857 | 10544,4142 | 4 |
| 57 | 9439,0141 | 9982,9501 | 9456,0640 | 10543,9359 | 3 |
| 58 | 9439,4559 | 9982,9140 | 9456,5419 | 10543,4580 | 2 |
| 59 | 9439,8972 | 9982,8778 | 9457,0194 | 10542,9805 | 1 |
| 60 | 9440,3380 | 9982,8416 | 9457,4964 | 10542,5035 | 0 |
| | | Sin. 74. | | Tan. 47. | M |

| M | Sin. 16. | | Tan. 16. | | |
|---|---|---|---|---|---|
| 0 | 9440,3380 | 9982,8416 | 9457,4964 | 10542,5035 | 60 |
| 1 | 9440,7784 | 9982,8053 | 9457,9730 | 10542,0269 | 59 |
| 2 | 9441,2182 | 9982,7691 | 9458,4491 | 10541,5508 | 58 |
| 3 | 9441,6576 | 9982,7327 | 9458,9248 | 10541,0751 | 57 |
| 4 | 9442,0964 | 9982,6964 | 9459,4000 | 10540,5999 | 56 |
| 5 | 9442,5348 | 9982,6600 | 9459,8748 | 10540,1251 | 55 |
| 6 | 9442,9728 | 9982,6235 | 9460,3492 | 10539,6507 | 54 |
| 7 | 9443,4102 | 9982,5870 | 9460,8231 | 10539,1768 | 53 |
| 8 | 9443,8472 | 9982,5505 | 9461,2966 | 10538,7033 | 52 |
| 9 | 9444,2837 | 9902,5140 | 9461,7697 | 10538,2302 | 51 |
| 10 | 9444,7197 | 9982,4774 | 9462,2423 | 10537,7576 | 50 |
| 11 | 9445,1552 | 9982,4407 | 9462,7145 | 10537,2854 | 49 |
| 12 | 9445,5903 | 9982,4040 | 9463,1862 | 10536,8137 | 48 |
| 13 | 9446,0249 | 9082,3673 | 9463,6576 | 10536,3423 | 47 |
| 14 | 9446,4590 | 9982,3305 | 9464,1285 | 10535,8715 | 46 |
| 15 | 9446,8927 | 9982,2937 | 9464,5989 | 10535,4010 | 45 |
| 16 | 9447,3259 | 9982,2569 | 9465,0690 | 10534,9310 | 44 |
| 17 | 9447,7586 | 9982,2200 | 9465,5386 | 10534,4614 | 43 |
| 18 | 9448,1909 | 9982,1831 | 9466,0077 | 10533,9922 | 42 |
| 19 | 9448,6226 | 9982,1461 | 9466,4765 | 10533,5234 | 41 |
| 20 | 9449,0540 | 9982,1091 | 9466,9448 | 10533,0551 | 40 |
| 21 | 9449,4848 | 9982,0721 | 9467,4127 | 10532,5872 | 39 |
| 22 | 9449,9152 | 9982,0350 | 9467,8802 | 10532,1198 | 38 |
| 23 | 9450,3451 | 9981,9979 | 9468,3472 | 10531,6527 | 37 |
| 24 | 9450,7746 | 9981,9607 | 9468,8138 | 10531,1861 | 36 |
| 25 | 9451,2036 | 9981,9235 | 9469,2801 | 10530,7199 | 35 |
| 26 | 9451,6322 | 9981,8863 | 9469,7459 | 10530,2541 | 34 |
| 27 | 9452,0603 | 9981,8490 | 9470,2112 | 10529,7887 | 33 |
| 28 | 9452,4879 | 9981,8117 | 9470,6762 | 10529,3238 | 32 |
| 29 | 9452,9150 | 9981,7743 | 9471,1407 | 10528,8592 | 31 |
| 30 | 9453,3418 | 9981,7369 | 9471,6048 | 10528,3951 | 30 |
| | | Sin. 73. | | Tan. 73. | M |

| M | Sin. 16. | | Tan. 16. | | |
|---|---|---|---|---|---|
| 30 | 9453,3418 | 9981,7369 | 9471,6048 | 10528,3951 | 30 |
| 31 | 9453,7680 | 9981,6995 | 9472,0685 | 10527,9314 | 29 |
| 32 | 9454,1938 | 9981,6620 | 9472,5318 | 10527,4681 | 28 |
| 33 | 9454,6192 | 9981,6245 | 9472,9947 | 10527,0053 | 27 |
| 34 | 9455,0441 | 9981,5869 | 9473,4571 | 10526,5428 | 26 |
| 35 | 9455,4685 | 9981,5493 | 9473,9192 | 10526,0807 | 25 |
| 36 | 9455,8925 | 9981,5117 | 9474,3808 | 10525,6191 | 24 |
| 37 | 9456,3161 | 9981,4740 | 9474,8420 | 10525,1579 | 23 |
| 38 | 9456,7392 | 9981,4363 | 9475,3029 | 10524,6971 | 22 |
| 39 | 9457,1618 | 9981,3985 | 9475,7633 | 10524,2367 | 21 |
| 40 | 9457,5840 | 9981,3607 | 9476,2233 | 10523,7767 | 20 |
| 41 | 9458,0058 | 9981,3229 | 9476,6828 | 10523,3171 | 19 |
| 42 | 9458,4271 | 9981,2850 | 9477,1420 | 10522,8579 | 18 |
| 43 | 9458,8479 | 9981,2471 | 9477,6008 | 10522,3991 | 17 |
| 44 | 9459,2683 | 9981,2091 | 9478,0592 | 10521,9407 | 16 |
| 45 | 9459,6883 | 9981,1711 | 9478,5172 | 10521,4827 | 15 |
| 46 | 9460,1078 | 9981,1331 | 9478,9747 | 10521,0252 | 14 |
| 47 | 9460,5269 | 9981,0950 | 9479,4319 | 10520,5680 | 13 |
| 48 | 9460,9456 | 9981,0569 | 9479,8887 | 10520,1112 | 12 |
| 49 | 9461,3638 | 9981,0187 | 9480,3451 | 10519,6549 | 11 |
| 50 | 9461,7816 | 9980,9805 | 9480,8010 | 10519,1989 | 10 |
| 51 | 9462,1989 | 9980,9423 | 9481,2566 | 10518,7433 | 9 |
| 52 | 9462,6158 | 9980,9040 | 9481,7118 | 10518,2881 | 8 |
| 53 | 9463,0323 | 9980,8657 | 9482,1666 | 10517,8334 | 7 |
| 54 | 9463,4483 | 9980,8273 | 9482,6209 | 10517,3790 | 6 |
| 55 | 9463,8638 | 9980,7889 | 9483,0749 | 10516,9250 | 5 |
| 56 | 9464,2790 | 9980,7504 | 9483,5285 | 10516,4714 | 4 |
| 57 | 9464,6937 | 9980,7120 | 9483,9817 | 10516,0182 | 3 |
| 58 | 9465,1080 | 9980,6734 | 9484,4345 | 10515,5654 | 2 |
| 59 | 9465,5219 | 9980,6349 | 9484,8870 | 10515,1130 | 1 |
| 60 | 9465,9353 | 9980,5963 | 9485,3390 | 10514,6609 | 0 |
| | | Sin. 73. | | Tan. 73. | M. |

| M | Sin. 17. | | Tan. 17. | | |
|---|---|---|---|---|---|
| 0 | 9465,9353 | 9980,5963 | 9485,3390 | 10514,6609 | 60 |
| 1 | 9466,3483 | 9980,5576 | 9485,7906 | 10514,2093 | 59 |
| 2 | 9466,7609 | 9980,5189 | 9486,2429 | 10513,7580 | 58 |
| 3 | 9467,1730 | 9980,4802 | 9486,6927 | 10513,3072 | 57 |
| 4 | 9467,5847 | 9980,4415 | 9487,1432 | 10512,8567 | 56 |
| 5 | 9467,9960 | 9980,4027 | 9487,5933 | 10512,4066 | 55 |
| 6 | 9468,4069 | 9980,3638 | 9488,0430 | 10511,9569 | 54 |
| 7 | 9468,8173 | 9980,3249 | 9488,4923 | 10511,5076 | 53 |
| 8 | 9469,2273 | 9980,2860 | 9488,9412 | 10511,0583 | 52 |
| 9 | 9469,6369 | 9980,2470 | 9489,3898 | 10510,6101 | 51 |
| 10 | 9470,0460 | 9980,2080 | 9489,8380 | 10510,1619 | 50 |
| 11 | 9470,4548 | 9980,1690 | 9490,2858 | 10509,7142 | 49 |
| 12 | 9470,8634 | 9980,1299 | 9490,7332 | 10509,2668 | 48 |
| 13 | 9471,2710 | 9980,0908 | 9491,1802 | 10508,8197 | 47 |
| 14 | 9471,6785 | 9980,0516 | 9491,6268 | 10508,3731 | 46 |
| 15 | 9472,0856 | 9980,0124 | 9492,0731 | 10507,9268 | 45 |
| 16 | 9472,4922 | 9979,9732 | 9492,5109 | 10507,4809 | 44 |
| 17 | 9472,8984 | 9979,9339 | 9492,9645 | 10507,0354 | 43 |
| 18 | 9473,3042 | 9979,8945 | 9493,4097 | 10506,5903 | 42 |
| 19 | 9473,7096 | 9979,8552 | 9493,8544 | 10506,1455 | 41 |
| 20 | 9474,1146 | 9979,8158 | 9494,2988 | 10505,7011 | 40 |
| 21 | 9474,5192 | 9979,7763 | 9494,7428 | 10505,2571 | 39 |
| 22 | 9474,9233 | 9979,7368 | 9495,1865 | 10504,8135 | 38 |
| 23 | 9475,3271 | 9979,6973 | 9495,6297 | 10504,3702 | 37 |
| 24 | 9475,7304 | 9979,6577 | 9496,0726 | 10503,9273 | 36 |
| 25 | 9476,1333 | 9979,6181 | 9496,5152 | 10503,4848 | 35 |
| 26 | 9476,5358 | 9979,5785 | 9496,9573 | 10503,0426 | 34 |
| 27 | 9476,9379 | 9979,5388 | 9497,3991 | 10502,6008 | 33 |
| 28 | 9477,3396 | 9979,4990 | 9497,8405 | 10502,1594 | 32 |
| 29 | 9477,7409 | 9979,4593 | 9498,2816 | 10501,7183 | 31 |
| 30 | 9478,1418 | 9979,4195 | 9498,7223 | 10501,2777 | 30 |
| | | Sin. 72. | | Tan. 72. | M |

| M | Sin. 17. | | Tan. 17. | | |
|---|---|---|---|---|---|
| 30 | 9478,1418 | 9979,4195 | 9498,7223 | 10501,2777 | 30 |
| 31 | 9478,5422 | 9979,3796 | 9499,1626 | 10500,8373 | 29 |
| 32 | 9478,9423 | 9979,3397 | 9499,6025 | 10500,3974 | 28 |
| 33 | 9479,3420 | 9979,2998 | 9500,0421 | 10499,9578 | 27 |
| 34 | 9479,7412 | 9979,2598 | 9500,4814 | 10499,5186 | 26 |
| 35 | 9480,1401 | 9979,2198 | 9500,9202 | 10499,0797 | 25 |
| 36 | 9480,5385 | 9979,1797 | 9501,3587 | 10498,6412 | 24 |
| 37 | 9480,9365 | 9979,1396 | 9501,7969 | 10498,2030 | 23 |
| 38 | 9481,3342 | 9979,0995 | 9502,2346 | 10497,7653 | 22 |
| 39 | 9481,7314 | 9979,0593 | 9502,6721 | 10497,3279 | 21 |
| 40 | 9482,1283 | 9979,0191 | 9503,1091 | 10496,8908 | 20 |
| 41 | 9482,5247 | 9978,9789 | 9503,5458 | 10496,4541 | 19 |
| 42 | 9482,9208 | 9978,9386 | 9503,9822 | 10496,0177 | 18 |
| 43 | 9483,3164 | 9978,8982 | 9504,4182 | 10495,5818 | 17 |
| 44 | 9483,7117 | 9978,8579 | 9504,8538 | 10495,1461 | 16 |
| 45 | 9484,1065 | 9978,8174 | 9505,2891 | 10494,7109 | 15 |
| 46 | 9484,5010 | 5978,7770 | 9505,7240 | 10494,2759 | 14 |
| 47 | 9484,8951 | 9978,7365 | 9506,1585 | 10493,8414 | 13 |
| 48 | 9485,2887 | 9978,6959 | 9506,5928 | 10493,4072 | 12 |
| 49 | 9485,6820 | 9978,6553 | 9507,0266 | 10492,9733 | 11 |
| 50 | 9486,0749 | 9978,6147 | 9507,4601 | 10492,5398 | 10 |
| 51 | 9486,4674 | 9978,5741 | 9507,8933 | 10492,1066 | 9 |
| 52 | 9486,8595 | 9978,5333 | 9508,3261 | 10491,6738 | 8 |
| 53 | 9487,2512 | 9978,4926 | 9508,7586 | 10491,2414 | 7 |
| 54 | 9487,6425 | 9978,4518 | 9509,1906 | 10490,8093 | 6 |
| 55 | 9488,0335 | 9978,4110 | 9509,6224 | 10490,3775 | 5 |
| 56 | 9488,4240 | 9978,3701 | 9510,0538 | 10489,9461 | 4 |
| 57 | 9488,8142 | 9978,3292 | 9510,4849 | 10489,5150 | 3 |
| 58 | 9489,2039 | 9978,2883 | 9510,9156 | 10489,0843 | 2 |
| 59 | 9489,5933 | 9978,2473 | 9511,3460 | 10488,6539 | 1 |
| 60 | 9489,9823 | 9978,2063 | 9511,7760 | 10488,2239 | 0 |
| | | Sin. 72. | | Tan. 72. | M |

| M | Sin. 18 | | Tan. 18. | | |
|---|---|---|---|---|---|
| 0 | 9489,9823 | 9978,2063 | 9511,7760 | 10488,2239 | 60 |
| 1 | 9490,3709 | 9978,1652 | 9512,2057 | 10487,7942 | 59 |
| 2 | 9490 7592 | 9978,1241 | 9512,6350 | 10487,3649 | 58 |
| 3 | 9491,1470 | 9978,0830 | 9513,0640 | 10486,9359 | 57 |
| 4 | 9491,5345 | 9978,0418 | 9513,4927 | 10486,5073 | 56 |
| 5 | 9491,9216 | 9978,0005 | 9513,9210 | 10486,0789 | 55 |
| 6 | 9492,3083 | 9977,9593 | 9514,3490 | 10485,6510 | 54 |
| 7 | 9492,6946 | 9977,9180 | 9514,7766 | 10485,2233 | 53 |
| 8 | 9493,0805 | 9977,8766 | 9515,2039 | 10484,7960 | 52 |
| 9 | 9493,4661 | 9977,8352 | 9515,6308 | 10484,3691 | 51 |
| 10 | 9493,8513 | 9977,7938 | 9516,0575 | 10483,9424 | 50 |
| 11 | 9494,2361 | 9977,7523 | 9516,4838 | 10483,5162 | 49 |
| 12 | 9494,6205 | 9977,7108 | 9516,9097 | 10483,0902 | 48 |
| 13 | 9495,0046 | 9977,6692 | 9517,3353 | 10482,6646 | 47 |
| 14 | 9495,3882 | 9977,6276 | 9517,7606 | 10482,2394 | 46 |
| 15 | 9495,7715 | 9977,5860 | 9518,1855 | 10481,8144 | 45 |
| 16 | 9496,1544 | 9977,5443 | 9518,6101 | 10481,3898 | 44 |
| 17 | 9496,5370 | 9977,5026 | 9519,0344 | 10480,9656 | 43 |
| 18 | 9496,9192 | 9977,4608 | 9519,4583 | 10480,5416 | 42 |
| 19 | 9497,3010 | 9977,4190 | 9519,8819 | 10480,1180 | 41 |
| 20 | 9497,6824 | 9977,3772 | 9520,3052 | 10479,6947 | 40 |
| 21 | 9498,0635 | 9977,3353 | 9520,7281 | 10479,2718 | 39 |
| 22 | 9498,4442 | 9977,2934 | 9521,1507 | 10478,8492 | 38 |
| 23 | 9498,8245 | 9977,2514 | 9521,5730 | 10478,4269 | 37 |
| 24 | 9499,2044 | 9977,2094 | 9521,9950 | 10478,0050 | 36 |
| 25 | 9499,5840 | 9977,1674 | 9522,4166 | 10477,5833 | 35 |
| 26 | 9499,9632 | 9977,1253 | 9522,8379 | 10477,1620 | 34 |
| 27 | 9500,3421 | 9977,0832 | 9523,2589 | 10476,7411 | 33 |
| 28 | 9500,7205 | 9977,0410 | 9523,6795 | 10476,3204 | 32 |
| 29 | 9501,0987 | 9976,9988 | 9524,0998 | 10475,9001 | 31 |
| 30 | 9501,4764 | 9976,9565 | 9524,5198 | 10475,4801 | 30 |
| | | Sin. 71. | | Tang. 71 | M |

| M | Sin. 18. | | Tan. 18. | | |
|---|---|---|---|---|---|
| 30 | 9501,4764 | 9976,9565 | 9524,5198 | 10475,4801 | 30 |
| 31 | 9501,8538 | 9976,9143 | 9524,9395 | 10475,0604 | 29 |
| 32 | 9502,2308 | 9976,8719 | 9525,3588 | 10474,6411 | 28 |
| 33 | 9502,6075 | 9976,8296 | 9525,7779 | 10474,2221 | 27 |
| 34 | 9502,9837 | 9976,7871 | 9526,1966 | 10473,8033 | 26 |
| 35 | 9503,3597 | 9976,7447 | 9526,6150 | 10473,3850 | 25 |
| 36 | 9503,7352 | 9976,7022 | 9527,0330 | 10472,9669 | 24 |
| 37 | 9504,1104 | 9976,6597 | 9527,4508 | 10472,5492 | 23 |
| 38 | 9504,4853 | 9976,6171 | 9527,8682 | 10472,1318 | 22 |
| 39 | 9504,8598 | 9976,5745 | 9528,2853 | 10471,7146 | 21 |
| 40 | 9505,2339 | 9976,5318 | 9528,7021 | 10471,2979 | 20 |
| 41 | 9505,6077 | 9976,4891 | 9529,1185 | 10470,8814 | 19 |
| 42 | 9505,9811 | 9976,4464 | 9529,5347 | 10470,4652 | 18 |
| 43 | 9506,3541 | 9976,4036 | 9529,9505 | 10470,0494 | 17 |
| 44 | 9506,7268 | 9976,3608 | 9530,3660 | 10469,6339 | 16 |
| 45 | 9507,0992 | 9976,3179 | 9530,7812 | 10469,2187 | 15 |
| 46 | 9507,4711 | 9976,2750 | 9531,1961 | 10468,8038 | 14 |
| 47 | 9507,8428 | 9976,2320 | 9531,6107 | 10468,3892 | 13 |
| 48 | 9508,2140 | 9976,1891 | 9532,0249 | 10467,9750 | 12 |
| 49 | 9508,5850 | 9976,1460 | 9532,4389 | 10467,5610 | 11 |
| 50 | 9508,9555 | 9976,1030 | 9532,8525 | 10467,1474 | 10 |
| 51 | 9509,3257 | 9976,0599 | 9533,2658 | 10466,7341 | 9 |
| 52 | 9509,6956 | 9976,0167 | 9533,6789 | 10466,3211 | 8 |
| 53 | 9510,065 | 9975,9735 | 9534,0916 | 10465,9084 | 7 |
| 54 | 9510,4845 | 9975,9303 | 9534,5039 | 10465,4960 | 6 |
| 55 | 9510,8031 | 9975,8870 | 9534,9160 | 10465,0839 | 5 |
| 56 | 9511,1715 | 9975,8437 | 9535,3278 | 10464,6721 | 4 |
| 57 | 9511,5396 | 9975,8003 | 9535,7393 | 10464,2607 | 3 |
| 58 | 9511,9[illegible]74 | 9975,7569 | 9536,1504 | 10463,8495 | 2 |
| 59 | 9512,2748 | 9975,7135 | 9536,5613 | 10463,4386 | 1 |
| 60 | 9512,6419 | 9975,6700 | 6536,9718 | 10463,0281 | 0 |
| | | Sin. 71. | | Tan. 71. | M |

F

| M | Sin. 19. | | Tan. 19. | | |
|---|---|---|---|---|---|
| 0 | 9512,6419 | 9975,6700 | 9536,9718 | 10463,0281 | 60 |
| 1 | 9513,0086 | 9975,6265 | 9537,3820 | 10462,6179 | 59 |
| 2 | 9513,3750 | 9975,5829 | 9537,7920 | 10462,2079 | 58 |
| 3 | 9513,7410 | 9975,5393 | 9538,2016 | 10461,7983 | 57 |
| 4 | 9514,1067 | 9975,4957 | 9538,6109 | 10461,3890 | 56 |
| 5 | 9514,4720 | 9975,4520 | 9539,0200 | 10460,9800 | 55 |
| 6 | 9514,8370 | 9975,4083 | 9539,4287 | 10460,5712 | 54 |
| 7 | 9515,2017 | 9975,3645 | 9539,8371 | 10460,1628 | 53 |
| 8 | 9515,5660 | 9975,3207 | 9540,2452 | 10459,7547 | 52 |
| 9 | 9515,9299 | 9975,2769 | 9540,6530 | 10459,3469 | 51 |
| 10 | 9516,2936 | 9975,2330 | 9541,0606 | 10458,9394 | 50 |
| 11 | 9516,6569 | 9975,1890 | 9541,4678 | 10458,5321 | 49 |
| 12 | 9517,0198 | 9975,1451 | 9541,8747 | 10458,1252 | 48 |
| 13 | 9517,3824 | 9975,1010 | 9542,2813 | 10457,7186 | 47 |
| 14 | 9517,7447 | 9975,0570 | 9542,6876 | 10457,3123 | 46 |
| 15 | 9518,1066 | 9975,0129 | 9543,0936 | 10457,9063 | 45 |
| 16 | 9518,4682 | 9974,9688 | 9543,4994 | 10456,5006 | 44 |
| 17 | 9518,8294 | 9974,9246 | 9543,9048 | 10456,0951 | 43 |
| 18 | 9519,1903 | 9974,8804 | 9544,3099 | 10455,6900 | 42 |
| 19 | 9519,5509 | 9974,8361 | 9544,7148 | 10455,2851 | 41 |
| 20 | 9519,9112 | 9974,79[illegible]8 | 9545,1193 | 10454,8806 | 40 |
| 21 | 9520,2711 | 9974,7475 | 9545,5236 | 10454,4764 | 39 |
| 22 | 9520,6306 | 9974,7031 | 9545,9275 | 10454,0724 | 38 |
| 23 | 9520,9899 | 9974,6587 | 9546,3312 | 10453,6687 | 37 |
| 24 | 9521,3488 | 9974,6142 | 9546,7346 | 10453,2654 | 36 |
| 25 | 9521,7073 | 9974,5697 | 9547,1376 | 10452,8623 | 35 |
| 26 | 9522,0656 | 9974,5251 | 9547,5404 | 10452,4595 | 34 |
| 27 | 9522,4235 | 9974,4805 | 9547,9429 | 10452,0570 | 33 |
| 28 | 9522,7811 | 9974,4359 | 9548,3451 | 10451,6548 | 32 |
| 29 | 9523,1383 | 9974,3912 | 9548,7470 | 10451,2529 | 31 |
| 30 | 9523,4952 | 9974,3465 | 9549,1487 | 10450,8513 | 30 |
| | | Sin. 70. | | Tan. 70. | M |

| M | Sin. 19. | | Tan. 19. | | |
|---|---|---|---|---|---|
| 30 | 9523,4952 | 9974,3465 | 9549,1487 | 10450,8513 | 30 |
| 31 | 9523,8518 | 9974,3018 | 9549,5500 | 10450,4499 | 29 |
| 32 | 9524,2080 | 9974,2570 | 9549,9511 | 10450,0489 | 28 |
| 33 | 9524,5640 | 9974,2121 | 9550,3518 | 10449,6481 | 27 |
| 34 | 9524,9196 | 9974,1672 | 9550,7523 | 10449,2476 | 26 |
| 35 | 9525,2748 | 9974,1223 | 9551,1525 | 14448,8474 | 25 |
| 36 | 9525,6298 | 9974,0774 | 9551,5524 | 10448,4475 | 24 |
| 37 | 9525,9844 | 9974,0324 | 9551,9520 | 10448,0479 | 23 |
| 38 | 9526,3387 | 9973,9873 | 9552,3514 | 10447,6486 | 22 |
| 39 | 9526,6927 | 9973,9422 | 9552,7504 | 18447,2495 | 21 |
| 40 | 9527,0463 | 9973,8971 | 9553,1492 | 10446,8507 | 20 |
| 41 | 9527,3996 | 9973,8519 | 9553,5477 | 10446,4522 | 19 |
| 42 | 9527,7526 | 9973,8067 | 9553,9459 | 10446,0540 | 18 |
| 43 | 9728,1053 | 9973,7614 | 9554,3438 | 10445,6561 | 17 |
| 44 | 9528,4576 | 9973,7161 | 9554,7414 | 10445,2585 | 16 |
| 45 | 9528,8096 | 9973,6708 | 9555,1388 | 10444,8611 | 15 |
| 46 | 9529,1613 | 9973,6254 | 9555,5359 | 10444,4641 | 14 |
| 47 | 9529,5127 | 9973,5800 | 9555,9327 | 10444,0673 | 13 |
| 48 | 9529,8638 | 9973,5346 | 9556,3292 | 10443,6707 | 12 |
| 49 | 6530,2145 | 9973,4890 | 9556,7254 | 10443,2745 | 11 |
| 50 | 9530,5649 | 9973,4435 | 9557,1214 | 10442,8785 | 10 |
| 51 | 9530,9150 | 9973,3979 | 9557,5171 | 10442,4828 | 9 |
| 52 | 9531,2648 | 9973,3523 | 9557,9125 | 10442,0874 | 8 |
| 53 | 9531,6143 | 9973,3066 | 9558,3076 | 10441,6923 | 7 |
| 54 | 9531,9634 | 9973,2609 | 9558,7025 | 10441,2974 | 6 |
| 55 | 9532,3123 | 9973,2152 | 9559,0971 | 10440,9029 | 5 |
| 56 | 9532,6608 | 9973,1694 | 9559,4914 | 10440,5086 | 4 |
| 57 | 9533,0090 | 9973,1235 | 9559,8854 | 10440,1145 | 3 |
| 58 | 9533,3568 | 9973,0777 | 9560,2791 | 10439,7208 | 2 |
| 59 | 9533,7044 | 9973,0317 | 9560,6726 | 10439,3273 | 1 |
| 60 | 9534,0516 | 9972,9858 | 9561,0658 | 10438,9341 | 0 |
| | | Sin. 70. | | Tan. 70. | M |

| M | Sin.20. | | Tan.16 | | |
|---|---|---|---|---|---|
| 0 | 9534,0516 | 9972,9858 | 9561,0658 | 10438,9341 | 60 |
| 1 | 9534,3986 | 9972,9398 | 9561,4588 | 10438,5411 | 59 |
| 2 | 9534,7452 | 9972,8937 | 9561,8514 | 10438,1485 | 58 |
| 3 | 9535,0915 | 9972,8476 | 9562,2438 | 10437,7561 | 57 |
| 4 | 9535,4375 | 9972,8015 | 9562,6359 | 10437,3640 | 56 |
| 5 | 9535,7832 | 9972,7554 | 9563,0278 | 10436,9721 | 55 |
| 6 | 9536,1286 | 9972,7091 | 9563,4194 | 10436,5805 | 54 |
| 7 | 9536,4736 | 9972,6629 | 9563,8107 | 10436,1892 | 53 |
| 8 | 9536,8184 | 9972,6166 | 9564,2017 | 10435,7982 | 52 |
| 9 | 9537,1628 | 9972,5703 | 9564,5925 | 10435,4074 | 51 |
| 10 | 9537,5069 | 9972,5239 | 9564,9830 | 10435,0169 | 50 |
| 11 | 9537,8508 | 9972,4775 | 9565,3733 | 10434,6267 | 49 |
| 12 | 9538,1943 | 9972,4310 | 9565,7632 | 10434,2367 | 48 |
| 13 | 9538,5375 | 9972,3845 | 9566,1530 | 10433,8470 | 47 |
| 14 | 9538,8804 | 9972,3380 | 9566,5424 | 10433,4575 | 46 |
| 15 | 9539,2230 | 9972,2914 | 9566,9316 | 10433,0684 | 45 |
| 16 | 9539,5653 | 9972,2448 | 9567,3205 | 10432,6795 | 44 |
| 17 | 9539,9073 | 9972,1981 | 9567,7091 | 10432,2908 | 43 |
| 18 | 9540,2489 | 9972,1514 | 9568,0975 | 10431,9024 | 42 |
| 19 | 9540,5903 | 9972,1046 | 9568,4856 | 10431,5143 | 41 |
| 20 | 9540,9313 | 9972,0578 | 9568,8735 | 10431,1265 | 40 |
| 21 | 9541,2721 | 9972,0110 | 9569,2610 | 10430,7389 | 39 |
| 22 | 9541,6125 | 9971,9641 | 9569,6484 | 10430,3515 | 38 |
| 23 | 9541,9527 | 9971,9172 | 9570,0354 | 10429,9645 | 37 |
| 24 | 9542,2925 | 9971,8702 | 9570,4222 | 10429,5777 | 36 |
| 25 | 9542,6321 | 9971,8232 | 9570,8088 | 10429,1911 | 35 |
| 26 | 9542,9713 | 9971,7762 | 9571,1951 | 10428,8048 | 34 |
| 27 | 9543,3102 | 9971,7291 | 9571,5811 | 10428,4188 | 33 |
| 28 | 9543,6489 | 9971,6820 | 9571,9669 | 10428,0330 | 32 |
| 29 | 9543,9872 | 9971,6348 | 9572,3524 | 10427,6475 | 31 |
| 30 | 9544,3253 | 9971,5876 | 9572,7376 | 10427,2623 | 30 |
| | | Sin.69. | | Tan.60. | M |

| M | Sin. 20. | | Tan. 20. | | |
|---|---|---|---|---|---|
| 30 | 9544,3253 | 9971,5876 | 9572,7376 | 10427,2623 | 30 |
| 31 | 9544,6630 | 9971,5403 | 9573,1226 | 10426,8773 | 29 |
| 32 | 9545,0004 | 9971,4930 | 9573,5074 | 10426,4925 | 28 |
| 33 | 9545,3376 | 9971,4457 | 9573,8918 | 10426,1081 | 27 |
| 34 | 9545,6744 | 9971,3983 | 9574,2761 | 10425,7239 | 26 |
| 35 | 9546,0110 | 9971,3509 | 9574,6600 | 10425,3399 | 25 |
| 36 | 9546,3472 | 9971,3034 | 9575,0437 | 10424,9562 | 24 |
| 37 | 9546,6832 | 9971,2559 | 9575,4272 | 10424,5727 | 23 |
| 38 | 9547,0188 | 9971,2084 | 9575,8104 | 10424,1895 | 22 |
| 39 | 9547,3542 | 9971,1608 | 9576,1933 | 10423,8066 | 21 |
| 40 | 9547,6892 | 9971,1131 | 9576,5760 | 10423,4239 | 20 |
| 41 | 9548,0240 | 9971,0655 | 9576,9585 | 10423,0414 | 19 |
| 42 | 9548,3585 | 9971,0178 | 9577,3407 | 10422,6592 | 18 |
| 43 | 9548,6926 | 9970,9700 | 9577,7226 | 10422,2773 | 17 |
| 44 | 9549,0265 | 9970,9222 | 9578,1043 | 10421,8956 | 16 |
| 45 | 9549,3601 | 9970,8744 | 9578,4857 | 10421,5142 | 15 |
| 46 | 9549,6934 | 9970,8265 | 9578,8669 | 10421,1330 | 14 |
| 47 | 9550,0264 | 9970,7786 | 9579,2478 | 10420,7521 | 13 |
| 48 | 9550,3591 | 9970,7306 | 9579,6285 | 10420,3714 | 12 |
| 49 | 9550,6916 | 9970,6826 | 9580,0090 | 10419,9910 | 11 |
| 50 | 9551,0237 | 9970,6345 | 9580,3891 | 10419,6108 | 10 |
| 51 | 9551,3555 | 9970,5864 | 9580,7691 | 10419,2308 | 9 |
| 52 | 9551,6871 | 9970,5383 | 9581,1488 | 10418,8512 | 8 |
| 53 | 9552,0184 | 9970,4901 | 9581,5282 | 10418,4717 | 7 |
| 54 | 9552,3493 | 9970,4419 | 9581,9074 | 10418,0925 | 6 |
| 55 | 9552,6800 | 9970,3936 | 9582,2864 | 10417,7126 | 5 |
| 56 | 9553,0104 | 9970,3453 | 9582,6651 | 10417,3349 | 4 |
| 57 | 9553,3405 | 9970,2970 | 9583,0435 | 10416,9564 | 3 |
| 58 | 9553,6703 | 9970,2486 | 9583,4217 | 17416,5782 | 2 |
| 59 | 9553,9999 | 9970,2002 | 9583,7997 | 10416,2002 | 1 |
| 60 | 9554,3291 | 9970,1517 | 9584,1774 | 10415,8225 | 0 |
| | | Sin. 69. | | Tan. 69. | M |

| M | Sin. 21. | | Tan. 21. | | |
|---|---|---|---|---|---|
| 0 | 9554,3291 | 9970,1517 | 9584,1774 | 10415,8225 | 60 |
| 1 | 9554,6581 | 9970,1032 | 9584,5549 | 10415,4451 | 59 |
| 2 | 9554,9868 | 9970,0546 | 9584,9321 | 10415,0678 | 58 |
| 3 | 9555,315[illegible] | 9970,0060 | 9585,3091 | 10414,6908 | 57 |
| 4 | 9555,6433 | 9969,9574 | 9585,6858 | 10414,3141 | 56 |
| 5 | 9555,9711 | 9969,9087 | 9586,0623 | 10413,9376 | 55 |
| 6 | 9556,2986 | 9969,8600 | 9586,4386 | 10413,5613 | 54 |
| 7 | 9556,6259 | 9969,8112 | 9586,8146 | 10413,1853 | 53 |
| 8 | 9556,9528 | 9969,7624 | 9587,1904 | 10412,8095 | 52 |
| 9 | 9557,2795 | 9969,7135 | 9587,5659 | 10412,4340 | 51 |
| 10 | 9557,6059 | 9969,6647 | 9587,9412 | 10412,0587 | 50 |
| 11 | 9557,9326 | 9969,6157 | 9588,3163 | 10411,6836 | 49 |
| 12 | 9558,2579 | 9969,5667 | 9588,6911 | 10411,3088 | 48 |
| 13 | 9558,5835 | 9969,5177 | 9589,0657 | 10410,9342 | 47 |
| 14 | 9558,9087 | 9969,4686 | 9589,4401 | 10410,5599 | 46 |
| 15 | 9559,2337 | 9969,4195 | 9589,8142 | 10410,1858 | 45 |
| 16 | 9559,5585 | 9969,3704 | 9590,1880 | 10409,8119 | 44 |
| 17 | 9559,8829 | 9969,3212 | 6590,5617 | 10409,4383 | 43 |
| 18 | 9560,2071 | 9969,2720 | 9590,9351 | 10409,0649 | 42 |
| 19 | 9560,5309 | 9969,2227 | 9591,3082 | 10408,6917 | 41 |
| 20 | 9560,8546 | 9969,1734 | 9591,6811 | 10408,3188 | 40 |
| 21 | 9561,1779 | 9969,1240 | 9592,0538 | 10407,9461 | 39 |
| 22 | 9561,5009 | 9969,0746 | 9592,4263 | 10407,5736 | 38 |
| 23 | 9561,8237 | 9969,0252 | 9592,7985 | 10407,2014 | 37 |
| 24 | 9562,1462 | 9968,9757 | 9593,1705 | 10406,8294 | 36 |
| 25 | 9562,4684 | 9968,9261 | 9593,5422 | 10406,4577 | 35 |
| 26 | 9562,7904 | 9968,8766 | 9593,9137 | 10406,0862 | 34 |
| 27 | 9563,1120 | 9968,8270 | 9594,2850 | 10405,7149 | 33 |
| 28 | 9563,4334 | 9968,7773 | 9594,6561 | 10405,3438 | 32 |
| 29 | 9563,7565 | 9968,7276 | 9595,0269 | 10404,9730 | 31 |
| 30 | 9564,0754 | 9968,6779 | 9595,3975 | 10404,6024 | 30 |
| | | Sin. 68. | | Tan. 68. | M |

| M | Sin. 21. | | Tan. 21. | | |
|---|---|---|---|---|---|
| 30 | 9564,0754 | 9968,6779 | 9595,3975 | 10404,6024 | 30 |
| 31 | 9564,3960 | 9968,6281 | 9595,7678 | 10404,2321 | 29 |
| 32 | 9564,7163 | 9968,5783 | 9596,1380 | 10403,8619 | 28 |
| 33 | 9565,0363 | 9968,5284 | 9596,5079 | 10403,4920 | 27 |
| 34 | 9565,3560 | 9968,4785 | 9596,8776 | 10403,1224 | 26 |
| 35 | 9565,6755 | 9968,4285 | 9597,2470 | 10402,7529 | 25 |
| 36 | 9565,9947 | 9968,3785 | 9597,6162 | 10402,3837 | 24 |
| 37 | 9566,3137 | 9968,3285 | 9597,9852 | 10402,0147 | 23 |
| 38 | 9566,6324 | 9968,2784 | 9598,3539 | 10401,6460 | 22 |
| 39 | 9566,9508 | 9968,2283 | 9598,7224 | 10401,2775 | 21 |
| 40 | 9567,2689 | 9968,1781 | 9599,0907 | 10400,9092 | 20 |
| 41 | 9567,5867 | 9968,1279 | 9599,4588 | 10400,5412 | 19 |
| 42 | 9567,9043 | 9968,0776 | 9599,8267 | 10400,1733 | 18 |
| 43 | 9568,2217 | 9968,0274 | 9600,1943 | 10399,8057 | 17 |
| 44 | 9568,5387 | 9967,9770 | 9600,5617 | 10399,4383 | 16 |
| 45 | 9568,8555 | 9967,9266 | 9600,9288 | 10399,0711 | 15 |
| 46 | 9569,1720 | 9967,8762 | 9601,2958 | 10398,7041 | 14 |
| 47 | 9569,4883 | 9967,8257 | 9601,6625 | 10398,3374 | 13 |
| 48 | 9569,8042 | 9967,7752 | 9602,0290 | 10397,9709 | 12 |
| 49 | 9570,1200 | 9967,7247 | 9602,3952 | 10397,6047 | 11 |
| 50 | 9570,4354 | 9967,6741 | 9602,7613 | 10397,2386 | 10 |
| 51 | 9570,7506 | 9967,6235 | 9603,1271 | 10396,8728 | 9 |
| 52 | 9571,0645 | 9967,5728 | 9603,4927 | 10396,5072 | 8 |
| 53 | 9571,3802 | 9967,5221 | 9603,8581 | 10396,1418 | 7 |
| 54 | 9571,6946 | 9967,4713 | 9604,2232 | 10395,7767 | 6 |
| 55 | 9572,0087 | 9967,4205 | 9604,5881 | 10395,4118 | 5 |
| 56 | 9572,3225 | 9967,3697 | 9604,9529 | 10395,0471 | 4 |
| 57 | 9572,6362 | 9967,3188 | 9605,3174 | 10394,6826 | 3 |
| 58 | 9572,9495 | 9967,2678 | 9605,6816 | 10394,3183 | 2 |
| 59 | 9573,2626 | 9967,2168 | 9606,0457 | 10393,9542 | 1 |
| 60 | 9573,5754 | 9967,1658 | 9606,4095 | 10393,5904 | 0 |
| | | Sin. 68 | | Tan. 68. | M |

| M | Sin.22 | | Tan.22. | | |
|---|---|---|---|---|---|
| 0 | 9573,5754 | 9967,1658 | 9606,4095 | 10393,5904 | 60 |
| 1 | 9573,8879 | 9967,1147 | 9606,7731 | 10393,2268 | 59 |
| 2 | 9574,2002 | 9967,0636 | 9607,1365 | 10392,8634 | 58 |
| 3 | 9574,5122 | 9967,0125 | 9607,4997 | 10392,5002 | 57 |
| 4 | 9574,8240 | 9966,9613 | 9607,8627 | 10392,1372 | 56 |
| 5 | 9575,1355 | 9966,9101 | 9608,2254 | 10391,7745 | 55 |
| 6 | 9575,4468 | 9966,8588 | 9608,5879 | 10391,4120 | 54 |
| 7 | 9575,7578 | 9966,8075 | 9608,9502 | 10391,0497 | 53 |
| 8 | 9576,0685 | 9966,7561 | 9609,3123 | 10390,6876 | 52 |
| 9 | 9576,3789 | 9966,7047 | 9609,6742 | 10390,3257 | 51 |
| 10 | 9576,6892 | 9966,6533 | 9610,0359 | 10389,9641 | 50 |
| 11 | 9576,9991 | 9966,6018 | 9610,3973 | 10389,6026 | 49 |
| 12 | 9577,3088 | 9966,5502 | 9610,7585 | 10389,2414 | 48 |
| 13 | 9577,6182 | 9966,4987 | 9611,1195 | 10388,8804 | 47 |
| 14 | 9577,9274 | 9966,4470 | 9611,4803 | 10388,5196 | 46 |
| 15 | 9578,2363 | 9966,3954 | 9611,8409 | 10388,1590 | 45 |
| 16 | 9578,5450 | 9966,3437 | 9612,2013 | 10387,7986 | 44 |
| 17 | 9578,8534 | 9966,2919 | 9612,5614 | 10387,4385 | 43 |
| 18 | 9579,1616 | 9966,2401 | 9612,9214 | 10387,0785 | 42 |
| 19 | 9579,4695 | 9966,1883 | 9613,2811 | 10386,7188 | 41 |
| 20 | 9579,7771 | 9966,1364 | 9613,6407 | 10386,3593 | 40 |
| 21 | 9580,0845 | 9966,0845 | 9614,0000 | 10386,0000 | 39 |
| 22 | 9580,3916 | 9966,0325 | 9614,3591 | 10385,6409 | 38 |
| 23 | 9580,6985 | 9965,9805 | 9614,7179 | 10385,2820 | 37 |
| 24 | 9581,0051 | 9965,9285 | 9615,0766 | 10384,9233 | 36 |
| 25 | 9581,3115 | 9965,8764 | 9615,4351 | 10384,5648 | 35 |
| 26 | 9581,6176 | 9965,8243 | 9615,7933 | 10384,2066 | 34 |
| 27 | 9581,9235 | 9965,7721 | 9616,1514 | 10383,8485 | 33 |
| 28 | 9582,2291 | 9965,7199 | 9616,5092 | 10383,4907 | 32 |
| 29 | 9582,5345 | 9965,6676 | 9616,8669 | 10383,1331 | 31 |
| 30 | 9582,8396 | 9965,6153 | 9617,2243 | 10382,7756 | 30 |
| | | Sin. 67. | | Tang.67 | M |

| M | Sin.22. | | Tan.22. | | |
|---|---|---|---|---|---|
| 30 | 9582,8396 | 9965,6153 | 9617,2243 | 10382,7756 | 30 |
| 31 | 9583,1445 | 9965,5629 | 9617,5815 | 10382,4184 | 29 |
| 32 | 9583,4421 | 9965,5106 | 9617,9385 | 10382,0614 | 28 |
| 33 | 9583,7532 | 9965,4581 | 9618,2953 | 10381,7046 | 27 |
| 34 | 9584,0576 | 9965,4057 | 9618,6519 | 10381,3480 | 26 |
| 35 | 9584,3614 | 9995,3531 | 9619,0083 | 10380,9917 | 25 |
| 36 | 9584,6650 | 9965,3006 | 9619,3644 | 10380,6355 | 24 |
| 37 | 9584,9684 | 9965,2480 | 9619,7004 | 10380,2795 | 23 |
| 38 | 9585,2715 | 9965,1953 | 9620,0762 | 10379,9237 | 22 |
| 39 | 9585,5744 | 9965,1426 | 9620,4318 | 10379,5681 | 21 |
| 40 | 9585,8770 | 9965,0899 | 9620,7871 | 10379,2128 | 20 |
| 41 | 9586,1794 | 9965,0371 | 9621,1423 | 10378,8576 | 19 |
| 42 | 9586,4815 | 9964,9843 | 9621,4972 | 10378,5027 | 18 |
| 43 | 9586,7834 | 9964,9314 | 9621,8520 | 10378,1479 | 17 |
| 44 | 9587,0851 | 9964,8785 | 9622,2065 | 10377,7934 | 16 |
| 45 | 9587,3864 | 9964,8255 | 9622,5609 | 10377,4390 | 15 |
| 46 | 9587,6876 | 9964,7725 | 9622,9150 | 10377,0849 | 14 |
| 47 | 9587,9885 | 9964,7195 | 9623,2690 | 10376,7310 | 13 |
| 48 | 9588,2891 | 9964,6664 | 9623,6227 | 10376,3772 | 12 |
| 49 | 9588,5895 | 9964,6133 | 9623,9762 | 10376,0237 | 11 |
| 50 | 9588,8897 | 9964,5601 | 9624,3296 | 10375,6704 | 10 |
| 51 | 9589,1896 | 9964,5069 | 9624,6827 | 10375,3172 | 9 |
| 52 | 9589,4893 | 9964,4536 | 9625,0356 | 19374,9643 | 8 |
| 53 | 9589,7887 | 9964,4003 | 9625,3883 | 10374,6116 | 7 |
| 54 | 9590,0879 | 9964,3470 | 9625,7409 | 10374,2590 | 6 |
| 55 | 9590,3869 | 9964,2936 | 9626,0932 | 10373,9067 | 5 |
| 56 | 9590,6856 | 9964,2402 | 9626,4453 | 10373,5546 | 4 |
| 57 | 9590,9840 | 9964,1867 | 9626,7973 | 10373,2026 | 3 |
| 58 | 9591,2823 | 9964,1332 | 9627,1490 | 10372,8509 | 2 |
| 59 | 9591,5802 | 9964,0796 | 9627,5006 | 10372,4994 | 1 |
| 60 | 9591,8780 | 9964,0260 | 9627,8519 | 10372,1480 | 0 |
| | | Sin.67. | | Tan.67. | M |

| M | Sin 23. | | Tan. 23. | | |
|---|---|---|---|---|---|
| 0 | 9591,8780 | 9964,0260 | 9627,8519 | 10372,1480 | 60 |
| 1 | 9592,1755 | 9963,9724 | 9628,2030 | 10371,7969 | 59 |
| 2 | 9592,4727 | 9963,9187 | 9628,5540 | 10371,4459 | 58 |
| 3 | 9592,7697 | 9963,8650 | 9628,9047 | 10371,0952 | 57 |
| 4 | 9593,0665 | 9963,8112 | 9629,2553 | 10370,7446 | 56 |
| 5 | 9593,3631 | 9963,7574 | 9629,6057 | 10370,3943 | 55 |
| 6 | 9593,6594 | 9963,7035 | 9629,9558 | 10370,0441 | 54 |
| 7 | 9593,9554 | 9963,6496 | 9630,3058 | 10369,6942 | 53 |
| 8 | 9594,2512 | 9963,5957 | 9630,6555 | 10369,3444 | 52 |
| 9 | 9594,5468 | 9963,5417 | 9631,0051 | 10368,9948 | 51 |
| 10 | 9594,8422 | 9963,4876 | 9631,3545 | 10368,6454 | 50 |
| 11 | 9595,1373 | 9963,4335 | 9631,7037 | 10368,2962 | 49 |
| 12 | 9595,4321 | 9963,3794 | 9632,0527 | 10367,9472 | 48 |
| 13 | 9595,7268 | 9963,3253 | 9632,4015 | 10367,5984 | 47 |
| 14 | 9596,0212 | 9963,2710 | 9632,7501 | 10367,2498 | 46 |
| 15 | 9596,3153 | 9963,2168 | 9633,0985 | 10366,9014 | 45 |
| 16 | 9596,6093 | 9963,1625 | 9633,4467 | 10366,5532 | 44 |
| 17 | 9596,9030 | 9963,1081 | 9633,7948 | 10366,2051 | 43 |
| 18 | 9597,1964 | 9963,0538 | 9634,1426 | 10365,8573 | 42 |
| 19 | 9597,4896 | 9962,9993 | 9634,4903 | 10365,5097 | 41 |
| 20 | 9527,7826 | 9962,9449 | 9634,8377 | 10365,1622 | 40 |
| 21 | 9598,0754 | 9962,8904 | 9635,1840 | 10364,8149 | 39 |
| 22 | 9598,3679 | 9962,8358 | 9635,5321 | 10364,4679 | 38 |
| 23 | 9598,6602 | 9962,7812 | 9635,8790 | 10364,1210 | 37 |
| 24 | 9598,9522 | 9962,7265 | 9636,2256 | 10363,7743 | 36 |
| 25 | 9599,2440 | 9962,6718 | 9636,5722 | 10363,4278 | 35 |
| 26 | 9599,5356 | 9962,6171 | 9636,9185 | 10363,0815 | 34 |
| 27 | 9599,8270 | 9962,5623 | 9637,2646 | 10362,7353 | 33 |
| 28 | 9600,1181 | 9962,5075 | 9637,6105 | 10362,3894 | 32 |
| 29 | 9600,4090 | 9962,4527 | 9637,9563 | 10362,0436 | 31 |
| 30 | 9600,6997 | 9962,3977 | 9638,3019 | 10361,6981 | 30 |
| | | Sin. 66. | | Tan. 66. | M |

| M | Sin. 23. | | Tan. 23. | | |
|---|---|---|---|---|---|
| 30 | 9600,6997 | 9962,3977 | 9638,3019 | 10361,6981 | 30 |
| 31 | 9600,9901 | 9962,3428 | 9638,6472 | 10361,3527 | 29 |
| 32 | 9601,2805 | 9962,2878 | 9638,9924 | 10361,0075 | 28 |
| 33 | 9601,5702 | 9962,2328 | 9639,3374 | 10360,6625 | 27 |
| 34 | 9601,8600 | 9962,1777 | 9639,6823 | 10360,3177 | 26 |
| 35 | 9602,1495 | 9962,1225 | 9640,0269 | 10359,9730 | 25 |
| 36 | 9602,4387 | 9962,0674 | 9640,3713 | 10359,6286 | 24 |
| 37 | 9602,7278 | 9962,0122 | 9640,7156 | 10359,2843 | 23 |
| 38 | 9603,0166 | 9961,9569 | 9641,0597 | 10358,9402 | 22 |
| 39 | 9603,3052 | 9961,9016 | 9641,4036 | 10358,5964 | 21 |
| 40 | 9603,5936 | 9961,8463 | 9641,7475 | 10358,2527 | 20 |
| 41 | 9603,8817 | 9961,7909 | 9642,0908 | 10357,9091 | 19 |
| 42 | 9604,1696 | 9961,7354 | 9642,4341 | 10357,5658 | 18 |
| 43 | 9604,4573 | 9961,6799 | 9642,7773 | 10357,2226 | 17 |
| 44 | 9604,7447 | 9961,6244 | 9643,1203 | 10356,8797 | 16 |
| 45 | 9605,0319 | 9961,5689 | 9643,4630 | 10356,5369 | 15 |
| 46 | 9605,3189 | 9961,5133 | 9643,8056 | 10356,1943 | 14 |
| 47 | 9605,6057 | 9961,4576 | 9644,1481 | 10355,8519 | 13 |
| 48 | 9605,8922 | 9961,4019 | 9644,4903 | 10355,5096 | 12 |
| 49 | 9606,1786 | 9961,3462 | 9644,8324 | 10355,1676 | 11 |
| 50 | 9606,4646 | 9961,2904 | 9645,1742 | 10354,8257 | 10 |
| 51 | 9606,7505 | 9961,2346 | 9645,5159 | 10354,4840 | 9 |
| 52 | 9607,0362 | 9961,1787 | 9645,8575 | 10354,1425 | 8 |
| 53 | 9607,3216 | 9961,1228 | 9646,1988 | 10353,8011 | 7 |
| 54 | 9607,6068 | 9961,0668 | 9646,5399 | 10353,4600 | 6 |
| 55 | 9607,8918 | 9961,0108 | 9646,8809 | 10353,1190 | 5 |
| 56 | 9608,1765 | 9960,9548 | 9647,2217 | 10352,7782 | 4 |
| 57 | 9608,4610 | 9960,8987 | 9647,5623 | 10352,4376 | 3 |
| 58 | 9608,7453 | 9960,8425 | 9647,9028 | 10352,0972 | 2 |
| 59 | 9609,0294 | 9960,7863 | 9648,2430 | 10351,7569 | 1 |
| 60 | 9609,3133 | 9960,7301 | 9648,5831 | 10351,4168 | 0 |
| | | Sin. 66. | | Tan. 66. | M |

| M | Sin. 24. | | Tan. 24. | | |
|---|---|---|---|---|---|
| 0 | 9609,3133 | 9960,7301 | 9648,5831 | 10351,4168 | 60 |
| 1 | 9609,5969 | 9960,6738 | 9648,9230 | 10351,0769 | 59 |
| 2 | 9609,8803 | 9960,6175 | 9649,2627 | 10350,7372 | 58 |
| 3 | 9610,1635 | 9960,5612 | 9649,6023 | 10350,3976 | 57 |
| 4 | 9610,4465 | 9960,5048 | 9649,9416 | 10350,0583 | 56 |
| 5 | 9610,7292 | 9960,4483 | 9650,2808 | 10349,7191 | 55 |
| 6 | 9611,0117 | 9960,3919 | 9650,6198 | 10349,3801 | 54 |
| 7 | 9611,2940 | 9960,3353 | 9650,9587 | 10349,0412 | 53 |
| 8 | 9611,5751 | 9960,2787 | 9651,2974 | 10348,7026 | 52 |
| 9 | 9611,8580 | 9960,2221 | 9651,6358 | 10348,3641 | 51 |
| 10 | 9612,1396 | 9960,1655 | 9651,9742 | 10348,0258 | 50 |
| 11 | 9612,4211 | 9960,1087 | 9652,3123 | 10347,6876 | 49 |
| 12 | 9612,7023 | 9960,0520 | 9652,6503 | 10347,3497 | 48 |
| 13 | 9612,9833 | 9959,9952 | 9652,9880 | 10347,0119 | 47 |
| 14 | 9613,2641 | 9959,9383 | 9653,3257 | 10346,6742 | 46 |
| 15 | 9613,5446 | 9959,8815 | 9653,6631 | 10346,3368 | 45 |
| 16 | 9613,8249 | 9959,8245 | 9654,0004 | 10345,9995 | 44 |
| 17 | 9614,1051 | 9959,7676 | 9654,3375 | 10345,6624 | 43 |
| 18 | 9614,3850 | 9959,7105 | 9654,6744 | 10345,3255 | 42 |
| 19 | 9614,6646 | 9959,6535 | 9655,0111 | 10344,9888 | 41 |
| 20 | 9614,9441 | 9959,5964 | 9655,3477 | 10344,6522 | 40 |
| 21 | 9615,2234 | 9959,5392 | 9655,6841 | 10344,3158 | 39 |
| 22 | 9615,5024 | 9959,4820 | 9656,0203 | 10343,9796 | 38 |
| 23 | 9615,7812 | 9959,4248 | 9656,3564 | 10343,6435 | 37 |
| 24 | 9616,0598 | 9959,3675 | 9656,6922 | 10343,3077 | 36 |
| 25 | 9616,3382 | 9959,3102 | 9657,0280 | 10342,9719 | 35 |
| 26 | 9616,6164 | 9959,2528 | 9657,3635 | 10342,6364 | 34 |
| 27 | 9616,8943 | 9959,1954 | 9657,6989 | 10342,3010 | 33 |
| 28 | 9617,1721 | 9959,1379 | 9658,0341 | 10341,9658 | 32 |
| 29 | 9617,4496 | 9959,0804 | 9658,3962 | 10341,6267 | 31 |
| 30 | 9617,7269 | 9959,0229 | 9658,7040 | 10341,2959 | 30 |
| | | Sin. 65. | | Tan. 65. | M |

| M | Sin.24. | | Tan.24. | | |
|---|---|---|---|---|---|
| 30 | 9617,7269 | 9959,0229 | 9658,7040 | 10341,2959 | 30 |
| 31 | 9618,0040 | 9958,9653 | 9659,0387 | 10341,9612 | 29 |
| 32 | 9618,2809 | 9958,9076 | 9659,3732 | 10340,6267 | 28 |
| 33 | 9618,5576 | 9958,8500 | 9559,7076 | 10340,2923 | 27 |
| 34 | 9618,8340 | 9958,7922 | 9660,0418 | 10339,9581 | 26 |
| 35 | 9619,1103 | 9958,7344 | 9660,3758 | 10339,6241 | 25 |
| 36 | 9619,3863 | 9958,6766 | 9660,7097 | 10339,2903 | 24 |
| 37 | 9619,6622 | 9958,6188 | 9661,0434 | 10338,9566 | 23 |
| 38 | 9619,9378 | 9958,5609 | 9661,3769 | 10338,6230 | 22 |
| 39 | 9620,2132 | 9958,5029 | 9561,7102 | 10338,2897 | 21 |
| 40 | 9620,4884 | 9958,4449 | 9662,0434 | 10337,9565 | 20 |
| 41 | 9620,7633 | 9958,3869 | 9662,3764 | 10337,6235 | 19 |
| 42 | 9621,0381 | 9958,3288 | 9662,7093 | 10337,2906 | 18 |
| 43 | 9621,3127 | 9958,2707 | 9663,0420 | 10336,9579 | 17 |
| 44 | 9621,5870 | 9958,2125 | 9663,3745 | 10336,6254 | 16 |
| 45 | 9621,8612 | 9958,1543 | 9663,7068 | 10336,2931 | 15 |
| 46 | 9622,1351 | 9958,0960 | 9664,0390 | 10335,9609 | 14 |
| 47 | 9622,4088 | 9958,0377 | 9664,3711 | 10335,6289 | 13 |
| 48 | 9622,6823 | 9957,9794 | 9664,7029 | 10335,2970 | 12 |
| 49 | 9622,9556 | 9957,9210 | 9665,0346 | 10334,9653 | 11 |
| 50 | 9623,2287 | 9957,8625 | 9665,3661 | 10334,6338 | 10 |
| 51 | 9623,5016 | 9957,8040 | 9665,6975 | 10334,3024 | 9 |
| 52 | 9623,7743 | 9957,7455 | 9666,0287 | 10333,9712 | 8 |
| 53 | 9624,0467 | 9957,6869 | 9666,3598 | 10333,6401 | 7 |
| 54 | 9624,3190 | 9957,6283 | 9666,6906 | 10333,3093 | 6 |
| 55 | 9624,5911 | 9957,5697 | 9667,0214 | 10332,9786 | 5 |
| 56 | 9624,8629 | 9957,5109 | 9667,3519 | 10332,6480 | 4 |
| 57 | 9625,1343 | 9957,4522 | 9667,6823 | 10332,3176 | 3 |
| 58 | 9625,4060 | 9957,3934 | 9668,0125 | 10331,9874 | 2 |
| 59 | 9625,6772 | 9957,3340 | 9668,3420 | 10331,6573 | 1 |
| 60 | 9625,9482 | 9957,2757 | 9668,6725 | 10331,3274 | 0 |
| | | Sin.65. | | Tan.65. | M |

| M | Sin. 25. | | Tan. 25. | | |
|---|---|---|---|---|---|
| 0 | 9625,9482 | 9957,2757 | 9668,6725 | 10331,3274 | 60 |
| 1 | 9626,2190 | 9957,2167 | 9669,0023 | 10330,9976 | 59 |
| 2 | 9626,4897 | 9957,1578 | 9669,3319 | 10330,6681 | 58 |
| 3 | 9626,7601 | 9957,0987 | 9669,6613 | 10330,3386 | 57 |
| 4 | 9627,0303 | 9957,0397 | 9669,9905 | 10330,0094 | 56 |
| 5 | 9627,3002 | 9956,9806 | 9670,3196 | 10329,6803 | 55 |
| 6 | 9627,5700 | 9956,9214 | 9670,6486 | 10329,3513 | 54 |
| 7 | 9627,8396 | 9956,8622 | 9670,9774 | 10329,0225 | 53 |
| 8 | 9628,1090 | 9956,8030 | 9671,3060 | 10328,6939 | 52 |
| 9 | 9628,3782 | 9956,7437 | 9671,6345 | 10328,3655 | 51 |
| 10 | 9628,6471 | 9956,6843 | 9671,9628 | 10328,0371 | 50 |
| 11 | 9628,9159 | 9956,6250 | 9672,2909 | 10327,7090 | 49 |
| 12 | 9629,1845 | 9956,5655 | 9672,6189 | 10327,3810 | 48 |
| 13 | 9629,4529 | 9956,5061 | 9672,9468 | 10327,0532 | 47 |
| 14 | 9629,7210 | 9956,4465 | 9673,2744 | 10326,7255 | 46 |
| 15 | 9629,9890 | 9956,3870 | 9673,6020 | 10326,3980 | 45 |
| 16 | 9630,2567 | 9956,3274 | 9673,9293 | 10326,0706 | 44 |
| 17 | 9630,5243 | 9956,2677 | 9674,2565 | 10325,7434 | 43 |
| 18 | 9630,7917 | 9956,2080 | 9674,5836 | 10325,4163 | 42 |
| 19 | 9631,0588 | 9956,1483 | 9674,9105 | 10325,0894 | 41 |
| 20 | 9631,3258 | 9956,0885 | 9675,2372 | 10324,7627 | 40 |
| 21 | 9631,5925 | 9956,0278 | 9675,5638 | 10324,4361 | 39 |
| 22 | 9631,8591 | 9955,9688 | 9675,8902 | 10324,1097 | 38 |
| 23 | 9632,1254 | 9955,9089 | 9676,2165 | 10323,7834 | 37 |
| 24 | 9632,3916 | 9955,8489 | 9676,5426 | 10323,4573 | 36 |
| 25 | 9632,6575 | 9955,7889 | 9676,8689 | 10323,1313 | 35 |
| 26 | 9632,9233 | 9955,7289 | 9677,1944 | 10322,8055 | 34 |
| 27 | 9633,1888 | 9955,6688 | 9677,5200 | 10322,4799 | 33 |
| 28 | 9633,4542 | 9955,6086 | 9677,8455 | 10322,1544 | 32 |
| 29 | 9633,7194 | 9955,5484 | 9678,1709 | 10321,8290 | 31 |
| 30 | 9633,9843 | 9955,4882 | 9678,4961 | 10321,5038 | 30 |
| | | Sin. 64. | | Tan. 64. | M |

| M | Sin. 25. | | Tan. 25. | | |
|---|---|---|---|---|---|
| 30 | 9633,9843 | 9955,4882 | 9678,4961 | 10321,5038 | 30 |
| 31 | 9634,2491 | 9955,4279 | 9678,8211 | 10321,1788 | 29 |
| 32 | 9634,5136 | 9955,3676 | 9679,1460 | 10320,8539 | 28 |
| 33 | 9634,7780 | 9955,3072 | 9679,4707 | 10320,5292 | 27 |
| 34 | 9635,0422 | 9955,2468 | 9679,7953 | 10320,2046 | 26 |
| 35 | 9635,3061 | 9955,1864 | 9680,1197 | 10319,8802 | 25 |
| 36 | 9635,5699 | 9955,1259 | 9680,4440 | 10319,5559 | 24 |
| 37 | 9635,8335 | 9955,0653 | 9680,7682 | 10319,2318 | 23 |
| 38 | 9636,0969 | 9955,0047 | 9681,0921 | 10318,9078 | 22 |
| 39 | 9636,3600 | 9954,9441 | 9681,4159 | 10318,5840 | 21 |
| 40 | 9636,6230 | 9954,8834 | 9681,7396 | 10318,2603 | 20 |
| 41 | 9636,8858 | 9954,8226 | 9682,0631 | 10317,9368 | 19 |
| 42 | 9637,1484 | 9954,7619 | 9682,3865 | 10317,6134 | 18 |
| 43 | 9637,4108 | 9954,7011 | 9682,7097 | 10317,2902 | 17 |
| 44 | 9637,6730 | 9954,6402 | 9682,0328 | 10316,9671 | 16 |
| 45 | 9637,9350 | 9954,5793 | 9683,3557 | 10316,6442 | 15 |
| 46 | 9638,1968 | 9954,5183 | 9683,6785 | 10316,3214 | 14 |
| 47 | 9638,4585 | 9954,4573 | 9684,0011 | 10315,9988 | 13 |
| 48 | 9638,7199 | 9954,3963 | 9684,3236 | 10315,6763 | 12 |
| 49 | 9638,9811 | 9954,3352 | 9684,6459 | 10315,3540 | 11 |
| 50 | 9639,2422 | 9954,2740 | 9684,9681 | 10315,0318 | 10 |
| 51 | 9639,5030 | 9954,2128 | 9685,2901 | 10314,7098 | 9 |
| 52 | 9639,7636 | 9954,1516 | 9685,6120 | 10314,3879 | 8 |
| 53 | 9640,0241 | 9954,0903 | 9685,9337 | 10314,0662 | 7 |
| 54 | 9640,2844 | 9954,0290 | 9686,2555 | 10313,7446 | 6 |
| 55 | 9640,5444 | 9953,9677 | 9686,5757 | 10313,4232 | 5 |
| 56 | 9640,8043 | 9953,9062 | 9686,8980 | 10313,1019 | 4 |
| 57 | 9641,0640 | 9953,8448 | 9687,2192 | 10312,7807 | 3 |
| 58 | 9641,3235 | 9953,7833 | 9687,5402 | 10312,4597 | 2 |
| 59 | 9641,5828 | 9953,7217 | 9687,8610 | 10312,1389 | 1 |
| 60 | 9641,8419 | 9953,6601 | 9688,1817 | 10311,8182 | 0 |
| | | Sin. 64 | | Tan. 64. | M |

| M | Sin. 26. | | Tan. 26. | | |
|---|---|---|---|---|---|
| 0 | 9641,8419 | 9953,6601 | 9688,1817 | 10311,8182 | 60 |
| 1 | 9642,1008 | 9953,5985 | 9688,5023 | 10311,4976 | 59 |
| 2 | 9642,3596 | 9953,5368 | 9688,8227 | 10311,1772 | 58 |
| 3 | 9642,6182 | 9953,4751 | 9689,1430 | 10310,8569 | 57 |
| 4 | 9642,8765 | 9953,4133 | 9689,4631 | 10310,5368 | 56 |
| 5 | 9643,1346 | 9953,3515 | 9689,7831 | 10310,2168 | 55 |
| 6 | 9643,3926 | 9953,2896 | 9690,1029 | 10309,8970 | 54 |
| 7 | 9643,6504 | 9953,2277 | 9690,4226 | 10309,5773 | 53 |
| 8 | 9643,9080 | 9953,1658 | 9690,7422 | 10309,2578 | 52 |
| 9 | 9644,1654 | 9953,1038 | 9691,0616 | 10308,9384 | 51 |
| 10 | 9644,4226 | 9953,0417 | 9691,3808 | 10308,6191 | 50 |
| 11 | 9644,6796 | 9952,9796 | 9691,6999 | 10308,3000 | 49 |
| 12 | 9644,9364 | 9952,9175 | 9692,0189 | 10307,9810 | 48 |
| 13 | 9645,1931 | 9952,8553 | 9692,3378 | 10307,6622 | 47 |
| 14 | 9645,4495 | 9952,7931 | 9692,6564 | 10307,3435 | 46 |
| 15 | 9645,7058 | 9952,7308 | 9692,9750 | 10307,0249 | 45 |
| 16 | 9645,9619 | 9952,6685 | 9693,2934 | 10306,7065 | 44 |
| 17 | 9646,2178 | 9952,6061 | 9693,6116 | 10306,3883 | 43 |
| 18 | 9646,4735 | 9952,5437 | 9693,9298 | 10306,0702 | 42 |
| 19 | 9646,7290 | 9952,4812 | 9694,2478 | 10305,7522 | 41 |
| 20 | 9646,9843 | 9952,4817 | 9694,5656 | 10305,4343 | 40 |
| 21 | 9647,2395 | 9952,3562 | 9694,8833 | 10305,1167 | 39 |
| 22 | 9647,4944 | 9952,2936 | 9695,2008 | 10304,7997 | 38 |
| 23 | 9647,7492 | 9952,2309 | 9695,5182 | 10304,4817 | 37 |
| 24 | 9648,0038 | 9952,1682 | 9695,8355 | 10304,1644 | 36 |
| 25 | 9648,2582 | 9952,1055 | 9696,1526 | 10304,8473 | 35 |
| 26 | 9648,5124 | 9952,0427 | 9696,4696 | 10303,5303 | 34 |
| 27 | 9648,7664 | 9951,9799 | 9696,7865 | 10303,2134 | 33 |
| 28 | 9649,0203 | 9951,9170 | 9697,1032 | 10302,8967 | 32 |
| 29 | 9649,2739 | 9951,8541 | 9697,4198 | 10302,5801 | 31 |
| 30 | 9649,5274 | 9951,7911 | 9697,7362 | 10302,2637 | 30 |
| | | Sin. 63. | | Tang. 63 | M |

| M | Sin. 26. | | Tan. 26. | | |
|---|---|---|---|---|---|
| 30 | 9649,5274 | 9951,7911 | 9697,7362 | 10302,2637 | 30 |
| 31 | 9609,7807 | 9951,7281 | 9698,0525 | 10301,9474 | 29 |
| 32 | 9650,0338 | 9951,6651 | 9698,3687 | 10301,6312 | 28 |
| 33 | 9650,2867 | 9951,6020 | 9698,6847 | 10301,3152 | 27 |
| 34 | 9650,5394 | 9988,5388 | 9699,0006 | 10300,9993 | 26 |
| 35 | 9650,7920 | 9951,4756 | 9699,3163 | 10300,6836 | 25 |
| 36 | 9651,0444 | 9951,4124 | 9699,6319 | 10300,3680 | 24 |
| 37 | 9651,2965 | 9951,3491 | 9699,9474 | 10300,0525 | 23 |
| 38 | 9651,5485 | 9951,2858 | 9700,2627 | 10299,7372 | 22 |
| 39 | 9651,8004 | 9951,2224 | 9700,5779 | 10299,4220 | 21 |
| 40 | 9652,0520 | 9951,1590 | 9700,8930 | 10299,1069 | 20 |
| 41 | 9652,3035 | 9951,0955 | 9701,2079 | 10298,7920 | 19 |
| 42 | 9652,5547 | 9951,0320 | 9701,5227 | 10298,4773 | 18 |
| 43 | 9652,8058 | 9950,9684 | 9701,8373 | 10298,1626 | 17 |
| 44 | 9653,0567 | 9950,9048 | 9702,1518 | 10297,8481 | 16 |
| 45 | 9653,3075 | 9950,8412 | 9702,4663 | 10297,5337 | 15 |
| 46 | 9653,5580 | 9950,7775 | 9702,7805 | 10297,2194 | 14 |
| 47 | 9653,8084 | 9950,7137 | 9703,0946 | 10296,9053 | 13 |
| 48 | 9654,0586 | 9950,6499 | 9703,4086 | 10296,5913 | 12 |
| 49 | 9654,3086 | 9950,5861 | 9703,7224 | 10296,2775 | 11 |
| 50 | 9654,5584 | 9950,5222 | 9704,0361 | 10295,9638 | 10 |
| 51 | 9654,8080 | 9950,4583 | 9704,3497 | 10295,6502 | 9 |
| 52 | 9655,0575 | 9950,3943 | 9704,6631 | 10295,3368 | 8 |
| 53 | 9655,3068 | 9950,3303 | 9704,9764 | 10295,0235 | 7 |
| 54 | 9655,5559 | 9950,2662 | 9705,2896 | 10294,7103 | 6 |
| 55 | 9655,8048 | 9950,2021 | 9705,6026 | 10294,3973 | 5 |
| 56 | 9656,0535 | 9950,1380 | 9705,9155 | 10294,0844 | 4 |
| 57 | 9656,3021 | 9950,0737 | 9706,2283 | 10293,7716 | 3 |
| 58 | 9656,5505 | 9950,0095 | 9706,5410 | 10293,4 90 | 2 |
| 59 | 9656,7987 | 9949,9452 | 9706,8535 | 10293,1464 | 1 |
| 60 | 9657,0467 | 9949,8808 | 9707,1658 | 10292,8341 | 0 |
| | | Sin. 63. | | Tan. 63. | M |

| M | Sin. 27. | | Sin. 27. | | |
|---|---|---|---|---|---|
| 0 | 9657.0467 | 9949.8808 | 9707,1658 | 10292,8341 | 60 |
| 1 | 9657.2946 | 9949,8165 | 9707,4781 | 10292.5218 | 59 |
| 2 | 9657.5422 | 9949,7520 | 9707,7902 | 10292.2097 | 58 |
| 3 | 9657.7897 | 9949,6875 | 9708.1022 | 10291,8977 | 57 |
| 4 | 9658.0371 | 9949,6230 | 9708.4140 | 10291,5859 | 56 |
| 5 | 9658.2842 | 9949,5584 | 9708,7257 | 10291.2742 | 55 |
| 6 | 9658,5312 | 9949,4938 | 9709,0373 | 10290,9626 | 54 |
| 7 | 9658,7779 | 9949.4291 | 9709,3488 | 10290,6511 | 53 |
| 8 | 9659.0246 | 9949,3644 | 9709.6601 | 10290.3398 | 52 |
| 9 | 9659,2710 | 9949.2996 | 9709.9713 | 10290,0286 | 51 |
| 10 | 9659.5172 | 9949.2348 | 9710.2824 | 10289,7176 | 50 |
| 11 | 9659.7633 | 9949,1700 | 9710,5933 | 10289,4066 | 49 |
| 12 | 9660,0092 | 9949.1051 | 9710,9041 | 10289,0958 | 48 |
| 13 | 9660.2549 | 9949.0401 | 9711,2148 | 10288.7851 | 47 |
| 14 | 9960.5005 | 9948.9751 | 9711,5253 | 10288.4746 | 46 |
| 15 | 9660,7459 | 9948,9101 | 9711.8357 | 10288.1642 | 45 |
| 16 | 9660.9911 | 9948.8450 | 9712.1460 | 10287.8539 | 44 |
| 17 | 9661,2361 | 9948.7799 | 9712,4562 | 10287,5438 | 43 |
| 18 | 9661,4809 | 9948,7147 | 9712,7662 | 10287,2337 | 42 |
| 19 | 9661,7256 | 9948.6495 | 9713.0761 | 10286,9238 | 41 |
| 20 | 9661,9701 | 9948,5842 | 9713.3859 | 10286,6140 | 40 |
| 21 | 9662,2144 | 9948,5189 | 9713,6955 | 10286,3044 | 39 |
| 22 | 9662,4586 | 9948.4535 | 9714,0051 | 10285,9949 | 38 |
| 23 | 9662,7026 | 9948,3881 | 9714.3144 | 10285.6855 | 37 |
| 24 | 9662.9464 | 9948.3226 | 9714.6237 | 10285,3762 | 36 |
| 25 | 9663.1900 | 9948.2571 | 9714,9329 | 10285,0671 | 35 |
| 26 | 9663,4335 | 9948,1916 | 9715.2419 | 10284,7581 | 34 |
| 27 | 9663,6767 | 9948.1260 | 9715,5507 | 10284.4492 | 33 |
| 28 | 9663,9199 | 9948.0603 | 9715,8595 | 10284,1404 | 32 |
| 29 | 9664.1628 | 9947,9946 | 9716.1681 | 10243.8318 | 31 |
| 30 | 9664,4056 | 9947.9289 | 9716,4766 | 10283,5233 | 30 |
| | | Tan. 62. | | Tan. 62. | M |

| M | *Sin.27.* | | *Tan.27.* | | |
|---|---|---|---|---|---|
| 30 | 9664,4056 | 9947,9289 | 9716,4766 | 10283,5233 | 30 |
| 31 | 9664,6482 | 9947,8631 | 9716,7850 | 10283,2149 | 29 |
| 32 | 9664,8906 | 9947,7973 | 9717,0933 | 10282,9060 | 28 |
| 33 | 9665,1328 | 9947,7314 | 9717,4014 | 10282,5985 | 27 |
| 34 | 9665,3749 | 9947,6655 | 9717,7094 | 10282,2905 | 26 |
| 35 | 9665,6168 | 9947,5995 | 9718,0173 | 10281,9826 | 25 |
| 36 | 9665,8585 | 9947,5335 | 9718,3250 | 10281,6749 | 24 |
| 37 | 9666,1001 | 9947,4674 | 9718,6327 | 10281,3672 | 23 |
| 38 | 9666,3415 | 9947,4013 | 9718,9402 | 10281,0597 | 22 |
| 39 | 9566,5827 | 9947,3351 | 9719,2476 | 10280,7523 | 21 |
| 40 | 9666,8238 | 9947,2689 | 9719,5548 | 10280,4451 | 20 |
| 41 | 9667,0647 | 9947,2027 | 9719,8620 | 10280,1380 | 19 |
| 42 | 9667,3054 | 9947,1364 | 9720,1690 | 10279,8309 | 18 |
| 43 | 9667,5459 | 9947,0700 | 9720,4759 | 10279,5240 | 17 |
| 44 | 9667,7863 | 9947,0036 | 9720,7826 | 10279,2173 | 16 |
| 45 | 9668,0265 | 9946,9372 | 9721,0893 | 10278,9106 | 15 |
| 46 | 9668,2665 | 9946,8707 | 9721,3958 | 10278,6041 | 14 |
| 47 | 9668,5064 | 9946,8041 | 9721,7022 | 10278,2977 | 13 |
| 48 | 9668,7461 | 9946,7376 | 9722,0085 | 10277,9914 | 12 |
| 49 | 9668,9856 | 9946,6709 | 9722,3146 | 10277,6853 | 11 |
| 50 | 9669,2249 | 9946,6043 | 9722,6200 | 10277,3793 | 10 |
| 51 | 9669,4641 | 9946,5375 | 9722,9266 | 10277,0734 | 9 |
| 52 | 9669,7031 | 9946,4708 | 9723,2324 | 10276,7676 | 8 |
| 53 | 9669,9420 | 9946,4039 | 9723,5380 | 10276,4619 | 7 |
| 54 | 9670,1807 | 9946,3371 | 9723,8436 | 10276,1563 | 6 |
| 55 | 9670,4192 | 9946,2702 | 9724,1490 | 10275,8509 | 5 |
| 56 | 9670,6575 | 9946,2032 | 9724,4543 | 10275,5456 | 4 |
| 57 | 9670,8957 | 9946,1362 | 9724,7595 | 10275,2404 | 3 |
| 58 | 9671,1337 | 9946,0691 | 9725,0646 | 10274,9354 | 2 |
| 59 | 9671,3716 | 9946,0020 | 9725,3695 | 10274,6304 | 1 |
| 60 | 9671,6093 | 9945,9349 | 9725,6743 | 10274,3256 | 0 |
| | | *Sin.62.* | | *Tan.62.* | M |

| M | Sin.28. | | Tan.29. | | |
|---|---|---|---|---|---|
| 0 | 9671,6093 | 9945,9349 | 9725,6743 | 10274,3256 | 60 |
| 1 | 9671,8468 | 9945,8677 | 9725,9790 | 10274,0209 | 59 |
| 2 | 9672,0841 | 9945,8005 | 9726,2836 | 10273,7163 | 58 |
| 3 | 9672,3213 | 9945,7332 | 9726,5881 | 10273,4118 | 57 |
| 4 | 9672,558 | 9945,6658 | 9726,8924 | 10273,1075 | 56 |
| 5 | 9672,7952 | 9945,5984 | 9727,1967 | 10272,8032 | 55 |
| 6 | 9673,0318 | 9945,5310 | 9727,5008 | 10272,4991 | 54 |
| 7 | 9673,2683 | 9945,4635 | 9727,8048 | 10272,1951 | 53 |
| 8 | 9673,5047 | 9945,3960 | 9728,1087 | 10271,8913 | 52 |
| 9 | 9673,7409 | 9945,3284 | 9728,4124 | 10271,5875 | 51 |
| 10 | 9673,9769 | 9945,2608 | 9728,7160 | 10271,2839 | 50 |
| 11 | 9674,2128 | 9945,1932 | 9729,0196 | 10270,9804 | 49 |
| 12 | 9674,4484 | 9945,1254 | 9729,3230 | 10270,6770 | 48 |
| 13 | 9674,6840 | 9945,0577 | 9729,6262 | 10270,3737 | 47 |
| 14 | 9674,9193 | 9944,9899 | 9729,9294 | 10270,0705 | 46 |
| 15 | 9675,1545 | 9944,9220 | 9730,2325 | 10269,7674 | 45 |
| 16 | 9675,3895 | 9944,8541 | 9730,5354 | 10269,4645 | 44 |
| 17 | 9675,6244 | 9944,7862 | 9730,8382 | 10269,1617 | 43 |
| 18 | 9675,8591 | 9944,7182 | 9731,1409 | 10268,8590 | 42 |
| 19 | 9676,0937 | 9944,6501 | 9731,4435 | 10268,5564 | 41 |
| 20 | 9676,3280 | 9944,5820 | 9731,7460 | 10268,2539 | 40 |
| 21 | 9676,5622 | 9944,5139 | 9732,0483 | 10267,9516 | 39 |
| 22 | 9676,7963 | 9944,4457 | 9732,3506 | 10267,6493 | 38 |
| 23 | 9677,0302 | 9944,3774 | 9732,6527 | 10267,3472 | 37 |
| 24 | 9677,2639 | 9944,3092 | 9732,9547 | 10267,0452 | 36 |
| 25 | 9677,4975 | 9944,2408 | 9733,2566 | 10266,7433 | 35 |
| 26 | 9677,7309 | 9944,1724 | 9733,5584 | 10266,4415 | 34 |
| 27 | 9677,9641 | 9944,1040 | 9733,8601 | 10266,1399 | 33 |
| 28 | 9678,1972 | 9944,0356 | 9734,1616 | 10265,8383 | 32 |
| 29 | 9678,4301 | 9943,9670 | 9734,4630 | 10265,5369 | 31 |
| 30 | 9678,6629 | 9943,8985 | 9734,7644 | 10265,2356 | 30 |
| | | Sin.61. | | Tang.61 | M |

| M | Sin.28. | | Tan.28. | | |
|---|---|---|---|---|---|
| 30 | 9678,6629 | 9943,8985 | 9734,7644 | 10265,2356 | 30 |
| 31 | 9678,8955 | 9943,8298 | 9735,0656 | 10264,9343 | 29 |
| 32 | 9679,1279 | 9943,7612 | 9735,3669 | 10264,6333 | 28 |
| 33 | 9679,3601 | 9943,6925 | 9735,6676 | 10264,3323 | 27 |
| 34 | 9679,5923 | 9943,6237 | 9735,9685 | 10264,0314 | 26 |
| 35 | 9679,8242 | 9943,5549 | 9736,2693 | 10263,7306 | 25 |
| 36 | 9680,0560 | 9943,4861 | 9736,5699 | 10263,4300 | 24 |
| 37 | 9680,2876 | 9943,4172 | 9736,8704 | 10263,1295 | 23 |
| 38 | 9680,5191 | 9943,3482 | 9737,1709 | 10262,8291 | 22 |
| 39 | 9680,7504 | 9943,2792 | 9737,4712 | 10262,5288 | 21 |
| 40 | 9680,9816 | 9943,2102 | 9737,7714 | 10262,2286 | 20 |
| 41 | 9681,2125 | 9943,1411 | 9738,0714 | 10261,9285 | 19 |
| 42 | 9681,4434 | 9943,0719 | 9738,3714 | 10261,6285 | 18 |
| 43 | 9681,6740 | 9943,0027 | 9738,6713 | 10261,3287 | 17 |
| 44 | 9681,9045 | 9942,9335 | 9738,9710 | 10261,0289 | 16 |
| 45 | 9682,1349 | 9942,8642 | 9739,2706 | 10260,7293 | 15 |
| 46 | 9682,3651 | 9942,7949 | 9739,5702 | 10260,4298 | 14 |
| 47 | 9682,5951 | 9942,7255 | 9739,8696 | 10260,1304 | 13 |
| 48 | 9682,8250 | 9942,6561 | 9740,1689 | 10259,8310 | 12 |
| 49 | 9683,0547 | 9942,5866 | 974[illegible],4681 | 10259,5318 | 11 |
| 50 | 9683,2843 | 9942,5171 | 9740,7672 | 10259,2328 | 10 |
| 51 | 9683,5137 | 9942,4475 | 9741,0661 | 10258,9338 | 9 |
| 52 | 9683,7429 | 9942,3779 | 9741,3650 | 10258,6349 | 8 |
| 53 | 9683,9720 | 9942,3082 | 9741,6637 | 10258,3362 | 7 |
| 54 | 9684,2009 | 9942,2385 | 9741,9624 | 10258,0375 | 6 |
| 55 | 9684,4297 | 9942,1688 | 9742,2609 | 10257,7390 | 5 |
| 56 | 9684,6583 | 9942,0989 | 9742,5593 | 10257,4406 | 4 |
| 57 | 9684,8868 | 9942,0291 | 9742,8576 | 10257,1423 | 3 |
| 58 | 9685,1151 | 9941,9592 | 9743,1559 | 10256,8441 | 2 |
| 59 | 9685,3432 | 9941,8892 | 9743,4540 | 10256,5460 | 1 |
| 60 | 9685,5712 | 9941,8192 | 9743,7520 | 10256,2480 | 0 |
| | | Sin. 45. | | Tan.28. | M |

| M | Sin. 29. | | Tan. 29. | | |
|---|---|---|---|---|---|
| 0 | 9685,5712 | 9941,8192 | 9743,7519 | 10256,2480 | 60 |
| | 9685,7990 | 9941,7492 | 9744,0498 | 10255,9501 | 59 |
| 2 | 9686,0267 | 9941,6791 | 9744,3476 | 10255,6523 | 58 |
| 3 | 9686,2542 | 9941,6089 | 9744,6452 | 10255,3547 | 57 |
| 4 | 9686,4816 | 9941,5387 | 9744,9428 | 10255,0571 | 56 |
| 5 | 9686,7088 | 9941,4685 | 9745,2403 | 10254 7597 | 55 |
| 6 | 9686,9358 | 9941,3982 | 9745,5376 | 10254,4623 | 54 |
| 7 | 9687,1627 | 9941,3279 | 9745,8348 | 10254,1651 | 53 |
| 8 | 9687,3895 | 9941,2575 | 9746,1319 | 10253,8680 | 52 |
| 9 | 9687,6160 | 9941,1870 | 9746,4290 | 10253,5709 | 51 |
| 10 | 9687,8425 | 9941,1165 | 9746,7259 | 10253,2740 | 50 |
| 11 | 9688,0687 | 9941,0460 | 9747,0227 | 10252,9772 | 49 |
| 12 | 9688,2949 | 9940,9754 | 9747,3194 | 10252,6805 | 48 |
| 13 | 9688,5208 | 9940,9048 | 9747,6160 | 10252,3839 | 47 |
| 14 | 9688,7466 | 9940,8341 | 9747,9125 | 10252,0874 | 46 |
| 15 | 9688,9723 | 9940,7634 | 9748,2089 | 10251,7911 | 45 |
| 16 | 9689,1978 | 9940,6926 | 9748,5051 | 10251,4948 | 44 |
| 17 | 9689,4232 | 9940,6218 | 9748,8013 | 10251,1986 | 43 |
| 18 | 9689,6484 | 9940,5509 | 9749,0974 | 10250,9025 | 42 |
| 19 | 9689,8734 | 9940,4800 | 9749,3933 | 10250,6066 | 41 |
| 20 | 9690,0983 | 9940,4091 | 9749,6892 | 10250,3107 | 40 |
| 21 | 9690,3230 | 9940,3380 | 9749,9849 | 10250,0150 | 39 |
| 22 | 9690,5476 | 9940,2670 | 9750,2806 | 10249,7193 | 38 |
| 23 | 9690,7720 | 9940,1959 | 9750,5761 | 10249,4238 | 37 |
| 24 | 9690,9963 | 9940,1247 | 9750,8716 | 10249,1284 | 36 |
| 25 | 9691,2204 | 9940,0535 | 9751,1669 | 10248,8330 | 35 |
| 26 | 9691,4444 | 9939,9822 | 9751,4621 | 10248,5378 | 34 |
| 27 | 9691,6682 | 9939,9109 | 9751,7573 | 10248,2427 | 33 |
| 28 | 9691,8919 | 9939,8396 | 9752,0523 | 10247,9476 | 32 |
| 29 | 9692,1154 | 9939,7682 | 9752,3472 | 10247,6527 | 31 |
| 30 | 9692,3388 | 9939,6967 | 9752,6420 | 10247,3579 | 30 |
| | | Sin. 60. | | Tan. 60. | M |

| M | Sin. 29. | | Tan. 29. | | |
|---|---|---|---|---|---|
| 30 | 9692,3388 | 9939,6967 | 9752,6420 | 10247,3579 | 30 |
| 31 | 9692,5620 | 9939,6252 | 9752,9367 | 10247,0632 | 29 |
| 32 | 9692,7851 | 9939,5537 | 9753,2313 | 10246,7686 | 28 |
| 33 | 9693,0080 | 9939,4821 | 9753,5258 | 10246,4741 | 27 |
| 34 | 9693,2307 | 9939,4104 | 9753,8203 | 10246,1797 | 26 |
| 35 | 9693,4533 | 9939,3388 | 9754,1146 | 10245,8854 | 25 |
| 36 | 9693,6758 | 9939,2670 | 9754,4087 | 10245,5912 | 24 |
| 37 | 9693,8981 | 9939,1952 | 9754,7028 | 10245,2971 | 23 |
| 38 | 9694,1203 | 9939,1234 | 9754,9968 | 10245,0031 | 22 |
| 39 | 9694,3423 | 9939,0515 | 9755,2907 | 10244,7092 | 21 |
| 40 | 9694,5641 | 9938,9796 | 9755,5845 | 10244,4154 | 20 |
| 41 | 9694,7858 | 9938,9076 | 9755,8782 | 10244,1217 | 19 |
| 42 | 9695,0074 | 9938,8355 | 9756,1718 | 10243,8281 | 18 |
| 43 | 9695,2288 | 9938,7635 | 9756,4653 | 10243,5346 | 17 |
| 44 | 9695,4501 | 9938,6913 | 9756,7587 | 10243,2412 | 16 |
| 45 | 9695,6712 | 9938,6191 | 9757,0520 | 10242,9479 | 15 |
| 46 | 9695,8921 | 9938,5469 | 9757,3452 | 10242,6548 | 14 |
| 47 | 9696,1129 | 9938,4746 | 9757,6383 | 10242,3617 | 13 |
| 48 | 9696,3336 | 9938,4023 | 9757,9312 | 10242,0687 | 12 |
| 49 | 9696,5541 | 9938,3299 | 9758,2241 | 10241,7758 | 11 |
| 50 | 9696,7745 | 9938,2575 | 9758,5169 | 10241,4830 | 10 |
| 51 | 9696,9947 | 9938,1850 | 9758,8096 | 10241,1903 | 9 |
| 52 | 9697,2148 | 9938,1125 | 9759,1022 | 10240,8977 | 8 |
| 53 | 9697,4347 | 9938,0400 | 9759,3947 | 10240,6052 | 7 |
| 54 | 9697,6544 | 9937,9673 | 9759,6871 | 10240,3128 | 6 |
| 55 | 9697,8741 | 9937,8947 | 9759,9794 | 10240,0206 | 5 |
| 56 | 9698,0935 | 9937,8220 | 9760,2715 | 10239,7284 | 4 |
| 57 | 9698,3129 | 9937,7492 | 9760,5636 | 10239,4363 | 3 |
| 58 | 9698,5320 | 9937,6764 | 9760,8556 | 10239,1443 | 2 |
| 59 | 9698,7511 | 9937,6035 | 9761,1475 | 10238,8524 | 1 |
| 60 | 9698,9700 | 9937,5306 | 9761,4393 | 10238,5606 | 0 |
| | | Sin. 60. | | Tan. 60. | M |

| M | Sin. 30. | | Tan. 30. | | |
|---|---|---|---|---|---|
| 0 | 9698,9700 | 9937,5306 | 9761,4393 | 10238,5606 | 60 |
| 1 | 9699,1887 | 9937,4576 | 9761,7310 | 10238,2689 | 59 |
| 2 | 9699,4073 | 9937,3845 | 9762,0226 | 10237,9773 | 58 |
| 3 | 9699,6257 | 9937,3116 | 9762,3141 | 10237,6858 | 57 |
| 4 | 9699,8440 | 9937,2385 | 9762,6056 | 10237,3944 | 56 |
| 5 | 9700,0622 | 9937,1653 | 9762,8969 | 10237,1031 | 55 |
| 6 | 9700,2802 | 9937,0921 | 9763,1881 | 10236,8118 | 54 |
| 7 | 9700,4981 | 9937,0188 | 9763,4792 | 10236,5207 | 53 |
| 8 | 9700,7158 | 9936,9455 | 9763,7702 | 10236,2297 | 52 |
| 9 | 9700,9333 | 9936,8722 | 9764,0611 | 10235,9388 | 51 |
| 10 | 9701,1508 | 9936,7988 | 9764,3520 | 10235,6480 | 50 |
| 11 | 9701,3680 | 9936,7253 | 9764,6427 | 10235,3572 | 49 |
| 12 | 9701,5852 | 9936,6518 | 9764,9333 | 10235,0666 | 48 |
| 13 | 9701,8021 | 9936,5783 | 9765,2238 | 10234,7761 | 47 |
| 14 | 9702,0190 | 9936,5047 | 9765,5143 | 10234,4856 | 46 |
| 15 | 9702,2357 | 9936,4310 | 9765,8046 | 10234,1953 | 45 |
| 16 | 9702,4522 | 9936,3573 | 9766,0949 | 10233,9050 | 44 |
| 17 | 9702,6686 | 9936,2836 | 9766,3850 | 10233,6149 | 43 |
| 18 | 9702,8849 | 9936,2098 | 9766,6751 | 10233,3248 | 42 |
| 19 | 9703,1010 | 9936,1359 | 6766,9651 | 10233,0349 | 41 |
| 20 | 9703,3170 | 9936,0620 | 9767,2549 | 10232,7450 | 40 |
| 21 | 9703,5328 | 9935,9881 | 9767,5447 | 10232,4552 | 39 |
| 22 | 9703,7485 | 9935,9141 | 9767,8344 | 10232,1655 | 38 |
| 23 | 9703,9641 | 9935,8400 | 9768,1240 | 10231,8759 | 37 |
| 24 | 9704,1795 | 9935,7659 | 9768,4135 | 10231,5864 | 36 |
| 25 | 9704,3947 | 9935,6918 | 9768,7029 | 10231,2971 | 35 |
| 26 | 9704,6098 | 9935,6176 | 9768,9922 | 10231,0078 | 34 |
| 27 | 9704,8248 | 9935,5434 | 9769,2814 | 10230,7185 | 33 |
| 28 | 9705,0396 | 9935,4691 | 9769,5705 | 10230,4294 | 32 |
| 29 | 9705,2543 | 9935,3947 | 9769,8595 | 10230,1404 | 31 |
| 30 | 9705,4688 | 9935,3203 | 9770,1485 | 10229,8515 | 30 |
| | | Sin. 59. | | Tan. 59. | M |

| M | Sin. 30. | | Tan. 30. | | |
|---|---|---|---|---|---|
| 30 | 9705,4688 | 9935,3203 | 9770,1485 | 10229,8515 | 30 |
| 31 | 9705,6832 | 9935,2459 | 9770,4373 | 10229,5626 | 29 |
| 32 | 9705,8975 | 9935,1714 | 9770,7260 | 10229,2739 | 28 |
| 33 | 9706,1116 | 9935,0969 | 9771,0147 | 10228,9852 | 27 |
| 34 | 9706,3256 | 9935,0223 | 9771,3032 | 10228,6967 | 26 |
| 35 | 9706,5394 | 9934,9477 | 9771,5917 | 10228,4082 | 25 |
| 36 | 9706,7531 | 9934,8730 | 9771,8801 | 10228,1198 | 24 |
| 37 | 9706,9666 | 9934,7982 | 9772,1684 | 10227,8316 | 23 |
| 38 | 9707,1800 | 9934,7234 | 9772,4565 | 10227,5434 | 22 |
| 39 | 9707,3933 | 9934,6486 | 9772,7446 | 10227,2553 | 21 |
| 40 | 9707,6064 | 9934,5737 | 9773,0327 | 10226,9673 | 20 |
| 41 | 9707,8194 | 9934,4988 | 9773,3206 | 10226,6794 | 19 |
| 42 | 9708,0322 | 9934,4238 | 9773,6084 | 10226,3915 | 18 |
| 43 | 9708,2449 | 9934,3488 | 9773,8961 | 10226,1038 | 17 |
| 44 | 9708,4575 | 9934,2737 | 9774,1838 | 10225,8162 | 16 |
| 45 | 9708,6699 | 9934,1986 | 9774,4713 | 10225,5286 | 15 |
| 46 | 9708,8822 | 9934,1233 | 9774,7588 | 10225,2411 | 14 |
| 47 | 9709,0943 | 9934,0481 | 9775,0461 | 10224,9538 | 13 |
| 48 | 9709,3063 | 9933,9728 | 9775,3334 | 10224,6665 | 12 |
| 49 | 9709,5181 | 9933,8975 | 9775,6206 | 10224,3793 | 11 |
| 50 | 9709,7298 | 9933,8221 | 9775,9077 | 10224,0922 | 10 |
| 51 | 9709,9414 | 9933,7467 | 9776,1947 | 10223,8052 | 9 |
| 52 | 9710,1528 | 9933,6712 | 9776,4816 | 10223,5183 | 8 |
| 53 | 9710,3641 | 9933,5957 | 9776,7684 | 10223,2315 | 7 |
| 54 | 9710,5753 | 9933,5201 | 9777,0552 | 10222,9448 | 6 |
| 55 | 9710,7863 | 9933,4445 | 9777,3418 | 10222,6581 | 5 |
| 56 | 9710,9972 | 9933,3688 | 9777,6284 | 10222,3715 | 4 |
| 57 | 9711,2079 | 9933,2931 | 9777,9148 | 10222,0851 | 3 |
| 58 | 9711,4185 | 9933,2173 | 9778,2012 | 10221,7987 | 2 |
| 59 | 9711,6290 | 9933,1414 | 9778,4875 | 10221,5124 | 1 |
| 60 | 9711,8393 | 9933,0656 | 9778,7737 | 10221,2262 | 0 |
| | | Sin. 59. | | Tan. 59. | M |

| M | Sin. 31. | | Tang. 31. | | |
|---|---|---|---|---|---|
| 0 | 9711,8393 | 9933,0656 | 9778.7737 | 10221,2262 | 60 |
| 1 | 9712.0495 | 9932,9896 | 9779.0598 | 10220.9401 | 59 |
| 2 | 9712,2595 | 9932,9136 | 9779,3458 | 10220,6541 | 58 |
| 3 | 9712,4694 | 9932,8376 | 9779.6318 | 10220,3681 | 57 |
| 4 | 9712,6792 | 9932.7615 | 9779.9176 | 10220,0823 | 56 |
| 5 | 9712,8888 | 9932.6854 | 9780.2034 | 10219,7965 | 55 |
| 6 | 9713,0983 | 9932.6092 | 9780,4891 | 10219 5109 | 54 |
| 7 | 9713.3077 | 9932,5330 | 9780.7746 | 10219,2253 | 53 |
| 8 | 9713.5169 | 9932.4567 | 9781.0602 | 10218,9398 | 52 |
| 9 | 9713,7260 | 9932,3804 | 9781,3456 | 10218,6544 | 51 |
| 10 | 9713,9349 | 9932,3040 | 9781,6309 | 10218,3690 | 50 |
| 11 | 9714,1437 | 9932,2275 | 9781,9161 | 10218,0838 | 49 |
| 12 | 9714.3524 | 9932.1511 | 9782,2013 | 10217.7989 | 48 |
| 13 | 9714,5609 | 9932,0745 | 9782,4863 | 10217.5136 | 47 |
| 14 | 9714,7693 | 9931,9979 | 9782.7713 | 10217 2286 | 46 |
| 15 | 9714,9775 | 9931,9213 | 9783.0562 | 10216.9437 | 45 |
| 16 | 9715,1857 | 9931,8446 | 9783,3410 | 10216,6589 | 44 |
| 17 | 9715.3936 | 9931.7679 | 9783,6257 | 10216,3742 | 43 |
| 18 | 9715.6015 | 9931,6911 | 9783,9103 | 10216.0896 | 42 |
| 19 | 9715.8092 | 9931.6143 | 9784,1949 | 10215,8050 | 41 |
| 20 | 9716.0168 | 9931.5374 | 9784,4794 | 10215.5205 | 40 |
| 21 | 9716.2242 | 9931.4604 | 9784,7637 | 10215,2362 | 39 |
| 22 | 9716.4315 | 9931,3835 | 9785.0480 | 10214,9519 | 38 |
| 23 | 9716,6387 | 9931.3064 | 9785.3322 | 10214.6677 | 37 |
| 24 | 9716 8457 | 9931,2293 | 9785,6163 | 10214,3836 | 36 |
| 25 | 9717,0526 | 9931.1522 | 9785.9004 | 10214.0995 | 35 |
| 26 | 9717,2594 | 9931.0750 | 9786.1843 | 10213,8156 | 34 |
| 27 | 9717.4660 | 9930.9978 | 9786,4682 | 10213,5317 | 33 |
| 28 | 9717.6725 | 9930,9205 | 9786.7520 | 10213.2479 | 32 |
| 29 | 9717,8788 | 9930,8431 | 9787.0357 | 10212,9642 | 31 |
| 30 | 9718,0851 | 9930.7657 | 9787.3193 | 10212,6806 | 30 |
| | | Tan. 58. | | Sin. 58. | M. |

| M | Sin. 31. | | Tan. 31. | | |
|---|---|---|---|---|---|
| 30 | 9718,0851 | 9930,7657 | 9787,3193 | 10212,6806 | 30 |
| 31 | 9718,2912 | 9930,6883 | 9787,6028 | 10212,3971 | 29 |
| 32 | 9718,4971 | 9930,6108 | 9787,8865 | 10212,1137 | 28 |
| 33 | 9718,7029 | 9930,5333 | 9788,1696 | 10211,8303 | 27 |
| 34 | 9718,9086 | 9930,4557 | 9788,4529 | 10211,5470 | 26 |
| 35 | 9719,1142 | 9930,3780 | 9788,7361 | 10211,2638 | 25 |
| 36 | 9719,3196 | 9930,3003 | 9789,0192 | 10210,9807 | 24 |
| 37 | 9719,5249 | 9930,2226 | 9789,3022 | 10210,6977 | 23 |
| 38 | 9719,7300 | 9930,1448 | 9789,5852 | 10210,4147 | 22 |
| 39 | 9719,9350 | 9930,0670 | 9789,8680 | 10210,1319 | 21 |
| 40 | 9720,1399 | 9929,9891 | 9790,1508 | 10209,8491 | 20 |
| 41 | 9720,3446 | 9929,9111 | 9790,4335 | 10209,5664 | 19 |
| 42 | 9720,5493 | 9929,8331 | 9790,7161 | 10209,2838 | 18 |
| 43 | 9720,7537 | 9929,7551 | 9790,9986 | 10209,0013 | 17 |
| 44 | 9720,9581 | 9929,6770 | 9791,2811 | 10208,7188 | 16 |
| 45 | 9721,1623 | 9929,5988 | 9791,5634 | 10208,4365 | 15 |
| 46 | 9721,3664 | 9929,5206 | 9791,8457 | 10208,1542 | 14 |
| 47 | 9721,5703 | 9929,4424 | 9792,1279 | 10207,8720 | 13 |
| 48 | 9721,7741 | 9929,3641 | 9792,4101 | 10207,5899 | 12 |
| 49 | 9721,9778 | 9929,2857 | 9792,6921 | 10207,3078 | 11 |
| 50 | 9722,1814 | 9929,2073 | 9792,9741 | 10207,0259 | 10 |
| 51 | 9722,3848 | 9929,1288 | 9793,2559 | 10206,7440 | 9 |
| 52 | 9722,5881 | 9929,0503 | 9793,5377 | 10206,4622 | 8 |
| 53 | 9722,7913 | 9928,9718 | 9793,8194 | 10206,1805 | 7 |
| 54 | 9722,9943 | 9928,8932 | 9794,1011 | 10205,8988 | 6 |
| 55 | 9723,1972 | 9928,8145 | 9794,3826 | 10205,6173 | 5 |
| 56 | 9723,3999 | 9928,7358 | 9794,6641 | 10205,3358 | 4 |
| 57 | 9723,6026 | 9928,6570 | 9794,9455 | 10205,0544 | 3 |
| 58 | 9723,8051 | 9928,5782 | 9795,2268 | 10204,7731 | 2 |
| 59 | 9724,0074 | 9928,4994 | 9795,5080 | 10204,4919 | 1 |
| 60 | 9724,2097 | 9928,4204 | 9795,7892 | 10204,2107 | 0 |
| | | Sin. 58. | | Tan. 58. | M |

| M | Sin. 32 | | Tan. 32. | | |
|---|---|---|---|---|---|
| 0 | 9724,2097 | 9928,4204 | 9795,7890 | 10204,2107 | 60 |
| 1 | 9724,4118 | 9928,3415 | 9796,0705 | 10203,9297 | 59 |
| 2 | 9724,6138 | 9928,2625 | 9796,3513 | 10203,6487 | 58 |
| 3 | 9724,8156 | 9928,1834 | 9796,6322 | 10203,3678 | 57 |
| 4 | 9725,0173 | 9928,1043 | 9796,9130 | 10203,0869 | 56 |
| 5 | 9725,2189 | 9928,0251 | 9797,1938 | 10202,8062 | 55 |
| 6 | 9725,4203 | 9927,9459 | 9797,4744 | 10202,5255 | 54 |
| 7 | 9725,6217 | 9927,8666 | 9797,7550 | 10202,2449 | 53 |
| 8 | 9725,8229 | 9927,7873 | 9798,0356 | 10201,9644 | 52 |
| 9 | 9726,0239 | 9927,7079 | 9798,3160 | 10201,6839 | 51 |
| 10 | 9726,2249 | 9927,6285 | 9798,5964 | 10201,4036 | 50 |
| 11 | 9726,4257 | 9927,5490 | 9798,8766 | 10201,1233 | 49 |
| 12 | 9726,6263 | 9927,4695 | 9799,1568 | 10200,8431 | 48 |
| 13 | 9726,8269 | 9927,3899 | 9799,4370 | 10200,5629 | 47 |
| 14 | 9727,0273 | 9927,3103 | 9799,7170 | 10200,2829 | 46 |
| 15 | 9727,2276 | 9927,2306 | 9799,9970 | 10200,0029 | 45 |
| 16 | 9727,4278 | 9927,1508 | 9800,2769 | 10199,7230 | 44 |
| 17 | 9727,6278 | 9927,0711 | 9800,5567 | 10199,4432 | 43 |
| 18 | 9727,8277 | 9926,9912 | 9800,8364 | 10199,1635 | 42 |
| 19 | 9728,0275 | 9926,9113 | 9801,1161 | 10198,8838 | 41 |
| 20 | 9728,2271 | 9926,8314 | 9801,3957 | 10198,6042 | 40 |
| 21 | 9728,4266 | 9926,7514 | 9801,6752 | 10198,3247 | 39 |
| 22 | 9728,6260 | 9926,6713 | 9801,9546 | 10198,0453 | 38 |
| 23 | 9728,8253 | 9926,5913 | 9802,2340 | 10197,7659 | 37 |
| 24 | 9729,0244 | 9926,5111 | 9802,5132 | 10197,4867 | 36 |
| 25 | 9729,2234 | 9926,4309 | 9802,7924 | 10197,2075 | 35 |
| 26 | 9729,4223 | 9926,3507 | 9803,0716 | 10196,9284 | 34 |
| 27 | 9729,6210 | 9926,2704 | 9803,3506 | 10196,6494 | 33 |
| 28 | 9729,8196 | 9926,1900 | 9803,6296 | 10196,3703 | 32 |
| 29 | 9730,0181 | 9926,1096 | 9803,9085 | 10196,0914 | 31 |
| 30 | 9730,2165 | 9926,0292 | 9804,1873 | 10195,8126 | 30 |
| | | Sin. 57. | | Tang. 75 | M |

| M | Sin. 32. | | Tan. 32. | | |
|---|---|---|---|---|---|
| 30 | 9730,2165 | 9926,0292 | 9804,1873 | 10195,8126 | 30 |
| 31 | 9730,4147 | 9925,9486 | 9804,4660 | 10195,5339 | 29 |
| 32 | 9730,6128 | 9925,8681 | 9804,7447 | 10195,2552 | 28 |
| 33 | 9730,8108 | 9925,7875 | 9805,0233 | 10194,9766 | 27 |
| 34 | 9731,0087 | 9925,7068 | 9805,3018 | 10194,6981 | 26 |
| 35 | 9731,2064 | 9925,6261 | 9805,5803 | 10194,4196 | 25 |
| 36 | 9731,4040 | 9925,5453 | 9805,8586 | 10194,1413 | 24 |
| 37 | 9731,6015 | 9925,4645 | 9806,1369 | 10193,8630 | 23 |
| 38 | 9731,7988 | 9925,3836 | 9806,4151 | 10193,5848 | 22 |
| 39 | 9731,9960 | 9925,3027 | 9806,6933 | 10193,3066 | 21 |
| 40 | 9732,1931 | 9925,2218 | 9806,9714 | 10193,0285 | 20 |
| 41 | 9732,3901 | 9925,1407 | 9807,2494 | 10192,7506 | 19 |
| 42 | 9732,5870 | 9925,0596 | 9807,5273 | 10192,4726 | 18 |
| 43 | 9732,7837 | 9924,9785 | 9807,8051 | 10192,1948 | 17 |
| 44 | 9732,9803 | 9924,8973 | 9808,0829 | 10191,9170 | 16 |
| 45 | 9733,1767 | 9924,8161 | 9808,3606 | 10191,6393 | 15 |
| 46 | 9733,3731 | 9924,7348 | 9808,6382 | 10191,3617 | 14 |
| 47 | 9733,5693 | 9924,6535 | 9808,9158 | 10191,0842 | 13 |
| 48 | 9733,7654 | 9924,5721 | 9809,1932 | 10190,8067 | 12 |
| 49 | 9733,9613 | 9924,4906 | 9809,4707 | 10190,5293 | 11 |
| 50 | 9734,1572 | 9924,4092 | 9809,7480 | 10190,2519 | 10 |
| 51 | 9734,3529 | 9924,3276 | 9810,0252 | 10189,9747 | 9 |
| 52 | 9734,5485 | 9924,2460 | 9810,3024 | 10189,6975 | 8 |
| 53 | 9734,7440 | 9924,1644 | 9810,5796 | 10189,4204 | 7 |
| 54 | 9734,9393 | 9924,0827 | 9810,8566 | 10189,1433 | 6 |
| 55 | 9735,1345 | 9924,0009 | 9811,1336 | 10188,8663 | 5 |
| 56 | 9735,3296 | 9923,9191 | 9811,4105 | 10188,5894 | 4 |
| 57 | 9735,5246 | 9923,8372 | 9811,6873 | 10188,3126 | 3 |
| 58 | 9735,7194 | 9923,7553 | 9811,9640 | 10188,0359 | 2 |
| 59 | 9735,9141 | 9923,6734 | 9812,2407 | 10187,7592 | 1 |
| 60 | 9736,1087 | 9923,5914 | 9812,5173 | 10187,4826 | 0 |
| | | Sin. 57. | | Tan. 57. | M |

| M | Sin. 33. | | Tan. 33. | | |
|---|---|---|---|---|---|
| 0 | 9736,1087 | 9923,5914 | 9812,5173 | 10187,4826 | 60 |
| 1 | 9736,3032 | 9923,5093 | 9812,7939 | 10187,2061 | 59 |
| 2 | 9736,4975 | 9923,4272 | 9813,0703 | 10186,9296 | 58 |
| 3 | 9736,6918 | 9923,3450 | 9813,3467 | 10186,6532 | 57 |
| 4 | 9736,8859 | 9923,2628 | 9813,6231 | 10186,3769 | 56 |
| 5 | 9737,0798 | 9923,1805 | 9813,8993 | 10186,1006 | 55 |
| 6 | 9737,2737 | 9923,0982 | 9814,1755 | 10185,8244 | 54 |
| 7 | 9737,4674 | 9923,0158 | 9814,4516 | 10185,5483 | 53 |
| 8 | 9737,6610 | 9922,9334 | 9814,7276 | 10185,2723 | 52 |
| 9 | 9737,8545 | 9922,8509 | 9815,0036 | 10184,9963 | 51 |
| 10 | 9738,0479 | 9922,7683 | 9815,2795 | 10184,7204 | 50 |
| 11 | 9738,2411 | 9922,6858 | 9815,5553 | 10184,4446 | 49 |
| 12 | 9738,4342 | 9922,6031 | 9815,8311 | 10184,1688 | 48 |
| 13 | 9738,6272 | 9922,5204 | 9816,1068 | 10183,8931 | 47 |
| 14 | 9738,8201 | 9922,4377 | 9816,3824 | 10183,6175 | 46 |
| 15 | 9739,0128 | 9922,3549 | 9816,6579 | 10183,3420 | 45 |
| 16 | 9739,2055 | 9922,2720 | 9816,9334 | 10183,0665 | 44 |
| 17 | 9739,3980 | 9922,1891 | 9817,2088 | 10182,7911 | 43 |
| 18 | 9739,5904 | 9922,1062 | 9817,4842 | 10182,5158 | 42 |
| 19 | 9739,7826 | 9922,0231 | 9817,7594 | 10182,2405 | 41 |
| 20 | 9739,0748 | 9921,9401 | 9818,0346 | 10181,9653 | 40 |
| 21 | 9740,1668 | 9921,8570 | 9818,3098 | 10181,6902 | 39 |
| 22 | 9740,3587 | 9921,7738 | 9818,5848 | 10181,4151 | 38 |
| 23 | 9740,5504 | 9921,6906 | 9818,8598 | 10181,1401 | 37 |
| 24 | 9740,7421 | 9921,6073 | 9819,1347 | 10180,8652 | 36 |
| 25 | 9740,9336 | 9921,5240 | 9819,4096 | 10180,5903 | 35 |
| 26 | 9741,1250 | 9921,4406 | 9819,6844 | 10180,3155 | 34 |
| 27 | 9741,3163 | 9921,3572 | 9819,9591 | 10180,0408 | 33 |
| 28 | 9741,5075 | 9921,2737 | 9820,2338 | 10179,7662 | 32 |
| 29 | 9741,6985 | 9921,1901 | 5820,5084 | 10179,4916 | 31 |
| 30 | 9741,8895 | 9921,1066 | 9820,7829 | 10179,2171 | 30 |
| | | | | Tan. 46. | M |

| M | Sin. 33. | | Tan. 33. | | |
|---|---|---|---|---|---|
| 30 | 9741,8895 | 9921,1066 | 9820,7829 | 10179,2171 | 30 |
| 31 | 9742,0803 | 9921,0229 | 9821,0573 | 10178,9426 | 29 |
| 32 | 9742,2710 | 9920,9392 | 9821,3317 | 10178,6682 | 28 |
| 33 | 9742,4615 | 9920,8555 | 9821,6060 | 10178,3939 | 27 |
| 34 | 9742,6520 | 9920,7717 | 9821,8803 | 10178,1197 | 26 |
| 35 | 9742,8423 | 9920,6878 | 9822,1544 | 10177,8455 | 25 |
| 36 | 9743,0325 | 9920,6039 | 9822,4286 | 10177,5714 | 24 |
| 37 | 9743,2226 | 9920 5199 | 6822,7026 | 10177,2973 | 23 |
| 38 | 9743,4125 | 9920,4359 | 9822,9766 | 10177,0233 | 22 |
| 39 | 9743,6024 | 9920,3519 | 9823,2505 | 10176,7494 | 21 |
| 40 | 9743,7921 | 9920,2677 | 9823,5243 | 10176,4756 | 20 |
| 41 | 9743,9817 | 9920,1836 | 9823,7981 | 10176,2018 | 19 |
| 42 | 9744,1712 | 9920,0993 | 9824,0718 | 10175,9281 | 18 |
| 43 | 9744,3606 | 9920,0151 | 9824,3455 | 10175,6545 | 17 |
| 44 | 9744,5498 | 9919,9307 | 9824,6190 | 10175,3809 | 16 |
| 45 | 9744,7389 | 9919,8465 | 9824,8925 | 10175,1074 | 15 |
| 46 | 9744,9279 | 9919,7619 | 9825,1660 | 10174,8339 | 14 |
| 47 | 9745,1168 | 9919,6774 | 9825,4394 | 10174,5605 | 13 |
| 48 | 9745,3056 | 9919,5929 | 9825,7127 | 10174,2872 | 12 |
| 49 | 9745,4942 | 9919,5083 | 9825,9859 | 10174,0140 | 11 |
| 50 | 9745,6828 | 9919,4236 | 9826,2591 | 10173,7408 | 10 |
| 51 | 9745,8712 | 9919,3389 | 9826,5322 | 10173,4677 | 9 |
| 52 | 9746,0595 | 9919,2542 | 9826,8053 | 10173,1946 | 8 |
| 53 | 9746,2477 | 9919,1693 | 9827,0783 | 10172,9216 | 7 |
| 54 | 9746,4357 | 9919,0845 | 9827,3512 | 10172,6487 | 6 |
| 55 | 9746,6237 | 9918,9996 | 9827,6241 | 10172,3758 | 5 |
| 56 | 9746,8115 | 9918,9146 | 9827,8969 | 10172,1030 | 4 |
| 57 | 9746,9992 | 9918,8296 | 9828,1696 | 10171,8303 | 3 |
| 58 | 9747[illegible]868 | 9918,7445 | 9828,4423 | 10171,5576 | 2 |
| 59 | 9747,3743 | 9918,6594 | 9828,7149 | 10171,2850 | 1 |
| 60 | 9747,5616 | 9918,5742 | 9828,9874 | 10171,0125 | 0 |
| | | Sin. 56. | | Tan. 56. | M |

| M | Sin. 34. | | Tan. 34. | | |
|---|---|---|---|---|---|
| 0 | 9747,5616 | 9918,5744 | 9828,9874 | 10171,0125 | 60 |
| 1 | 9747,7489 | 9918,4889 | 9829,2599 | 10170,7400 | 59 |
| 2 | 9747,9360 | 9918,4036 | 9829,5323 | 10170,4676 | 58 |
| 3 | 9748,1230 | 9918,3183 | 9829,8046 | 10170,1953 | 57 |
| 4 | 9748,3099 | 9918,2329 | 9830,0769 | 10169,9230 | 56 |
| 5 | 9748,4966 | 9918,1474 | 9830,3491 | 10169,6508 | 55 |
| 6 | 9748,6833 | 9918,0619 | 9830,6213 | 10169,3786 | 54 |
| 7 | 9748,8698 | 9917,9764 | 9830,8934 | 10169,1065 | 53 |
| 8 | 9749,0562 | 9917,8908 | 9831,1654 | 10168,8345 | 52 |
| 9 | 9749,2425 | 9917,8051 | 9831,4374 | 10168,5626 | 51 |
| 10 | 9749,4287 | 9917,7194 | 9831,7093 | 10168,2906 | 50 |
| 11 | 9749,6148 | 9917,6336 | 9831,9811 | 10168,0188 | 49 |
| 12 | 9749,8007 | 9917,5478 | 9832,2529 | 10167,7470 | 48 |
| 13 | 9749,9865 | 9917,4619 | 9832,5246 | 10167,4753 | 47 |
| 14 | 9750,1723 | 9917,3760 | 9832,7963 | 10167,2037 | 46 |
| 15 | 9750,3579 | 9917,2900 | 9833,0678 | 10166,9321 | 45 |
| 16 | 9750,5433 | 9917,2039 | 9833,3394 | 10166,6605 | 44 |
| 17 | 9750,7287 | 9917,1178 | 9833,6108 | 10166,3891 | 43 |
| 18 | 9750,9140 | 9917,0317 | 9833,8822 | 10166,1177 | 42 |
| 19 | 9751,0991 | 9916,9455 | 9834,1536 | 10165,8463 | 41 |
| 20 | 9751,2841 | 9916,8592 | 9834,4249 | 10165,5751 | 40 |
| 21 | 9751,4690 | 9916,7729 | 9834,6961 | 10165,3039 | 39 |
| 22 | 9751,6538 | 9916,6865 | 9834,9672 | 10165,0327 | 38 |
| 23 | 9751,8385 | 9916,6001 | 9835,2383 | 10164,7616 | 37 |
| 24 | 9752,0230 | 9916,5137 | 9835,5094 | 10164,4906 | 36 |
| 25 | 9752,2075 | 9916,4271 | 9835,7803 | 10164,2196 | 35 |
| 26 | 9752,3918 | 9916,3405 | 9836,0513 | 10163,9487 | 34 |
| 27 | 9752,5760 | 9916,2539 | 9836,3221 | 10163,6778 | 33 |
| 28 | 9752,7601 | 9916,1672 | 9836,5929 | 10163,4070 | 32 |
| 29 | 9752,9441 | 9916,0805 | 9836,8636 | 10163,1363 | 31 |
| 30 | 9753,1280 | 9915,9937 | 9837,1343 | 10162,8656 | 30 |
| | | Sin. 55. | | Tan. 58. | M |

| M | Sin. 34. | | Tan. 34. | | |
|---|---|---|---|---|---|
| 30 | 9753,1280 | 9915,9937 | 9837,1343 | 10162,8656 | 30 |
| 31 | 9753,3117 | 9915,9068 | 9837,4049 | 10162,5950 | 29 |
| 32 | 9753,4954 | 9915,8199 | 9837,6754 | 10162,3245 | 28 |
| 33 | 9753,6789 | 9915,7330 | 9837,9459 | 10162,0540 | 27 |
| 34 | 9753,8623 | 9915,6460 | 9838,2163 | 10161,7836 | 26 |
| 35 | 9754,0456 | 9915,5589 | 9838,4867 | 10161,5132 | 25 |
| 36 | 9754,2288 | 9915,4718 | 9838,7570 | 10161,2429 | 24 |
| 37 | 9754,4119 | 9915,3846 | 9839,0273 | 10160,9726 | 23 |
| 38 | 9754,5948 | 9915,2973 | 9839,2975 | 10160,7025 | 22 |
| 39 | 9754,7777 | 9915,2101 | 9839,5676 | 10160,4323 | 21 |
| 40 | 9754,9604 | 9915,1227 | 9839,8377 | 10160,1623 | 20 |
| 41 | 9755,1430 | 9915,0353 | 9840,1077 | 10159,8922 | 19 |
| 42 | 9755,3255 | 9914,9479 | 9840,3776 | 10159,6223 | 18 |
| 43 | 9755,5079 | 9914,8604 | 9840,6475 | 10159,3524 | 17 |
| 44 | 9755,6902 | 9914,7728 | 9840,9173 | 10159,0826 | 16 |
| 45 | 9755,8723 | 9914,6852 | 9841,1871 | 10158,8128 | 15 |
| 46 | 9756,0544 | 9914,5975 | 9841,4568 | 10158,5431 | 14 |
| 47 | 9756,2363 | 9914,5098 | 9841,7265 | 10158,2734 | 13 |
| 48 | 9756,4182 | 9914,4220 | 9841,9961 | 10158,0038 | 12 |
| 49 | 9756,5999 | 9914,3342 | 9842,2656 | 10157,7343 | 11 |
| 50 | 9756,7815 | 9914,2463 | 9842,5351 | 10157,4648 | 10 |
| 51 | 9756,9630 | 9914,1584 | 9842,8045 | 10157,1954 | 9 |
| 52 | 9757,1443 | 9914,0704 | 9843,0739 | 10156,9260 | 8 |
| 53 | 9757,3256 | 9913,9823 | 9843,3432 | 10156,6567 | 7 |
| 54 | 9757,5067 | 9913,8942 | 9843,6125 | 10156,3875 | 6 |
| 55 | 9757,6878 | 9913,8061 | 9843,8817 | 10156,1183 | 5 |
| 56 | 9757,8687 | 9913,7179 | 9844,1508 | 10155,8491 | 4 |
| 57 | 9758,0495 | 9913,6296 | 9844,4199 | 10155,5801 | 3 |
| 58 | 9758,2302 | 9913,5413 | 9844,6889 | 10155,3110 | 2 |
| 59 | 9758,4108 | 9913,4529 | 9844,9579 | 10155,0421 | 1 |
| 60 | 9758,5913 | 9913,3645 | 9845,2267 | 10154,7732 | 0 |
| | | Sin. 55. | | Tan. 55. | M |

| M | Sin. 35. | | Tan. 35. | | |
|---|---|---|---|---|---|
| 0 | 9758,5913 | 9913.3645 | 9845,2267 | 10154,7732 | 60 |
| 1 | 9758,7716 | 9913,2760 | 9845,4956 | 10154.5043 | 59 |
| 2 | 9758,9519 | 9913,1875 | 9845,7644 | 10154,2355 | 58 |
| 3 | 9759,1320 | 9913,0989 | 9846,0331 | 10153,9668 | 57 |
| 4 | 9759.3120 | 9913,0102 | 9846,3018 | 10153,6981 | 56 |
| 5 | 9759,4920 | 9912,9215 | 9846.5704 | 10153,4295 | 55 |
| 6 | 9759,6718 | 9912,8327 | 9846,8390 | 10153,1609 | 54 |
| 7 | 9759.8515 | 9912,7439 | 9847.1075 | 10152,8924 | 53 |
| 8 | 9760.0310 | 9912,6551 | 9847,3759 | 10152,6240 | 52 |
| 9 | 9760,2105 | 9912,5601 | 9847.6444 | 10152,3556 | 51 |
| 10 | 9760,3899 | 9912,4772 | 9847.9127 | 10152,0872 | 50 |
| 11 | 9760,5691 | 9912,3881 | 9848,1810 | 10151.8189 | 49 |
| 12 | 9760,7483 | 9912,2990 | 9848,4492 | 10151,5507 | 48 |
| 13 | 9760,9273 | 9912,2099 | 9848,7174 | 10151,2825 | 47 |
| 14 | 9761.1062 | 9912,1207 | 9848,9855 | 10151,0144 | 46 |
| 15 | 9761,2850 | 9912,0314 | 9849,2536 | 10150,7463 | 45 |
| 16 | 9761,4637 | 9911,9421 | 9849.5216 | 10150,4783 | 44 |
| 17 | 9761,6423 | 9911,8528 | 9849,7895 | 10150,2104 | 43 |
| 18 | 9761,8208 | 9911,7633 | 9850,0574 | 10149,9425 | 42 |
| 19 | 9761,9992 | 9911,6739 | 9850,3253 | 10149,6747 | 41 |
| 20 | 9762,1774 | 9911,5843 | 9850.5931 | 10149,4069 | 40 |
| 21 | 9762,3556 | 9911,4948 | 9850,8608 | 10149,1391 | 39 |
| 22 | 9762,5336 | 9911,4051 | 9851,1285 | 10148,8714 | 38 |
| 23 | 9762,7116 | 9911,3154 | 9851,3961 | 10148,6038 | 37 |
| 24 | 9762.8894 | 9911,2254 | 9851 6637 | 10148.3362 | 36 |
| 25 | 9763.0671 | 9911,1359 | 9851,9312 | 10148,0687 | 35 |
| 26 | 9763,2447 | 9911,0460 | 9852,1987 | 10147,8013 | 34 |
| 27 | 9763.4222 | 9910,9561 | 9852,4661 | 10147,5339 | 33 |
| 28 | 9763,5995 | 9910,8661 | 9852.7334 | 10147,2665 | 32 |
| 29 | 9763.7768 | 9910,7761 | 9853,0007 | 10146,9992 | 31 |
| 30 | 9763,9540 | 9910,6860 | 9853,2680 | 10146,7320 | 30 |
| | | Sin. 54. | | Sin. 54. | M |

| M | Sin. 35. | | Tan. 35. | | |
|---|---|---|---|---|---|
| 30 | 9763,9540 | 9910,6860 | 9853.2680 | 10146,7320 | 30 |
| 31 | 9764.1311 | 9910,5959 | 9853,5352 | 10146,4648 | 29 |
| 32 | 9764,3080 | 9910,5057 | 9853,8023 | 10146,1976 | 28 |
| 33 | 9764.4848 | 9910.4154 | 9854,0694 | 10145,9305 | 27 |
| 34 | 9764,6616 | 9910.3251 | 9854,3364 | 10145,6635 | 26 |
| 35 | 9764,8382 | 9910,2347 | 9854,6034 | 10145,3965 | 25 |
| 36 | 9765,0147 | 9910.1443 | 9854,8703 | 10145,1296 | 24 |
| 37 | 9765.1911 | 9910.0539 | 9855,1372 | 10144,8627 | 23 |
| 38 | 9765,3674 | 9909.9633 | 9855,4040 | 10144,5959 | 22 |
| 39 | 9765,5436 | 9909,8727 | 9855,6708 | 10144,3291 | 21 |
| 40 | 9765,7197 | 9909.7821 | 9855,9375 | 10144,0624 | 20 |
| 41 | 9765,8956 | 9909,6914 | 9856,2042 | 10143,7957 | 19 |
| 42 | 9766.0715 | 9909,6007 | 9856,4708 | 10143,5291 | 18 |
| 43 | 9766,2473 | 9909.5099 | 9856,7374 | 10143,2626 | 17 |
| 44 | 9766.4229 | 9909,4190 | 9857,0039 | 10142,9960 | 16 |
| 45 | 9766,5984 | 9909,3281 | 9857,2703 | 10142,7296 | 15 |
| 46 | 9766,7739 | 9909,2371 | 9857,5367 | 10142,4632 | 14 |
| 47 | 9766,9492 | 9909,1461 | 9857,8031 | 10142,1968 | 13 |
| 48 | 9767.1244 | 9909.0550 | 9858,0694 | 10141,9305 | 12 |
| 49 | 9767,2995 | 9908,9638 | 9858,3356 | 10141,6643 | 11 |
| 50 | 9767,4745 | 9908,8726 | 9858,6018 | 10141,3981 | 10 |
| 51 | 9767,6494 | 9908.7814 | 9858,8680 | 10141,1319 | 9 |
| 52 | 9767,8242 | 9908,6901 | 9859,1341 | 10140,8658 | 8 |
| 53 | 9767,9989 | 9908,5987 | 9859,4001 | 10140,5998 | 7 |
| 54 | 9768,1734 | 9908,5073 | 9859,6661 | 10140.3338 | 6 |
| 55 | 9768,3479 | 9908,4158 | 9859,9321 | 10140,0679 | 5 |
| 56 | 9768,5223 | 9908,3243 | 9860,1979 | 10139,8020 | 4 |
| 57 | 9768,6965 | 9908,2327 | 9860,4638 | 10139,5361 | 3 |
| 58 | 9768.8707 | 9908,1411 | 9860,7296 | 10139.2703 | 2 |
| 59 | 9769,0447 | 9908,0494 | 9860,9953 | 10139,0046 | 1 |
| 60 | 9769,2186 | 9907,9576 | 9861,2610 | 10138.7389 | 0 |
| | | Sin. 54. | | Tan. 54. | M |

| M | Sin. 36. | | Tan. 36. | | |
|---|---|---|---|---|---|
| 0 | 9769,2186 | 9907,9576 | 9861,2610 | 10138,7389 | 60 |
| 1 | 9769,3925 | 9907,8658 | 9861,5266 | 10138,4733 | 59 |
| 2 | 9769,5662 | 9907,7739 | 9861,7922 | 10138,2077 | 58 |
| 3 | 9769,7398 | 9907,6820 | 9862,0578 | 10137,9421 | 57 |
| 4 | 9769,9133 | 9907,5900 | 9862,3232 | 10137,6767 | 56 |
| 5 | 9770,0867 | 9907,4980 | 9862,5887 | 10137,4112 | 55 |
| 6 | 9770,2600 | 9907,4059 | 9862,8541 | 10137,1458 | 54 |
| 7 | 9770,4332 | 9907,3137 | 9863,1194 | 10136,8805 | 53 |
| 8 | 9770,6063 | 9907,2215 | 9863,3847 | 10136,6152 | 52 |
| 9 | 9770,7793 | 9907,1293 | 9863,6500 | 10136,3500 | 51 |
| 10 | 9770,9521 | 9907,0369 | 9863,9152 | 10136,0848 | 50 |
| 11 | 9771,1249 | 9906,9446 | 9864,1803 | 10135,8196 | 49 |
| 12 | 9771,2976 | 9906,8521 | 9864,4454 | 10135,5545 | 48 |
| 13 | 9771,4701 | 9906,7596 | 9864,7104 | 10135,2895 | 47 |
| 14 | 9771,6426 | 9906,6671 | 9864,9754 | 10135,0245 | 46 |
| 15 | 9771,8149 | 9906,5745 | 9865,2404 | 10134,7595 | 45 |
| 16 | 9771,9872 | 9906,4818 | 9865,5053 | 10134,4946 | 44 |
| 17 | 9772,1593 | 9906,3891 | 9865,7701 | 10134,2298 | 43 |
| 18 | 9772,3313 | 9906,2964 | 9866,0349 | 10133,9650 | 42 |
| 19 | 9772,5033 | 9906,2035 | 9866,2997 | 10133,7002 | 41 |
| 20 | 9772,6751 | 9906,1106 | 9866,5644 | 10133,4355 | 40 |
| 21 | 9772,8468 | 9906,0177 | 9866,8291 | 10133,1709 | 39 |
| 22 | 9773,0184 | 9905,9247 | 9867,0937 | 10132,9062 | 38 |
| 23 | 9773,1899 | 9905,8317 | 9867,3582 | 10132,6417 | 37 |
| 24 | 9773,3613 | 9905,7385 | 9867,6227 | 10132,3772 | 36 |
| 25 | 9773,5326 | 9905,6454 | 9867,8872 | 10132,1127 | 35 |
| 26 | 9773,7038 | 9905,5521 | 9868,1516 | 10131,8483 | 34 |
| 27 | 9773,8749 | 9905,4589 | 9868,4160 | 10131,5839 | 33 |
| 28 | 9774,0459 | 9905,3655 | 9868,6803 | 10131,3196 | 32 |
| 29 | 9774,2168 | 9905,2721 | 9868,9446 | 10131,0553 | 31 |
| 30 | 9774,3876 | 9905,1787 | 9869,2088 | 10130,7911 | 30 |
| | | Sin. 53. | | Tang. 53. | M |

| M | Sin. 36. | | Tan. 36. | | |
|---|---|---|---|---|---|
| 30 | 9774,3876 | 9905,1787 | 9869,2088 | 10130,7911 | 30 |
| 31 | 9774,5582 | 9905,0852 | 9869,4730 | 10130,5269 | 29 |
| 32 | 9774,7288 | 9904,9916 | 9869,7372 | 10130,2627 | 28 |
| 33 | 9774,8993 | 9904,8980 | 9870,0013 | 10129,9987 | 27 |
| 34 | 9775,0696 | 9904,8043 | 9870,2653 | 10129,7346 | 26 |
| 35 | 9775,2399 | 9904,7106 | 9870,5293 | 10129,4706 | 25 |
| 36 | 9775,4101 | 9904,6168 | 9870,7932 | 10129,2067 | 24 |
| 37 | 9775,5801 | 9904,5229 | 9871,0572 | 10128,9428 | 23 |
| 38 | 9775,7501 | 9904,4290 | 9871,3210 | 10128,6789 | 22 |
| 39 | 9775,9199 | 9904,3351 | 9871,5848 | 10128,4151 | 21 |
| 40 | 9776,0896 | 9904,2410 | 9871,8486 | 10128,1513 | 20 |
| 41 | 9776,2593 | 9904,1470 | 9872,1123 | 10127,8876 | 19 |
| 42 | 9776,4288 | 9904,0528 | 9872,3759 | 10127,6240 | 18 |
| 43 | 9776,5983 | 9903,9586 | 9872,6396 | 10127,3603 | 17 |
| 44 | 9776,7676 | 9903,8644 | 9872,9032 | 10127,0968 | 16 |
| 45 | 9776,9368 | 9903,7701 | 9873,1667 | 10126,8332 | 15 |
| 46 | 9777,1059 | 9903,6757 | 9873,4302 | 10126,5697 | 14 |
| 47 | 9777,2750 | 9903,5813 | 9873,6937 | 10126,3063 | 13 |
| 48 | 9777,4439 | 9903,4868 | 9873,9571 | 10126,0429 | 12 |
| 49 | 9777,6127 | 9903,3923 | 9874,2204 | 10125,7795 | 11 |
| 50 | 9777,7814 | 9903,2977 | 9874,4837 | 10125,5162 | 10 |
| 51 | 9777,9500 | 9903,2030 | 9874,7470 | 10125,2529 | 9 |
| 52 | 9778,1186 | 9903,1083 | 9875,0102 | 10124,9897 | 8 |
| 53 | 9778,2870 | 9903,0135 | 9875,2734 | 10124,7265 | 7 |
| 54 | 9778,4553 | 9902,9187 | 9875,5365 | 10124,4634 | 6 |
| 55 | 9778,6235 | 9902,8238 | 9875,7996 | 10124,2003 | 5 |
| 56 | 9778,7916 | 9902,7289 | 9876,0626 | 10123,9373 | 4 |
| 57 | 9778,9596 | 9902,6339 | 9876,3256 | 10123,6743 | 3 |
| 58 | 9779,1275 | 9902,5389 | 9876,5886 | 10123,4113 | 2 |
| 59 | 9779,2953 | 9902,4437 | 9876,8515 | 10123,1484 | 1 |
| 60 | 9779,4630 | 9902,3486 | 9877,1144 | 10122,8855 | 0 |
| | | Sin. 53. | | Tan. 53. | M |

| M | Sin. 37. | | Tan. 37. | | |
|---|---|---|---|---|---|
| 0 | 9779,4630 | 9902,3486 | 9877,1144 | 10122,8855 | 60 |
| 1 | 9779,6306 | 9902,2533 | 9877,3772 | 10122,6227 | 59 |
| 2 | 9779,7981 | 9902,1581 | 9877,6400 | 10122,3599 | 58 |
| 3 | 9779,9655 | 9902,0627 | 9877,9027 | 10122,0972 | 57 |
| 4 | 9780,1328 | 9901,9673 | 9878,1654 | 10121,8345 | 56 |
| 5 | 9780,3000 | 9901,8719 | 9878,4280 | 10121,5719 | 55 |
| 6 | 9780,4670 | 9901,7764 | 9878,6907 | 10121,3093 | 54 |
| 7 | 9780,6340 | 9901,6808 | 9878,9532 | 10121,0467 | 53 |
| 8 | 9780,8009 | 9901,5852 | 9879,2157 | 10120,7842 | 52 |
| 9 | 9780,9677 | 9901,4895 | 9879,4782 | 10120,5217 | 51 |
| 10 | 9781,1344 | 9901,3937 | 9879,7406 | 10120,2593 | 50 |
| 11 | 9781,3010 | 9901,2979 | 9880,0030 | 10119,9969 | 49 |
| 12 | 9781,4675 | 9901,2021 | 9880,2654 | 10119,7345 | 48 |
| 13 | 9781,6339 | 9901,1061 | 9880,5277 | 10119,4722 | 47 |
| 14 | 9781,8001 | 9901,0102 | 9880,7899 | 10119,2100 | 46 |
| 15 | 9781,9663 | 9900,9141 | 9881,0522 | 10118,9478 | 45 |
| 16 | 9782,1324 | 9900,8180 | 9881,3143 | 10118,6856 | 44 |
| 17 | 9782,2984 | 9900,7219 | 9881,5765 | 10118,4234 | 43 |
| 18 | 9782,4643 | 9900,6257 | 9881,8386 | 10118,1613 | 42 |
| 19 | 9782,6301 | 9900,5294 | 9882,1006 | 10117,8993 | 41 |
| 20 | 9782,7957 | 9900,4331 | 9882,3626 | 10117,6373 | 40 |
| 21 | 9782,9613 | 9900,3367 | 9882,6246 | 10117,3753 | 39 |
| 22 | 9783,1268 | 9900,2402 | 9882,8865 | 10117,1134 | 38 |
| 23 | 9783,2922 | 9900,1437 | 9883,1484 | 10116,8515 | 37 |
| 24 | 9783,4575 | 9900,0472 | 9883,4103 | 10116,5897 | 36 |
| 25 | 9783,6227 | 9899,9506 | 9883,6721 | 10116,3279 | 35 |
| 26 | 9783,7877 | 9899,8539 | 9883,9338 | 10116,0661 | 34 |
| 27 | 9783,9527 | 9899,7572 | 9884,1955 | 10115,8044 | 33 |
| 28 | 9784,1176 | 9899,6604 | 9884,4572 | 10115,5427 | 32 |
| 29 | 9784,2824 | 9899,5635 | 9884,7188 | 10115,2811 | 31 |
| 30 | 9784,4471 | 9899,4666 | 9884,9804 | 10115,0195 | 30 |
| | | Sin. 52. | | Tan. 52. | |

| M | Sin. 56. | | Tan. 37. | | |
|---|---|---|---|---|---|
| 30 | 9784,4471 | 9899,4666 | 9884,9804 | 10115,0195 | 30 |
| 31 | 9784,6117 | 9899,3696 | 9885,2420 | 10114,7579 | 29 |
| 32 | 9784,7762 | 9899,2726 | 9885,5035 | 10114,4964 | 28 |
| 33 | 9784,9406 | 9899,1755 | 9885,7650 | 10114,2349 | 27 |
| 34 | 9785,1048 | 9899,0784 | 9886,0264 | 10113,9735 | 26 |
| 35 | 9785,2690 | 9898,9812 | 9886,2878 | 10113,7121 | 25 |
| 36 | 9785,4331 | 9898,8839 | 9886,5492 | 10113,4508 | 24 |
| 37 | 9785,5971 | 9898,7866 | 9886,8105 | 10113,1894 | 23 |
| 38 | 9785,7610 | 9898,6892 | 9887,0717 | 10112,9282 | 22 |
| 39 | 9785,9248 | 9898,5918 | 9887,3330 | 10112,6669 | 21 |
| 40 | 9786,0885 | 9898,4943 | 9887,5942 | 10112,4057 | 20 |
| 41 | 9786,2521 | 9898,3968 | 9887,8553 | 10112,1446 | 19 |
| 42 | 9786,4156 | 9898,2992 | 9888,1164 | 10111,8835 | 18 |
| 43 | 9786,5790 | 9898,2015 | 9888,3775 | 10111,6224 | 17 |
| 44 | 9786,7423 | 9898,1038 | 9888,6385 | 10111,3614 | 16 |
| 45 | 9786,9055 | 9898,0060 | 9888,8995 | 10111,1004 | 15 |
| 46 | 9787,0687 | 9897,9081 | 9889,1605 | 10110,8394 | 14 |
| 47 | 9787,2317 | 9897,8102 | 9889,4214 | 10110,5785 | 13 |
| 48 | 9787,3946 | 9897,7123 | 9889 6823 | 10110,3176 | 12 |
| 49 | 9787,5574 | 9897,6142 | 9889,9431 | 10110,0568 | 11 |
| 50 | 9787,7201 | 9897,5162 | 9890,2039 | 10109,7960 | 10 |
| 51 | 9787,8827 | 9897,4180 | 9890,4647 | 10109,5352 | 9 |
| 52 | 9788,0453 | 9897,3198 | 9890,7254 | 10109,2745 | 8 |
| 53 | 9788 2077 | 9897,2216 | 9890,9861 | 10109,0138 | 7 |
| 54 | 9788,3700 | 9897,1232 | 9891,2467 | 10108,7532 | 6 |
| 55 | 9788,5322 | 9897,0249 | 9891,5073 | 10108,4926 | 5 |
| 56 | 9788,6944 | 9896,9264 | 9891,7679 | 10108,2320 | 4 |
| 57 | 9788,8564 | 9896,8279 | 9892,0284 | 10107,9715 | 3 |
| 58 | 9789,0184 | 9896,7294 | 9892,2889 | 10107,7110 | 2 |
| 59 | 9789,1802 | 9896,6308 | 9892,5494 | 10107,4505 | 1 |
| 60 | 9789,3419 | 9896,5321 | 9892,8098 | 10107,1901 | 0 |
| | | Sin. 33. | | Tan. 52. | M |

| M | Sin. 38. | | Tan. 38. | | |
|---|---|---|---|---|---|
| 0 | 9789,3419 | 9896,5321 | 9892,8098 | 10107,1901 | 60 |
| 1 | 9789,5036 | 9896,4334 | 9893,0702 | 10106,9297 | 59 |
| 2 | 9789,6652 | 9896,3346 | 9893,3305 | 10106,6694 | 58 |
| 3 | 9789,8266 | 9896,2357 | 9893,5908 | 10106,4091 | 57 |
| 4 | 9789,9880 | 9896,1368 | 9893,8511 | 10106,1488 | 56 |
| 5 | 9790,1492 | 9896,0379 | 9894,1113 | 10105,8886 | 55 |
| 6 | 9790,3104 | 9895,9388 | 9894,3715 | 10105,6284 | 54 |
| 7 | 9790,4714 | 9895,8398 | 9894,6317 | 10105,3683 | 53 |
| 8 | 9790,6324 | 9895,7406 | 9894,8918 | 10105,1081 | 52 |
| 9 | 9790,7933 | 9895,6414 | 9895,1519 | 10104,8481 | 51 |
| 10 | 9790,9541 | 9895,5421 | 9895,4119 | 10104,5880 | 50 |
| 11 | 9791,1148 | 9895,4428 | 9895,6719 | 10104,3280 | 49 |
| 12 | 9791,2753 | 9895,3434 | 9895,9319 | 10104,0680 | 48 |
| 13 | 9791,4358 | 9895,2440 | 9896,1918 | 10103,8081 | 47 |
| 14 | 9791,5962 | 9895,1445 | 9896,4517 | 10103,5482 | 46 |
| 15 | 9791,7565 | 9895,0449 | 9896,7116 | 10103,2884 | 45 |
| 16 | 9791,9167 | 9894,9453 | 9896,9714 | 10103,0285 | 44 |
| 17 | 9792,0768 | 9894,8456 | 9897,2312 | 10102,7687 | 43 |
| 18 | 9792,2368 | 9894,7459 | 9897,4909 | 10102,5090 | 42 |
| 19 | 9792,3968 | 9894,6461 | 9897,7507 | 10102,2493 | 41 |
| 20 | 9792,5566 | 9894,5462 | 9898,0103 | 10101,9896 | 40 |
| 21 | 9792,7163 | 9894,4463 | 9898,2700 | 10101,7300 | 39 |
| 22 | 9792,8759 | 9894,3463 | 9898,5296 | 10101,4704 | 38 |
| 23 | 9793,0355 | 9894,2463 | 9898,7891 | 10101,2108 | 37 |
| 24 | 9793,1949 | 9894,1462 | 9899,0487 | 10100,9512 | 36 |
| 25 | 9793,3542 | 9894,0460 | 9899,3082 | 10100,6917 | 35 |
| 26 | 9793,5135 | 9893,9458 | 9899,5677 | 10100,4323 | 34 |
| 27 | 9793,6726 | 9893,8455 | 9899,8271 | 10100,1728 | 33 |
| 28 | 9793,8317 | 9893,7452 | 9900,0865 | 10099,9134 | 32 |
| 29 | 9793,9907 | 9893,6448 | 9900,3458 | 10099,6541 | 31 |
| 30 | 9794,1495 | 9893,5443 | 9900,6052 | 10099,3948 | 30 |
| | | Sin. 51. | | Tan. 51. | M |

| M | Sin. 38. | | Tan. 38. | | |
|---|---|---|---|---|---|
| 30 | 9794,1495 | 9893,5443 | 9900,6052 | 10099,3948 | 30 |
| 31 | 9794,3083 | 9893,4438 | 9900,8644 | 10099,1355 | 29 |
| 32 | 9794,4670 | 9893,3432 | 9901,1237 | 10098,8762 | 28 |
| 33 | 9794,6256 | 9893,2426 | 9901,3829 | 10098,6170 | 27 |
| 34 | 9794,7840 | 9893,1419 | 9901,6421 | 10098,3578 | 26 |
| 35 | 9794,9424 | 9893,0411 | 9901,9013 | 10098,0987 | 25 |
| 36 | 9795,1007 | 9892,9403 | 9902,1604 | 10097,8395 | 24 |
| 37 | 9795,2590 | 9892,8394 | 9902,4195 | 10097,5804 | 23 |
| 38 | 9795,4171 | 9892,7385 | 9902,6785 | 10097,3214 | 22 |
| 39 | 9795,5751 | 9892,6375 | 9902,9375 | 10097,0624 | 21 |
| 40 | 9795,7330 | 9892,5364 | 9903,1965 | 10096,8034 | 20 |
| 41 | 9795,8908 | 9892,4353 | 9903,4555 | 10096,5445 | 19 |
| 42 | 9796,0486 | 9892,3341 | 9903,7144 | 10096,2855 | 18 |
| 43 | 9796,2062 | 9892,2329 | 9903,9733 | 10096,0267 | 17 |
| 44 | 9796,3637 | 9892,1316 | 9904,2321 | 10095,7678 | 16 |
| 45 | 9796,5212 | 9892,0302 | 9904,4909 | 10095,5090 | 15 |
| 46 | 9796,6785 | 9891,9288 | 9904,7497 | 10095,2502 | 14 |
| 47 | 9796,8358 | 9891,8273 | 9905,0084 | 10094,9915 | 13 |
| 48 | 9796,6930 | 9891,7258 | 9905,2672 | 10094,7328 | 12 |
| 49 | 9797,1501 | 9891,6242 | 9905,5258 | 10094,4741 | 11 |
| 50 | 9797,3070 | 9891,5225 | 9905,7845 | 10094,2154 | 10 |
| 51 | 9797,4639 | 9891,4208 | 9906,0431 | 10093,9568 | 9 |
| 52 | 9797,6207 | 9891,3190 | 9906,3017 | 10093,6982 | 8 |
| 53 | 9797,7774 | 9891,2172 | 9906,5602 | 10093,4397 | 7 |
| 54 | 9797,9341 | 9891,1153 | 9906,8188 | 10093,1812 | 6 |
| 55 | 9798,0906 | 9891,0133 | 9907,0772 | 10092,9227 | 5 |
| 56 | 9798,2470 | 9890,9113 | 9907,3357 | 10092,6642 | 4 |
| 57 | 9798,4033 | 9890,8092 | 9907,5941 | 10092,4058 | 3 |
| 58 | 9798,5596 | 9890,7070 | 9907,8525 | 10092,1474 | 2 |
| 59 | 9798,7157 | 9890,6048 | 9908,1109 | 10091,8891 | 1 |
| 60 | 9798,8718 | 9890,5026 | 9908,3692 | 10091,6307 | 0 |
| | | Sin. 51. | | Tan. 51. | M |

| M | Sin.35. | | Tan.39. | | |
|---|---|---|---|---|---|
| 0 | 9789,8718 | 9890,5026 | 9908,3692 | 10091,6307 | 60 |
| 1 | 9799,0277 | 9890,4002 | 9908,6275 | 10091,3724 | 59 |
| 2 | 9799,1836 | 9890,2978 | 9908,8857 | 10091,1142 | 58 |
| 3 | 9799,3394 | 9890,1954 | 9909,1440 | 10090,8560 | 57 |
| 4 | 9799,4950 | 9890,0929 | 9909,4022 | 10090,5978 | 56 |
| 5 | 9799,6506 | 9889,9903 | 9909,6603 | 10090,3396 | 55 |
| 6 | 9799,8061 | 9889,8877 | 9909,9184 | 10090,0815 | 54 |
| 7 | 9799,9615 | 9889,7850 | 9910,1765 | 10089,8234 | 53 |
| 8 | 9800,1168 | 9889,6822 | 9910,4346 | 10089,5653 | 52 |
| 9 | 9800,2721 | 9889,5794 | 9910,6927 | 10089,3073 | 51 |
| 10 | 9800,4272 | 9889,4765 | 9910,9507 | 10089,0493 | 50 |
| 11 | 9800,5822 | 9889,3736 | 9911,2086 | 10088,7913 | 49 |
| 12 | 9800,7372 | 9889,2706 | 9911,4666 | 10088,5333 | 48 |
| 13 | 9800,8920 | 9889,1675 | 9911,7245 | 10088,2754 | 47 |
| 14 | 9801,0468 | 9889,0644 | 9911,9824 | 10088,0175 | 46 |
| 15 | 9801,2015 | 9888,9612 | 9912,2402 | 10087,7597 | 45 |
| 16 | 9801,3560 | 9888,8579 | 9912,4981 | 10087,5019 | 44 |
| 17 | 9801,5105 | 9888,7546 | 9912,7558 | 10087,2441 | 43 |
| 18 | 9801,6649 | 9888,6513 | 9913,0136 | 10086,9863 | 42 |
| 19 | 9801,8192 | 9888,5478 | 9913,2714 | 10086,7286 | 41 |
| 20 | 9801,9734 | 9888,4443 | 9913,5291 | 10086,4709 | 40 |
| 21 | 9802,1275 | 9888,3408 | 9913,7867 | 10086,2132 | 39 |
| 22 | 9802,2816 | 9888,2372 | 9914,0444 | 10085,9559 | 38 |
| 23 | 9802,4355 | 9888,1335 | 9914,3020 | 10085,6980 | 37 |
| 24 | 9802,5893 | 9888,0297 | 9914,5596 | 10085,4404 | 36 |
| 25 | 9802,7431 | 9887,9259 | 9914,8171 | 10085,1828 | 35 |
| 26 | 9802,8967 | 9887,8221 | 9915,0746 | 10084,9253 | 34 |
| 27 | 9803,0503 | 9887,7182 | 9915,3321 | 10084,6678 | 33 |
| 28 | 9803,2038 | 9887,6142 | 9915,5896 | 10084,4103 | 32 |
| 29 | 9803,3572 | 9887,5101 | 9915,8470 | 10084,1529 | 31 |
| 30 | 9803,5105 | 9887,4060 | 9916,1044 | 10083,8955 | 30 |
| | | Sin.54. | Tang.50 | | M |

| M | Sin. 39. | | Tan. 39. | | |
|---|---|---|---|---|---|
| 30 | 9803,5105 | 9887,4060 | 9916,1044 | 10083.8955 | 30 |
| 31 | 9803,6637 | 9887,3018 | 9916,3618 | 10083,6381 | 29 |
| 32 | 9803,8168 | 9887,1976 | 9916,6192 | 10083,3808 | 28 |
| 33 | 9803,9698 | 9887.0933 | 9916,8765 | 10083,1234 | 27 |
| 34 | 9804,1228 | 9886,9890 | 9917.1338 | 10082,8661 | 26 |
| 35 | 9804.2756 | 9886.8845 | 9917,3910 | 10082,6089 | 25 |
| 36 | 9804,4284 | 9886,7801 | 9917,6483 | 10082,3517 | 24 |
| 37 | 9804,5810 | 9886,6755 | 9917,9055 | 10082.0944 | 23 |
| 38 | 9804.7336 | 9886,5709 | 9918,1626 | 10082,8373 | 22 |
| 39 | 9804,8861 | 9886,4663 | 9918.4198 | 10081,5801 | 21 |
| 40 | 9805.0385 | 9886,3615 | 9918,6769 | 10081,3230 | 20 |
| 41 | 9805,1908 | 9886.2567 | 9918.9340 | 10081,0659 | 19 |
| 42 | 9805,3430 | 9886,1519 | 9919.1911 | 10080,8089 | 18 |
| 43 | 9805,4951 | 9886,0470 | 9919,4481 | 10080,5518 | 17 |
| 44 | 9805,6471 | 9885,9420 | 9919,7051 | 10080,2948 | 16 |
| 45 | 9805,7991 | 9885,8370 | 9919,9621 | 10080,0378 | 15 |
| 46 | 9805,9509 | 9885,7319 | 9920,2190 | 10079,7809 | 14 |
| 47 | 9806,1027 | 9885,6267 | 9920,4760 | 10079,5240 | 13 |
| 48 | 9806,2544 | 9885,5215 | 9920,7328 | 10079,2671 | 12 |
| 49 | 9806,4060 | 9885,4162 | 9920,9897 | 10079,0102 | 11 |
| 50 | 9806,5575 | 9885,3108 | 9921,2466 | 10078,7533 | 10 |
| 51 | 9806.7088 | 9885.2054 | 9921,5034 | 10078,4965 | 9 |
| 52 | 9806.8601 | 9885,1000 | 9921,7602 | 10078,2397 | 8 |
| 53 | 9807.0114 | 9884,9944 | 9922,0169 | 10077,9830 | 7 |
| 54 | 9807,1625 | 9884,8888 | 9922,2737 | 10077,7263 | 6 |
| 55 | 9807,3136 | 9884,7832 | 9922,5304 | 10077,4695 | 5 |
| 56 | 9807,4645 | 9884,6774 | 9922,7870 | 10077,2129 | 4 |
| 57 | 9807,6154 | 9884,5717 | 9923,0437 | 10076,9562 | 3 |
| 58 | 9807,7662 | 9884,4658 | 9923,3003 | 10076,6996 | 2 |
| 59 | 9807,9169 | 9884,3599 | 9923,5569 | 10076,4430 | 1 |
| 60 | 9808,0675 | 9884,2539 | 9923,8135 | 10076.1864 | 0 |
| | | Sin. 50. | | Tan. 50. | M |

| M | Sin.40. | | Tan.40. | | |
|---|---|---|---|---|---|
| 0 | 9808,0675 | 9884,2539 | 9923,8135 | 10076,1864 | 60 |
| 1 | 9808,2180 | 9884,1479 | 9924,0700 | 10075,9299 | 59 |
| 2 | 9808,3684 | 9884,0418 | 9924,3266 | 10075,6734 | 58 |
| 3 | 9808,5187 | 9883,9356 | 9924,5831 | 10075,4169 | 57 |
| 4 | 9808,6690 | 9883,8294 | 9924,8395 | 10075,1604 | 56 |
| 5 | 9808,8191 | 9883,7231 | 9925,0960 | 10074,9039 | 55 |
| 6 | 9808,9692 | 9883,6168 | 9925,3524 | 10074,6475 | 54 |
| 7 | 9809,1192 | 9883,5104 | 9925,6088 | 10074,3911 | 53 |
| 8 | 9809,2691 | 9883,4039 | 9925,8651 | 10074,1348 | 52 |
| 9 | 9809,4189 | 9883,2973 | 9926,1215 | 10073,8784 | 51 |
| 10 | 9809,5686 | 9883,1907 | 9926,3778 | 10073,6221 | 50 |
| 11 | 9809,7182 | 9883,0841 | 9926,6341 | 10073,3658 | 49 |
| 12 | 9809,8677 | 9882,9774 | 9926,8903 | 10073,1096 | 48 |
| 13 | 9810,0172 | 9882,8706 | 9927,1466 | 10072,8533 | 47 |
| 14 | 9810,1665 | 9882,7637 | 9927,4028 | 10072,5971 | 46 |
| 15 | 9810,3158 | 9882,6568 | 9927,6590 | 10072,3409 | 45 |
| 16 | 9810,4650 | 9882,5498 | 9927,9152 | 10072,0848 | 44 |
| 17 | 9810,6141 | 9882,4428 | 9928,1713 | 10071,8286 | 43 |
| 18 | 9810,7631 | 9882,3357 | 9928,4274 | 10071,5725 | 42 |
| 19 | 9810,9120 | 9882,2285 | 9928,6835 | 10071,3164 | 41 |
| 20 | 9811,0609 | 9882,1213 | 9928,9396 | 10071,0604 | 40 |
| 21 | 9811,2096 | 9882,0140 | 9929,1956 | 10070,8043 | 39 |
| 22 | 9811,3583 | 9881,9066 | 9929,4516 | 10070,5483 | 38 |
| 23 | 9811,5068 | 9881,7992 | 9929,7076 | 10070,2923 | 37 |
| 24 | 9811,6553 | 9881,6917 | 9929,9636 | 10070,0364 | 36 |
| 25 | 9811,8037 | 9881,5842 | 9930,2195 | 10069,7804 | 35 |
| 26 | 9811,9520 | 9881,4766 | 9930,4754 | 10069,5245 | 34 |
| 27 | 9812,1002 | 9881,3689 | 9930,7313 | 10069,2686 | 33 |
| 28 | 9812,2484 | 9881,2611 | 9930,9872 | 10069,0127 | 32 |
| 29 | 9812,3964 | 9881,1533 | 9931,2430 | 10068,7569 | 31 |
| 30 | 9812,5444 | 9881,0455 | 9931,4989 | 10068,5011 | 30 |
| | | Sin.49. | | Tang.49 | M |

| M | Sin.40. | [illegible] | Tan.40. | [illegible] | |
|---|---|---|---|---|---|
| 30 | 9812,5444 | 9881,0455 | 9931,4989 | 10068,5011 | 30 |
| 31 | 9812,6922 | 9880,9375 | 9931,7547 | 10068,2452 | 29 |
| 32 | 9812,8400 | 9880,8295 | 9932,0104 | 10067,9895 | 28 |
| 33 | 9812,9877 | 9880,7215 | 9932,2662 | 10067,7337 | 27 |
| 34 | 9813,1353 | 9880,6134 | 9932,5219 | 10067,4780 | 26 |
| 35 | 9813,2829 | 9880,5052 | 9932,7776 | 10067,2223 | 25 |
| 36 | 9813,4303 | 9880,3969 | 9933,0333 | 10066,9666 | 24 |
| 37 | 9813,5776 | 9880,2886 | 9933,2890 | 10066,7109 | 23 |
| 38 | 9813,7249 | 9880,1803 | 9933,5446 | 10066,4553 | 22 |
| 39 | 9813,8721 | 9880,0718 | 9933,8002 | 10066,1997 | 21 |
| 40 | 9814,0192 | 9879,9633 | 9934,0558 | 10065,9441 | 20 |
| 41 | 9814,1661 | 9879,8547 | 9934,3114 | 10065,6885 | 19 |
| 42 | 9814,3131 | 9879,7461 | 9934,5669 | 10065,4330 | 18 |
| 43 | 9814,4599 | 9879,6374 | 9934,8225 | 10065,1775 | 17 |
| 44 | 9814,6067 | 9879,5287 | 9935,0780 | 10064,9220 | 16 |
| 45 | 9814,7533 | 9879,4199 | 9935,3334 | 10064,6665 | 15 |
| 46 | 9814,8999 | 9879,3110 | 9935,5889 | 10064,4110 | 14 |
| 47 | 9815,0464 | 9879,2020 | 9935,8443 | 10064,1556 | 13 |
| 48 | 9815,1928 | 9879,0930 | 9936,0997 | 10063,9002 | 12 |
| 49 | 9815,3391 | 9878,9839 | 9936,3552 | 10063,6448 | 11 |
| 50 | 9815,4853 | 9878,8748 | 9936,6105 | 10063,3894 | 10 |
| 51 | 9815,6315 | 9878,7656 | 9936,8659 | 10063,1341 | 9 |
| 52 | 9815,7775 | 9878,6563 | 9937,1212 | 10062,8787 | 8 |
| 53 | 9815,9235 | 9878,5470 | 9937,3765 | 10062,6234 | 7 |
| 54 | 9816,0694 | 9878,4376 | 9937,6318 | 10062,3682 | 6 |
| 55 | 9816,2152 | 9878,3281 | 9937,8870 | 10062,1129 | 5 |
| 56 | 9816,3609 | 9878,2186 | 9938,1423 | 10061,8576 | 4 |
| 57 | 9816,5065 | 9878,1090 | 9938,3975 | 10061,6024 | 3 |
| 58 | 9816,6521 | 9877,9993 | 9938,6527 | 10061,3472 | 2 |
| 59 | 9816,7975 | 9877,8896 | 9938,9079 | 10061,0921 | 1 |
| 60 | 9816,9429 | 9877,7798 | 9939,1630 | 10060,8369 | 0 |
| | | Sin.49. | | Tan.49. | M |

| M | Sin. 41. | | Tan. 41. | | |
|---|---|---|---|---|---|
| 0 | 9816,9929 | 9877,7798 | 9939,1630 | 10060,8369 | 60 |
| 1 | 9817,0882 | 9877,6700 | 9939,4182 | 10060,5818 | 59 |
| 2 | 9817,2334 | 9877,5601 | 9939,6733 | 10060,3266 | 58 |
| 3 | 9817,3785 | 9877,4501 | 9939,9284 | 10060,0716 | 57 |
| 4 | 9817,5235 | 9877,3400 | 9940,1834 | 10059,8165 | 56 |
| 5 | 9817,6684 | 9877,2299 | 9940,4385 | 10059,5614 | 55 |
| 6 | 9817,8133 | 9877,1198 | 9940,6935 | 10059,3064 | 54 |
| 7 | 9817,9581 | 9877,0095 | 9940,9485 | 10059,0514 | 53 |
| 8 | 9818,1028 | 9876,8992 | 9941,2035 | 10058,7964 | 52 |
| 9 | 9818,2474 | 9876,7888 | 9941,4585 | 10058,5414 | 51 |
| 10 | 9818,3919 | 9876,6784 | 9941,7134 | 10058,2865 | 50 |
| 11 | 9818,5363 | 9876,5679 | 9942,9684 | 10058,0316 | 49 |
| 12 | 9818,6807 | 9876,4574 | 9942,2233 | 10057,7766 | 48 |
| 13 | 9818,8249 | 9876,3467 | 9942,4782 | 10057,5217 | 47 |
| 14 | 9818,9691 | 9876,2360 | 9942,7331 | 10057,2669 | 46 |
| 15 | 9819,1132 | 9876,1253 | 9942,9879 | 10057,0120 | 45 |
| 16 | 9819,2572 | 9876,0145 | 9943,2427 | 10056,7572 | 44 |
| 17 | 9819,4012 | 9875,9036 | 9943,4976 | 10056,5024 | 43 |
| 18 | 9819,5450 | 9875,7926 | 9943,7523 | 10056,2476 | 42 |
| 19 | 9819,6888 | 9875,6816 | 9944,0071 | 10055,9928 | 41 |
| 20 | 9819,8324 | 9875,5705 | 9944,2619 | 10055,7380 | 40 |
| 21 | 9819,9760 | 9875,4594 | 9944,5166 | 10055,4833 | 39 |
| 22 | 9820,1195 | 9875,3481 | 9944,7713 | 10055,2286 | 38 |
| 23 | 9820,2629 | 9875,2369 | 9945,0260 | 10054,9739 | 37 |
| 24 | 9820,4063 | 9875,1255 | 9945,2807 | 10054,7192 | 36 |
| 25 | 9820,5495 | 9875,0141 | 9945,5354 | 10054,4645 | 35 |
| 26 | 9820,6927 | 9874,9027 | 9945,7900 | 10054,2099 | 34 |
| 27 | 9820,8358 | 9874,7911 | 9946,0446 | 10053,9553 | 33 |
| 28 | 9820,9788 | 9874,6795 | 9946,2992 | 10053,7007 | 32 |
| 29 | 9821,1217 | 9874,5678 | 9946,5538 | 10053,4461 | 31 |
| 30 | 9821,2645 | 9874,4561 | 9946,8084 | 10053,1915 | 30 |
| | | Sin. 48. | | Tan. 48. | M |

| M | Sin. 41. | | Tan. 41. | | |
|---|---|---|---|---|---|
| 30 | 9821,2645 | 9874,4561 | 9946,8084 | 10053,1915 | 30 |
| 31 | 9821,4073 | 9874,3443 | 9947,0622 | 10052,9370 | 29 |
| 32 | 9821,5500 | 9874,2324 | 9947,3175 | 10052,6824 | 28 |
| 33 | 9821,6925 | 9874,1205 | 9947,5720 | 10052,4279 | 27 |
| 34 | 9821,8350 | 9874,0085 | 9947,8265 | 10052,1734 | 26 |
| 35 | 9821,9774 | 9873,8964 | 9948,0810 | 10051,9190 | 25 |
| 36 | 9822,1198 | 9873,7843 | 9948,3354 | 10051,6645 | 24 |
| 37 | 9822,2620 | 9873,6721 | 9948,5899 | 10051,4101 | 23 |
| 38 | 9822,4042 | 9873,5599 | 9948,8443 | 10051,1556 | 22 |
| 39 | 9822,5463 | 9873,4475 | 9949,0987 | 10050,9012 | 21 |
| 40 | 9822,6883 | 9873,3351 | 9949,3531 | 10050,6468 | 20 |
| 41 | 9822,8302 | 9873,2227 | 9949,6075 | 10050,3925 | 19 |
| 42 | 9822,9720 | 9873,1102 | 9949,8618 | 10050,1381 | 18 |
| 43 | 9823,1138 | 9872,9976 | 9950,1162 | 10049,8837 | 17 |
| 44 | 9823,2554 | 9872,8849 | 9950,3705 | 10049,6294 | 16 |
| 45 | 9823,3970 | 9872,7722 | 9950,6248 | 10049,3752 | 15 |
| 46 | 9823,5385 | 9872,6594 | 9950,8791 | 10049,1208 | 14 |
| 47 | 9823,6799 | 9872,5465 | 9951,1334 | 10048,8666 | 13 |
| 48 | 9823,8213 | 9872,4336 | 9951,3870 | 10048,6123 | 12 |
| 49 | 9823,9625 | 9872,3206 | 9951,6418 | 10048,3581 | 11 |
| 50 | 9824,1037 | 9872,2076 | 9951,8961 | 11048,1039 | 10 |
| 51 | 9824,2448 | 9872,0945 | 9952,1503 | 10047,8496 | 9 |
| 52 | 9824,3858 | 9871,9813 | 9952,4045 | 10047,5955 | 8 |
| 53 | 9824,5267 | 9871,8680 | 9952,6580 | 10047,3413 | 7 |
| 54 | 9824,6675 | 9871,7547 | 9952,9128 | 10047,0871 | 6 |
| 55 | 9824,8083 | 9871,6413 | 9953,1669 | 10046,8330 | 5 |
| 56 | 9824,9490 | 9871,5279 | 9953,4211 | 10046,5789 | 4 |
| 57 | 9825,0896 | 9871,4144 | 9953,6752 | 10046,3247 | 3 |
| 58 | 9825,2301 | 9871,3008 | 9953,9293 | 10046,0707 | 2 |
| 59 | 9825,3701 | 9871,1871 | 9954,1833 | 10045,8166 | 1 |
| 60 | 9825,5109 | 9871,0734 | 9954,4374 | 10045,5625 | 0 |
| | | Sin. 48 | | Tan. 48. | M |

| M | Sin.42. | | Tan.42. | | |
|---|---|---|---|---|---|
| 0 | 9825,5109 | 9871,0734 | 9954,4374 | 10045,5625 | 60 |
| 1 | 9825,6511 | 9470,9596 | 9954,6914 | 10045,3085 | 59 |
| 2 | 9825,7913 | 9870,8458 | 9954,9455 | 10045,0545 | 58 |
| 3 | 9825,9314 | 9870,7319 | 9955,1995 | 10044,8004 | 57 |
| 4 | 9826,0714 | 9870,6179 | 9955,4535 | 10044,5464 | 56 |
| 5 | 9826,2114 | 9870,5038 | 9955,7075 | 10044,2924 | 55 |
| 6 | 9826,3512 | 9870,3897 | 9955,9615 | 10044,0385 | 54 |
| 7 | 9826,4910 | 9870,2755 | 9956,2154 | 10043,7845 | 53 |
| 8 | 9826,6307 | 9870,1613 | 9956,4693 | 10043,5306 | 52 |
| 9 | 9826,7703 | 9870,0470 | 9956,7233 | 10043,2766 | 51 |
| 10 | 9826,9098 | 9869,9326 | 9956,9772 | 10043,0227 | 50 |
| 11 | 9827,0493 | 9869,8181 | 9957,2311 | 10042,7688 | 49 |
| 12 | 9827,1886 | 9869,7036 | 9957,4850 | 10042,5150 | 48 |
| 13 | 9827,3279 | 9869,5890 | 9957,7388 | 10042,2611 | 47 |
| 14 | 9827,4671 | 9869,4744 | 9957,9927 | 10042,0072 | 46 |
| 15 | 9827,6062 | 9869,3597 | 9958,2465 | 10041,7534 | 45 |
| 16 | 9827,7453 | 9869,2449 | 9958,5003 | 10041,4996 | 44 |
| 17 | 9827,8842 | 9869,1300 | 9958,7541 | 10041,2458 | 43 |
| 18 | 9828,0231 | 9869,0151 | 9959,0079 | 10040,9920 | 42 |
| 19 | 9828,1619 | 9868,9001 | 9959,2617 | 10040,7382 | 41 |
| 20 | 9828,3006 | 9868,7851 | 9959,5155 | 10040,4844 | 40 |
| 21 | 9828,4392 | 9868,6700 | 9959,7692 | 10040,2307 | 39 |
| 22 | 9828,5778 | 9868,5548 | 9960,0230 | 10039,9769 | 38 |
| 23 | 9828,7163 | 9868,4395 | 9960,2767 | 10039,7232 | 37 |
| 24 | 9828,8547 | 9868,3242 | 9960,5304 | 10039,4695 | 36 |
| 25 | 9828,9930 | 9868,2088 | 9960,7841 | 10039,2158 | 35 |
| 26 | 9829,1312 | 9868,0934 | 9961,0378 | 10038,9621 | 34 |
| 27 | 9829,2693 | 9867,9778 | 9961,2915 | 10038,7084 | 33 |
| 28 | 9829,4074 | 9867,8622 | 9961,5451 | 10038,4548 | 32 |
| 29 | 9829,5454 | 9867,7466 | 9961,7988 | 10038,2011 | 31 |
| 30 | 9829,6833 | 9867,6308 | 9962,0524 | 10037,9475 | 30 |
| | | Sin.74. | | Tan.47. | M |

| M | Sin. 42. | | Tan. 42. | | |
|---|---|---|---|---|---|
| 30 | 9829,6833 | 9867,6308 | 9962,0524 | 10037,9475 | 30 |
| 31 | 9829,8211 | 9867,5150 | 9962,3061 | 10037,6939 | 29 |
| 32 | 9829,9589 | 9867,3992 | 9962,5597 | 10037,4403 | 28 |
| 33 | 9830,0965 | 9867,2833 | 9962,8133 | 10037,1867 | 27 |
| 34 | 9830,2341 | 9867,1673 | 9963,0668 | 10036,9331 | 26 |
| 35 | 9830,3716 | 9867,0512 | 9963,3204 | 10036,6795 | 25 |
| 36 | 9830,5091 | 9866,9351 | 9963,5740 | 10036,4260 | 24 |
| 37 | 9830,6464 | 9866,8189 | 9963,8275 | 10036,1724 | 23 |
| 38 | 9830,7837 | 9866,7026 | 9964,0810 | 10035,9189 | 22 |
| 39 | 9830,9208 | 9866,5863 | 9964,3346 | 10035,6654 | 21 |
| 40 | 9831,0579 | 9866,4698 | 9964,5881 | 10035,4119 | 20 |
| 41 | 9831,1950 | 9866,3534 | 9964,8416 | 10035,1584 | 19 |
| 42 | 9831,3319 | 9866,2368 | 9965,0950 | 10034,9049 | 18 |
| 43 | 9831,4688 | 9866,1202 | 9965,3485 | 10034,6514 | 17 |
| 44 | 9831,6056 | 9866,0036 | 9965,6020 | 10034,3979 | 16 |
| 45 | 9831,7423 | 9865,8868 | 9965,8554 | 10034,1445 | 15 |
| 46 | 9831,8789 | 9865,7700 | 9966,1089 | 10033,8910 | 14 |
| 47 | 9832,0154 | 9865,6531 | 9966,3623 | 10033,6376 | 13 |
| 48 | 9832,1519 | 9865,5362 | 9966,6157 | 10033,3842 | 12 |
| 49 | 9832,2883 | 9865,4191 | 9966,8691 | 10033,1308 | 11 |
| 50 | 9832,4246 | 9865,3021 | 9967,1225 | 10032,8774 | 10 |
| 51 | 9832,5608 | 9865,1849 | 9967,3759 | 10032,6240 | 9 |
| 52 | 9832,6970 | 9865,0677 | 9967,6293 | 10032,3707 | 8 |
| 53 | 9832,8330 | 9864,9504 | 9967,8826 | 10032,1173 | 7 |
| 54 | 9832,9690 | 9864,8330 | 9968,1360 | 10031,8640 | 6 |
| 55 | 9833,1049 | 9864,7156 | 9968,3893 | 10031,6106 | 5 |
| 56 | 9833,2408 | 9864,5981 | 9968,6426 | 10031,3573 | 4 |
| 57 | 9833,3765 | 9864,4805 | 9968,8959 | 10031,1040 | 3 |
| 58 | 9833,5122 | 9864,3629 | 9969,1493 | 10030,8507 | 2 |
| 59 | 9833,6478 | 9864,2452 | 9969,4026 | 10030,5974 | 1 |
| 60 | 9833,7833 | 9864,1274 | 9969,6558 | 10030,3441 | 0 |
| | | Sin. 47. | | Tan. 47. | M |

M

| M | Sin. 43. | | Tan. 43. | | |
|---|---|---|---|---|---|
| 0 | 9833,7833 | 9864,1274 | 9969,6558 | 10030,3441 | 60 |
| 1 | 9833,9187 | 9864,0096 | 9969,9091 | 10030,0908 | 59 |
| 2 | 9834,0541 | 9563,8917 | 9970,1624 | 10029,8376 | 58 |
| 3 | 9834,1894 | 9863,7737 | 9970,4156 | 10029,5843 | 57 |
| 4 | 9834,3246 | 9863,6556 | 9970,6689 | 10029,3310 | 56 |
| 5 | 9834,4597 | 9863,5375 | 9970,9221 | 10029,0778 | 55 |
| 6 | 9834,5947 | 9863,4194 | 9971,1753 | 10028,8246 | 54 |
| 7 | 9834,7297 | 9863,3011 | 9971,4285 | 10028,5714 | 53 |
| 8 | 9834,8646 | 9863,1828 | 9971,6817 | 10028,3182 | 52 |
| 9 | 9834,9994 | 9863,0644 | 9971,9349 | 10028,0650 | 51 |
| 10 | 9835,1341 | 9862,9459 | 9972,1881 | 10027,8118 | 50 |
| 11 | 9835,2687 | 9862,8274 | 9972,4413 | 10027,5586 | 49 |
| 12 | 9835,4033 | 9862,7088 | 9972,6945 | 10027,3055 | 48 |
| 13 | 9835,5378 | 9862,5901 | 9972,9476 | 10027,0523 | 47 |
| 14 | 9835,6722 | 9862,4714 | 9973,2008 | 10026,7991 | 46 |
| 15 | 9835,8065 | 9862,3526 | 9973,4539 | 10026,5460 | 45 |
| 16 | 9835,9408 | 9862,2337 | 9973,7071 | 10026,2929 | 44 |
| 17 | 9836,0750 | 9862,1148 | 9973,9602 | 10026,0397 | 43 |
| 18 | 9836,2091 | 9861,9958 | 9974,2133 | 10025,7866 | 42 |
| 19 | 9836,3431 | 9861,8767 | 9974,4664 | 10025,5335 | 41 |
| 20 | 9836,4770 | 9861,7575 | 9974,7195 | 10025,2804 | 40 |
| 21 | 9836,6109 | 9861,6383 | 9974,9726 | 10025,0274 | 39 |
| 22 | 9836,7447 | 9861,5190 | 9975,2256 | 10024,7743 | 38 |
| 23 | 9836,8784 | 9861,3996 | 9975,4787 | 10024,5212 | 37 |
| 24 | 9837,0120 | 9861,2802 | 9975,7318 | 10024,2682 | 36 |
| 25 | 9837,1456 | 9861,1607 | 9975,9848 | 10024,0151 | 35 |
| 26 | 9837,2790 | 9861,0411 | 9976,2379 | 10023,7621 | 34 |
| 27 | 9837,4124 | 9860,9215 | 9976,4909 | 10023,5090 | 33 |
| 28 | 9837,5457 | 9860,8018 | 9976,7439 | 10023,2560 | 32 |
| 29 | 9837,6790 | 9860,6820 | 9976,9969 | 10023,0030 | 31 |
| 30 | 9837,8122 | 9860,5621 | 9977,2500 | 10022,7500 | 30 |
| | | Sin. 46. | | Tan. 46. | M. |

| M | Sin. 43. | | Tan. 43. | | |
|---|---|---|---|---|---|
| 30 | 9837,8122 | 9860,5622 | 9977,2500 | 10022,7500 | 30 |
| 31 | 9837,9453 | 9860,4423 | 9977,5030 | 10022,4970 | 29 |
| 32 | 9838,0783 | 9860,3223 | 9977,7560 | 10022,2440 | 28 |
| 33 | 9838,2112 | 9860,2022 | 9978,0090 | 10021,9910 | 27 |
| 34 | 9838,3441 | 9860,0821 | 9978,2619 | 10021,7380 | 26 |
| 35 | 9838,4768 | 9859,9619 | 9978,5149 | 10021,4850 | 25 |
| 36 | 9838,6095 | 9859,8416 | 9978,7679 | 10021,2320 | 24 |
| 37 | 9838,7421 | 9859,7213 | 9979,0208 | 10020,9791 | 23 |
| 38 | 9838,8747 | 9859,6009 | 9979,2738 | 10020,7261 | 22 |
| 39 | 9839,0072 | 9859,4804 | 9979,5267 | 10020,4732 | 21 |
| 40 | 9839,1396 | 9859,3598 | 9979,7797 | 10020,2202 | 20 |
| 41 | 9839,2719 | 9859,2392 | 9980,0326 | 10019,9673 | 19 |
| 42 | 9839,4041 | 9859,1185 | 9980,2855 | 10019,7144 | 18 |
| 43 | 9839,5363 | 9858,9978 | 9980,5385 | 10019,4615 | 17 |
| 44 | 9839,6683 | 9858,8769 | 9980,7914 | 10019,2086 | 16 |
| 45 | 9839,8003 | 9858,7560 | 9981,0443 | 10018,9557 | 15 |
| 46 | 9839,9323 | 9858,6351 | 9981,2972 | 10018,7027 | 14 |
| 47 | 9840,0641 | 9858,5140 | 9981,5501 | 10018,4498 | 13 |
| 48 | 9840,1959 | 9858,3929 | 9981,8030 | 10018,1970 | 12 |
| 49 | 9840,3276 | 9858,2717 | 9982,0558 | 10017,9441 | 11 |
| 50 | 9840,4592 | 9858,1505 | 9982,3087 | 10017,6912 | 10 |
| 51 | 9840,5908 | 9858,0291 | 9982,5616 | 10017,4383 | 9 |
| 52 | 9840,7222 | 9857,9077 | 9982,8145 | 10017,1855 | 8 |
| 53 | 9840,8536 | 9857,7863 | 9983,0673 | 10016,9326 | 7 |
| 54 | 9840,9849 | 9857,6648 | 9983,3202 | 10016,6798 | 6 |
| 55 | 9841,1162 | 9857,5432 | 9983,5730 | 10016,4269 | 5 |
| 56 | 9841,2473 | 9857,4215 | 9983,8258 | 10016,1741 | 4 |
| 57 | 9841,3784 | 9857,2997 | 9984,0787 | 10015,9212 | 3 |
| 58 | 9841,5094 | 9857,1779 | 9984,3315 | 10015,6684 | 2 |
| 59 | 9841,6404 | 9857,0560 | 9984,5843 | 10015,4156 | 1 |
| 60 | 9841,7712 | 9856,9341 | 9984,8371 | 10015,1628 | 0 |
| | | Sin. 46. | | Tan. 46. | M |

| M | Sin. 44. | | Tan. 44. | | |
|---|---|---|---|---|---|
| 0 | 9841,7712 | 9856,9341 | 9984.8371 | 10015,1628 | 60 |
| 1 | 9841,9020 | 9856,8120 | 9985.0900 | 10014,9100 | 59 |
| 2 | 9842,0327 | 9856,6899 | 9985.3428 | 10014,6572 | 58 |
| 3 | 9842,1634 | 9856,5677 | 9985.5956 | 10014,4043 | 57 |
| 4 | 9842,2939 | 9856,4455 | 9985.8484 | 10014,1515 | 56 |
| 5 | 9842,4244 | 9856,3232 | 9986.1012 | 10013,8987 | 55 |
| 6 | 9842,5548 | 9856,2008 | 9986.3540 | 10013,6460 | 54 |
| 7 | 9842,6851 | 9856,0785 | 9986.6067 | 10013,3932 | 53 |
| 8 | 9842,8154 | 9855.9558 | 9986.8595 | 10013,1404 | 52 |
| 9 | 9842,9455 | 9855.8332 | 9987.1125 | 10012,8876 | 51 |
| 10 | 9843,0756 | 9855.7105 | 9987.3651 | 10012,6349 | 50 |
| 11 | 9843,2057 | 9855.5878 | 9987.6178 | 10012,3821 | 49 |
| 12 | 9843,3356 | 9855.4650 | 9987.8706 | 10012,1293 | 48 |
| 13 | 9843,4655 | 9855.3421 | 9988.1234 | 10011,8766 | 47 |
| 14 | 9843,5953 | 9855.2191 | 9988.3761 | 10011,6238 | 46 |
| 15 | 9843,7250 | 9855.0960 | 9988.6289 | 10011,3711 | 45 |
| 16 | 9843,8546 | 9854.9730 | 9988.8816 | 10011,1183 | 44 |
| 17 | 9843,9842 | 9854.8498 | 9989.1344 | 10010,8656 | 43 |
| 18 | 9844,1137 | 9854.7266 | 9989.3871 | 10010,6128 | 42 |
| 19 | 9844,2431 | 9854.6033 | 9989.6398 | 10010,3601 | 41 |
| 20 | 9844,3725 | 9854.4799 | 9989.8926 | 10010,1074 | 40 |
| 21 | 9844,5017 | 9854.3564 | 9990.1453 | 10009,8546 | 39 |
| 22 | 9844,6309 | 9854.2329 | 9990.3980 | 10009,6019 | 38 |
| 23 | 9844,7600 | 9854.1093 | 9990.6507 | 10009,3492 | 37 |
| 24 | 9844,8891 | 9853.9856 | 9990.9035 | 10009,0965 | 36 |
| 25 | 9845,0181 | 9853.8618 | 9991.1562 | 10008,8437 | 35 |
| 26 | 9845,1469 | 9853.7380 | 9991.4089 | 10008,5910 | 34 |
| 27 | 9845,2758 | 9853.6141 | 9991.6616 | 10008,3383 | 33 |
| 28 | 9845,4045 | 9853.4902 | 9991.9143 | 10008,0856 | 32 |
| 29 | 9845,5332 | 9853,3661 | 9992.1670 | 10007,8329 | 31 |
| 30 | 9845,6618 | 9853.2420 | 9992.4197 | 10007,5802 | 30 |
| | | Sin. 45. | | Tan. 55. | M |

| M | Sin. 44. | Sin. 45. | Tan. 44. | Tan. 45. | M |
|---|---|---|---|---|---|
| 30 | 9845,6618 | 9853,2420 | 9992,4197 | 10007,5802 | 30 |
| 31 | 9845,7903 | 9853,1178 | 9992,6724 | 10007,3275 | 29 |
| 32 | 9845,9187 | 9852,9936 | 9992,9251 | 10007,0748 | 28 |
| 33 | 9846,0471 | 9852,8693 | 9993,1778 | 10006,8221 | 27 |
| 34 | 9846,1754 | 9852,7449 | 9993,4305 | 10006,5694 | 26 |
| 35 | 9846,3036 | 9852,6204 | 9993,6832 | 10006,3167 | 25 |
| 36 | 9846,4317 | 9852,4958 | 9993,9359 | 10006,0641 | 24 |
| 37 | 9846,5598 | 9852,3712 | 9994,1886 | 10005,8114 | 23 |
| 38 | 9846,6878 | 9852,2465 | 9994,4412 | 10005,5587 | 22 |
| 39 | 9846,8157 | 9852,1218 | 9994,6939 | 10005,3060 | 21 |
| 40 | 9846,9436 | 9851,9969 | 9994,9466 | 10005,0533 | 20 |
| 41 | 9847,0713 | 9851,8720 | 9995,1993 | 10004,8006 | 19 |
| 42 | 9847,1991 | 9851,7471 | 9995,4520 | 10004,5480 | 18 |
| 43 | 9847,3267 | 9851,6220 | 9995,7047 | 10004,2953 | 17 |
| 44 | 9847,4542 | 9851,4969 | 9995,9573 | 10004,0426 | 16 |
| 45 | 9847,5817 | 9851,3717 | 9996,2100 | 10003,7899 | 15 |
| 46 | 9847,7091 | 9851,2464 | 9996,4627 | 10003,5373 | 14 |
| 47 | 9847,8364 | 9851,1211 | 9996,7153 | 10003,2846 | 13 |
| 48 | 9847,9637 | 9850,9957 | 9996,9680 | 10003,0319 | 12 |
| 49 | 9848,0909 | 9850,8702 | 9997,2207 | 10002,7793 | 11 |
| 50 | 9848,2180 | 9850,7446 | 9997,4733 | 10002,5266 | 10 |
| 51 | 9848,3450 | 9850,6190 | 9997,7260 | 10002,2739 | 9 |
| 52 | 9848,4720 | 9850,4933 | 9997,9787 | 10002,0212 | 8 |
| 53 | 9848,5988 | 9850,3675 | 9998,2313 | 10001,7686 | 7 |
| 54 | 9848,7257 | 9850,2416 | 9998,4840 | 10001,5159 | 6 |
| 55 | 9848,8524 | 9850,1157 | 9998,7367 | 10001,2633 | 5 |
| 56 | 9848,9790 | 9849,9897 | 9998,9893 | 10001,0106 | 4 |
| 57 | 9849,1056 | 9849,8636 | 9999,2420 | 10000,7579 | 3 |
| 58 | 9849,2321 | 9849,7375 | 9999,4946 | 10000,5053 | 2 |
| 59 | 9849,3586 | 9849,6113 | 9999,7473 | 10000,2526 | 1 |
| 60 | 9849,4850 | 9849,4850 | 10000,0000 | 10000,0000 | 0 |

# *Lectori practicæ Matheseos studioso,* S. P.

CANON noster vsum habet, in Triangulorum sphæricorum solutione, eumdem quem tabulæ *Sinuum* rectorum & *Tangentium*, ab alijs editæ, sed praxin paulo faciliorem. Nam eorum multiplicationem per additionem, & divisionem per subtractionem, & extractionem radicis quadratæ per bipartitionem evitamus.

Vt si datis tribus lateribus quæratur angulus, erit

Vt rectangulum sub *Sinibus* crurum,
ad quadratum *Radij*:
Ita rectangulum sub *Sinibus* semisummæ trium laterum,
& differentiæ inter hanc semisummam & basin,
ad quadratum *Co-sinus* semianguli quæsiti.

Et in triangulo primæ paginæ *P Z S*, (referente Polum, Zenith, & Solem) datis lateribus, *P S Gr*. 70, & *Z P Gr*. 38 *M*. 30, & *Z S Gr*. 40, si quæratur angulus *P Z S*, cuius basis est *P S*: summa laterum erit *Gr*. 148 *M*. 30, semisumma *Gr*. 74 *M*. 15, differentia inter semisummam & basin *Gr*. 4. *M*. 15.

Hic nos pro quadrato *Radij* ponimus 20000,0000 *Radij* duplum, cui addimus 9983, 3805 *Sinum Gr*. 74, *M*. 15, 8869 8679 *Sinum Gr*. 4, *M*. 15, fient 38853, 2484. Deinde pro rectangulo divisore addentes 9794, 1495 *Sinum Gr*. 38 *M*. 30. & 9808, 0675 *Sinum Gr*. 40, facimus 19602, 2170, & auferimus è 38853, 2484, ita restant 19251 0314. Horum semissis est 9625, 5157 *Sinus* semianguli externi *Gr*. 24, *M*. 58 *S*. 24. & *Co-sinus* simianguli interni *Gr*. 65, *M*. 1, *S*. 36, & proinde totus angulus quæsitus est *Gr*. 130, *M*. 3, *S*. 12.

Quod

Quod si quis pro *Sinibus* auferendis addat eorum complementa ad *Radium*, non alia indigebit subtractione. Vt patere potest ex collatione vtriusque praxeos.

| | | | |
|---|---|---|---|
| Gr. M. | | | |
| 70 0 | | | |
| 38 30 | 9794,1495 | | 205,8505 |
| 40 0 | 9808,0675 | | 191,9325 |
| 148 30 | 19602,2170 | | |
| 74 15 | 9983,3805 | | 9983,3805 |
| 4 15 | 8869,8679 | | 8869,8679 |
| | 20000,0000 | | |
| | 38853,2484 | | |
| Gr. M. S. | 19251,0314 | Gr. M. S. | 19251,0314 |
| 24 58 24 | 9625,5157 | 65 1 36 | 9625,5157 |
| 49 56 48 | | 130 3 12 | |

Eadem ratione, sed maiori compendio, solvuntur cætera quæ quæri solent in triangulis sphæricis, sine ope *Secantium* aut *Sinuum versorum*, vt pluribus non sit opus aut præceptis aut exemplis.

Idem si desideres in triangulis rectilineis, adiunge nostris, Amici & Collegæ *Henrici Briggij* Logarithmos. Nam eo nitimur fundamento, eodem vtimur operandi modo.

Vale, & si hæc tibi grata fuerint, plura à nobis in hoc genere expecta.

FINIS.

# The first thousand Logarithmes now againe set forth by the Authour *Henrie Briggs* professor of Geometrie in the Vniversitie of Oxford, who undertooke this worke at the entreatie, and with the approbation of the first Inventer of Logarithmes, worthy of all honor, *John Nepeir* Baron of *Merchiston*.

THe Reader hath here a short view of those 30000. Logarithmes, which are now come forth in Latin, and hereafter in English, which will affoord us,

The Quintessence of the Golden rule.

The valuation of Annuities, and the solution of all ordinary difficult questions of that kind.

The quantitie of any plaine Triangle, whose sides are given, together with the altitude thereof: the Diameters of the Circles inscribed and circumscribed; and the quantitie of any of the Angles.

The Diameter being givē, the circumference & Area of a Circle, and the Superficies and Soliditie of a Globe.

The quantitie of any round Caske.

And so neare as may be, the squaring of a Circle, the cubing of a Globe, the doubling or tribling of a Cube.

And in generall, The enlarging or diminishing of any plaine or solid figure, keeping the same forme; or the transforming it in any proportion assigned.

The alteration of the sides of any given plaine Triangle, keeping the same Area, and the same Perimeter.

The description of a Peripherie, every point whereof shall frō the three angles of any givē Triangle, keep the distances according to any possible proportiōs assigned.

Having two sides of a right angled Triangle given, to find the third: and generally all that may bee found in all right lined Triangles whatsoever.

*In tenui sed non tenuis fructusve laborve.*

| Nū | Logarithm. | Nū | Logarithm. | Nū | Logarithm. |
|---|---|---|---|---|---|
| 1 | 0 | 34 | 1531,47892 | 67 | 1826,07480 |
| 2 | 301,02999 | 35 | 1544,06804 | 68 | 1832,50891 |
| 3 | 477,12125 | 36 | 1556,30250 | 69 | 1838,84909 |
| 4 | 602,05999 | 37 | 1568,20172 | 70 | 1845,09804 |
| 5 | 698,97000 | 38 | 1579,78360 | 71 | 1851,25835 |
| 6 | 778,15125 | 39 | 1591,06461 | 72 | 1857,33250 |
| 7 | 845,09804 | 40 | 1602,05999 | 73 | 1863,32286 |
| 8 | 903,08999 | 41 | 1612,78386 | 74 | 1869,23172 |
| 9 | 954,24251 | 42 | 1623,24929 | 75 | 1875,06126 |
| 10 | 1000,00000 | 43 | 1633,46846 | 76 | 1880,81359 |
| 11 | 1041,39269 | 44 | 1643,45268 | 77 | 1886,49073 |
| 12 | 1079,18125 | 45 | 1653,21251 | 78 | 1892,09460 |
| 13 | 1113,94335 | 46 | 1662,75783 | 79 | 1897,62709 |
| 14 | 1146,12804 | 47 | 1672,09786 | 80 | 1903,08999 |
| 15 | 1176,09126 | 48 | 1681,24124 | 81 | 1908,48502 |
| 16 | 1204,11998 | 49 | 1690,19608 | 82 | 1913,81385 |
| 17 | 1230,44892 | 50 | 1698,97000 | 83 | 1919,07809 |
| 18 | 1255,27251 | 51 | 1707,57018 | 84 | 1924,27929 |
| 19 | 1278,75360 | 52 | 1716,00334 | 85 | 1929,41893 |
| 20 | 1301,02999 | 53 | 1724,27587 | 86 | 1934,49845 |
| 21 | 1322,21929 | 54 | 1732,39376 | 87 | 1939,51925 |
| 22 | 1342,42268 | 55 | 1740,36269 | 88 | 1944,48267 |
| 23 | 1361,72784 | 56 | 1748,18803 | 89 | 1949,39001 |
| 24 | 1380,21124 | 57 | 1755,87486 | 90 | 1954,24251 |
| 25 | 1397,94001 | 58 | 1763,42799 | 91 | 1959,04139 |
| 26 | 1414,97335 | 59 | 1770,85201 | 92 | 1963,78783 |
| 27 | 1431,36376 | 60 | 1778,15125 | 93 | 1968,48295 |
| 28 | 1447,15803 | 61 | 1785,32984 | 94 | 1973,12785 |
| 29 | 1462,39800 | 62 | 1792,39169 | 95 | 1977,72361 |
| 30 | 1477,12125 | 63 | 1799,34055 | 96 | 1982,27123 |
| 31 | 1491,36169 | 64 | 1806,17997 | 97 | 1986,77173 |
| 32 | 1505,14998 | 65 | 1812,91336 | 98 | 1991,22608 |
| 33 | 1518,51394 | 66 | 1819,54394 | 99 | 1995,63519 |
| 34 | 1531,47892 | 67 | 1826,07480 | 100 | 2000,00000 |

| Nu. | Logarithm. | Differ. | Nu. | Logarithm. | Differ. |
|---|---|---|---|---|---|
| 101 | 2004,32137 | 427880 | 134 | 2127,10480 | 322897 |
| 102 | 2008,60017 | 423705 | 135 | 2130,33377 | 320514 |
| 103 | 2012,83722 | 419612 | 136 | 2133,53891 | 318166 |
| 104 | 2017,03334 | 415596 | 137 | 2136,72057 | 315852 |
| 105 | 2021,18930 | 411657 | 138 | 2139,87909 | 313571 |
| 106 | 2025,30587 | 407791 | 139 | 2143,01480 | 311324 |
| 107 | 2029,38378 | 403998 | 140 | 2146,12804 | 309107 |
| 108 | 2033,42376 | 400274 | 141 | 2149,21911 | 306923 |
| 109 | 2037,42650 | 396619 | 142 | 2152,28834 | 304770 |
| 110 | 2041,39269 | 393029 | 143 | 2155,33604 | 302645 |
| 111 | 2045,32298 | 389504 | 144 | 2158,36249 | 300551 |
| 112 | 2049,21802 | 386042 | 145 | 2161,36800 | 298486 |
| 113 | 2053,07844 | 382641 | 146 | 2164,35286 | 296447 |
| 114 | 2056,90485 | 379299 | 147 | 2167,31733 | 294439 |
| 115 | 2060,69784 | 376015 | 148 | 2170,26172 | 292455 |
| 116 | 2064,45799 | 372787 | 149 | 2173,18627 | 290499 |
| 117 | 2068,18586 | 369615 | 150 | 2176,09126 | 288569 |
| 118 | 2071,88201 | 366495 | 151 | 2178,97695 | 286664 |
| 119 | 2075,54696 | 363429 | 152 | 2181,84359 | 284784 |
| 120 | 2079,18125 | 360412 | 153 | 2184,69143 | 282929 |
| 121 | 2082,78537 | 357446 | 154 | 2187,52072 | 281098 |
| 122 | 2086,35983 | 354528 | 155 | 2190,33170 | 279290 |
| 123 | 2089,90511 | 351658 | 156 | 2193,12460 | 277505 |
| 124 | 2093,42169 | 348832 | 157 | 2195,89965 | 275744 |
| 125 | 2096,91001 | 346054 | 158 | 2198,65709 | 274003 |
| 126 | 2100,37055 | 343317 | 159 | 2201,39712 | 272286 |
| 127 | 2103,80372 | 340625 | 160 | 2204,11998 | 270590 |
| 128 | 2107,20997 | 337974 | 161 | 2206,82588 | 268913 |
| 129 | 2110,58971 | 335364 | 162 | 2209,51501 | 267259 |
| 130 | 2113,94335 | 332795 | 163 | 2212,18760 | 265625 |
| 131 | 2117,27130 | 330263 | 164 | 2214,84385 | 264009 |
| 132 | 2120,57393 | 327771 | 165 | 2217,48394 | 262415 |
| 133 | 2123,85164 | 325316 | 166 | 2220,10809 | 260838 |
| 134 | 2127,10480 | 322897 | 167 | 2222,71647 | 259281 |

| Nu | Logarithm. | Differ. | Nu | Logarithm. | Differ. |
|---|---|---|---|---|---|
| 167 | 2222,71647 | 259281 | 201 | 2303,19606 | 215531 |
| 168 | 2225,30928 | 257742 | 202 | 2305,35137 | 214467 |
| 169 | 2227,88670 | 256222 | 203 | 2307,49604 | 213413 |
| 170 | 2230,44892 | 254719 | 204 | 2309,63017 | 212369 |
| 171 | 2232,99611 | 253234 | 205 | 2311,75386 | 211336 |
| 172 | 2235,52845 | 251765 | 206 | 2313,86722 | 210313 |
| 173 | 2238,04610 | 250315 | 207 | 2315,97035 | 209298 |
| 174 | 2240,54925 | 248880 | 208 | 2318,06333 | 208296 |
| 175 | 2243,03805 | 247462 | 209 | 2320,14629 | 207300 |
| 176 | 2245,51267 | 246060 | 210 | 2322,21929 | 206317 |
| 177 | 2247,97327 | 244673 | 211 | 2324,28246 | 205340 |
| 178 | 2250,42000 | 243303 | 212 | 2326,33586 | 204374 |
| 179 | 2252,85303 | 241948 | 213 | 2328,37960 | 203417 |
| 180 | 2255,27251 | 240606 | 214 | 2330,41377 | 202469 |
| 181 | 2257,67857 | 239282 | 215 | 2332,43846 | 201529 |
| 182 | 2260,07139 | 237970 | 216 | 2334,45375 | 200598 |
| 183 | 2262,45109 | 236673 | 217 | 2336,45973 | 199676 |
| 184 | 2264,81782 | 235391 | 218 | 2338,45649 | 198762 |
| 185 | 2267,17173 | 234121 | 219 | 2340,44411 | 197857 |
| 186 | 2269,51294 | 232867 | 220 | 2342,42268 | 196959 |
| 187 | 2271,84161 | 231624 | 221 | 2344,39227 | 196070 |
| 188 | 2274,15785 | 230395 | 222 | 2346,35297 | 195189 |
| 189 | 2276,46180 | 229180 | 223 | 2348,30486 | 194316 |
| 190 | 2278,75360 | 227977 | 224 | 2350,24802 | 193450 |
| 191 | 2281,03337 | 226786 | 225 | 2352,18252 | 192592 |
| 192 | 2283,30123 | 225608 | 226 | 2354,10844 | 191742 |
| 193 | 2285,55731 | 224442 | 227 | 2356,02586 | 190899 |
| 194 | 2287,80173 | 223288 | 228 | 2357,93485 | 190063 |
| 195 | 2290,03461 | 222146 | 229 | 2359,83548 | 189236 |
| 196 | 2292,25607 | 221016 | 230 | 2361,72784 | 188414 |
| 197 | 2294,46623 | 219897 | 231 | 2363,61198 | 187600 |
| 198 | 2296,66519 | 218789 | 232 | 2365,48798 | 186794 |
| 199 | 2298,85308 | 217691 | 233 | 2367,34592 | 185994 |
| 200 | 2301,02999 | 216606 | 234 | 2369,21586 | 185200 |

| Nū. | Logarithm. | Differ. | Nū. | Logarithm. | Differ. |
|---|---|---|---|---|---|
| 234 | 2369,21586 | 185200 | 267 | 2426,51126 | 162353 |
| 235 | 2371,06786 | 184414 | 268 | 2428,13479 | 161749 |
| 236 | 2372,91200 | 183635 | 269 | 2429,75228 | 161148 |
| 237 | 2374,74835 | 182861 | 270 | 2431,36376 | 160553 |
| 238 | 2376,57696 | 182094 | 271 | 2432,96929 | 159961 |
| 239 | 2378,39790 | 181334 | 272 | 2434,56890 | 159375 |
| 240 | 2380,21124 | 180580 | 273 | 2436,16265 | 158791 |
| 241 | 2382,01704 | 179833 | 274 | 2437,75056 | 158213 |
| 242 | 2383,81537 | 179090 | 275 | 2439,33269 | 157639 |
| 243 | 2385,60627 | 178356 | 276 | 2440,90908 | 157069 |
| 244 | 2387,38983 | 177625 | 277 | 2442,47977 | 156503 |
| 245 | 2389,16608 | 176903 | 278 | 2444,04480 | 155940 |
| 246 | 2390,93511 | 176184 | 279 | 2445,60420 | 155383 |
| 247 | 2392,69695 | 175473 | 280 | 2447,15803 | 154829 |
| 248 | 2394,45168 | 174767 | 281 | 2448,70632 | 154279 |
| 249 | 2396,19935 | 174066 | 282 | 2450,24911 | 153733 |
| 250 | 2397,94001 | 173371 | 283 | 2451,78644 | 153190 |
| 251 | 2399,67372 | 172682 | 284 | 2453,31834 | 152652 |
| 252 | 2401,40054 | 171998 | 285 | 2454,84486 | 152117 |
| 253 | 2403,12052 | 171320 | 286 | 2456,36603 | 151587 |
| 254 | 2404,83372 | 170646 | 287 | 2457,88190 | 151059 |
| 255 | 2406,54018 | 169979 | 288 | 2459,39249 | 150535 |
| 256 | 2408,23997 | 169315 | 289 | 2460,89784 | 150016 |
| 257 | 2409,93312 | 168659 | 290 | 2462,39800 | 149499 |
| 258 | 2411,61971 | 168005 | 291 | 2463,89299 | 148986 |
| 259 | 2413,29976 | 167359 | 232 | 2465,38285 | 148477 |
| 260 | 2414,97335 | 166716 | 293 | 2466,86762 | 147971 |
| 261 | 2416,64051 | 166078 | 294 | 2468,34733 | 147469 |
| 262 | 2418,30129 | 165446 | 295 | 2469,82202 | 146969 |
| 263 | 2419,95575 | 164818 | 296 | 2471,29171 | 146474 |
| 264 | 2421,60393 | 164194 | 297 | 2472,75645 | 145981 |
| 265 | 2423,24587 | 163577 | 298 | 2474,21626 | 145493 |
| 266 | 2424,88164 | 162962 | 299 | 2475,67119 | 145006 |
| 267 | 2426,51126 | 162353 | 300 | 3477,12125 | 144524 |

| Nũ. | Logarithm. | Differ. | Nũ. | Logarithm. | Differ. |
|---|---|---|---|---|---|
| 301 | 2478,56650 | 144044 | 334 | 2523,74647 | 129834 |
| 302 | 2480,00694 | 143569 | 335 | 2525,04481 | 129447 |
| 303 | 2481,44263 | 143095 | 336 | 2526,33928 | 129062 |
| 304 | 2482,87358 | 142626 | 337 | 2527,62990 | 128680 |
| 305 | 2484,29984 | 142159 | 338 | 2528,91670 | 128300 |
| 306 | 2485,72143 | 141695 | 339 | 2530,19970 | 127922 |
| 307 | 2487,13838 | 141234 | 340 | 2531,47892 | 127546 |
| 308 | 2488,55072 | 140776 | 341 | 2532,75438 | 127173 |
| 309 | 2489,95848 | 140321 | 342 | 2534,02611 | 126801 |
| 310 | 2491,36169 | 139470 | 343 | 2535,29412 | 126432 |
| 311 | 2492,76039 | 139320 | 344 | 2536,55844 | 126066 |
| 312 | 2494,15459 | 138975 | 345 | 2537,81910 | 125700 |
| 313 | 2495,54434 | 138531 | 346 | 2539,07610 | 125337 |
| 314 | 2496,92965 | 138090 | 347 | 2540,32947 | 124977 |
| 315 | 2498,31055 | 137653 | 348 | 2541,57924 | 124619 |
| 316 | 2499,68708 | 137218 | 349 | 2542,82543 | 124261 |
| 317 | 2501,05926 | 136786 | 350 | 2544,06804 | 123908 |
| 318 | 2502,42712 | 136356 | 351 | 2545,30712 | 123554 |
| 319 | 2503,79068 | 135930 | 352 | 2546,54266 | 123205 |
| 320 | 2505,14998 | 135505 | 353 | 2547,77471 | 122855 |
| 321 | 2506,50503 | 135084 | 354 | 2549,00326 | 122509 |
| 322 | 2507,85587 | 134665 | 355 | 2550,22835 | 122165 |
| 323 | 2509,20252 | 134249 | 356 | 2551,45000 | 121822 |
| 324 | 2510,54501 | 133835 | 357 | 2552,66822 | 121481 |
| 325 | 2511,88336 | 133424 | 358 | 2553,88303 | 121142 |
| 326 | 2513,21760 | 133015 | 359 | 2555,09445 | 120805 |
| 327 | 2514,54775 | 132609 | 360 | 2556,30250 | 120470 |
| 328 | 2515,87384 | 132206 | 361 | 2557,50720 | 120137 |
| 329 | 2517,19590 | 131804 | 362 | 2558,70857 | 119806 |
| 330 | 2518,51394 | 131405 | 363 | 2559,90663 | 119475 |
| 331 | 2519,82799 | 131009 | 364 | 2561,10138 | 119148 |
| 332 | 2521,13808 | 130615 | 365 | 2562,29286 | 118823 |
| 333 | 2522,44423 | 130224 | 366 | 2563,48109 | 118497 |
| 334 | 2523,74647 | 129834 | 367 | 2564,66606 | 118176 |

| Nũ. | Logarithm. | Differ. | Nũ. | Logarithm. | Differ. |
| --- | --- | --- | --- | --- | --- |
| 367 | 2564,66606 | 118176 | 401 | 2603,14437 | 108168 |
| 368 | 2565,84782 | 117855 | 402 | 2604,22605 | 107900 |
| 369 | 2567,02637 | 117535 | 403 | 2605,30505 | 107632 |
| 370 | 2568,20172 | 117219 | 404 | 2606,38137 | 107365 |
| 371 | 2569,37391 | 116903 | 405 | 2607,45502 | 107101 |
| 372 | 2570,54294 | 116589 | 406 | 2608,52603 | 106838 |
| 373 | 2571,70883 | 116277 | 407 | 2609,59441 | 106575 |
| 374 | 2572,87160 | 115967 | 408 | 2510,66016 | 106315 |
| 375 | 2574,03127 | 115657 | 409 | 2611,72331 | 106055 |
| 376 | 2575,18784 | 115351 | 410 | 2612,78386 | 105796 |
| 377 | 2576,34135 | 115045 | 411 | 2613,84182 | 105540 |
| 378 | 2577,49180 | 114741 | 412 | 2614,89722 | 105283 |
| 379 | 2578,63921 | 114439 | 413 | 2615,95005 | 105029 |
| 380 | 2579,78360 | 114138 | 414 | 2617,00034 | 104776 |
| 381 | 2580,92498 | 113838 | 415 | 2618,04810 | 104523 |
| 382 | 2582,06336 | 113541 | 416 | 2619,09333 | 104272 |
| 383 | 2583,19877 | 113245 | 417 | 2620,13605 | 104023 |
| 384 | 2584,33122 | 112951 | 418 | 2621,17628 | 103774 |
| 385 | 2585,46073 | 112657 | 419 | 2622,21402 | 103527 |
| 386 | 2586,58730 | 112367 | 420 | 2623,24929 | 103281 |
| 387 | 2587,71097 | 112076 | 421 | 2624,28210 | 103035 |
| 388 | 2588,83173 | 111787 | 422 | 2625,31245 | 102792 |
| 389 | 2589,94960 | 111501 | 423 | 2626,34037 | 102549 |
| 390 | 2591,06461 | 111215 | 424 | 2627,36586 | 102307 |
| 391 | 2592,17676 | 110931 | 425 | 2628,3889[illegible] | 102067 |
| 392 | 2593,28607 | 110648 | 426 | 2629,40960 | 101828 |
| 393 | 2594,39255 | 110367 | 427 | 2630,42788 | 101589 |
| 394 | 2595,49622 | 110088 | 428 | 2631,44377 | 101352 |
| 395 | 2596,59710 | 109809 | 429 | 2632,45729 | 101117 |
| 396 | 2597,69519 | 109532 | 430 | 2633,46846 | 100881 |
| 397 | 2598,79051 | 109256 | 431 | 2634,47727 | 100648 |
| 398 | 2599,88307 | 108983 | 432 | 2635,48375 | 100415 |
| 399 | 2600,97290 | 108709 | 433 | 3636,48790 | 100183 |
| 400 | 2602,05999 | 108438 | 434 | 2637,48973 | 99953 |

| Nũ. | Logarithm. | Differ. |
|---|---|---|
| 434 | 2637,48973 | 99953 |
| 435 | 2638,48926 | 99723 |
| 436 | 2639,48649 | 99495 |
| 437 | 2640,48144 | 99267 |
| 438 | 2641,47411 | 99041 |
| 439 | 2642,46452 | 98816 |
| 440 | 2643,45268 | 98591 |
| 441 | 2644,43859 | 98368 |
| 442 | 2645,42227 | 98146 |
| 443 | 2646,40373 | 97924 |
| 444 | 2647,38297 | 97704 |
| 445 | 2648,36001 | 97485 |
| 446 | 2649,33486 | 97266 |
| 447 | 2650,30752 | 97049 |
| 448 | 2651,27801 | 96833 |
| 449 | 2652,24634 | 96617 |
| 450 | 2653,21251 | 96403 |
| 451 | 2654,17654 | 96189 |
| 452 | 2655,13843 | 95977 |
| 453 | 2656,09820 | 95765 |
| 454 | 2657,05585 | 95555 |
| 455 | 2658,01140 | 95344 |
| 456 | 2658,96484 | 95136 |
| 457 | 2659,91620 | 94928 |
| 458 | 2660,86548 | 94721 |
| 459 | 2661,81269 | 94514 |
| 460 | 2662,75783 | 94310 |
| 461 | 2663,70093 | 94105 |
| 462 | 2664,64198 | 93901 |
| 463 | 2665,58099 | 93699 |
| 464 | 2666,51798 | 93497 |
| 465 | 2667,45295 | 93297 |
| 466 | 2668,38592 | 93096 |
| 467 | 2669,31688 | 92897 |

| Nũ | Logarithm. | Differ. |
|---|---|---|
| 467 | 2669,31688 | 92897 |
| 468 | 2670,24585 | 92699 |
| 469 | 2671,17284 | 92502 |
| 470 | 2672,09786 | 92305 |
| 471 | 2673,02091 | 92109 |
| 472 | 2673,94200 | 91914 |
| 473 | 2674,86114 | 91720 |
| 474 | 2675,77834 | 91527 |
| 475 | 2676,69361 | 91334 |
| 476 | 2677,60695 | 91143 |
| 477 | 2678,51838 | 90952 |
| 478 | 2679,42790 | 90761 |
| 479 | 2680,33551 | 90573 |
| 480 | 2681,24124 | 90384 |
| 481 | 2682,14508 | 90196 |
| 482 | 2683,04704 | 90009 |
| 483 | 2683,94713 | 89823 |
| 484 | 2684,84536 | 89638 |
| 485 | 2685,74174 | 89453 |
| 486 | 2686,63627 | 89269 |
| 487 | 2687,52896 | 89086 |
| 488 | 2688,41982 | 88904 |
| 489 | 2689,30886 | 88722 |
| 490 | 2690,19608 | 88541 |
| 491 | 2691,08149 | 88361 |
| 492 | 2691,96510 | 88182 |
| 493 | 2692,84692 | 88003 |
| 494 | 2693,72695 | 87825 |
| 495 | 2694,60520 | 87648 |
| 496 | 2695,48168 | 87471 |
| 497 | 2696,35639 | 87295 |
| 498 | 2697,22934 | 87121 |
| 499 | 2698,10055 | 86945 |
| 500 | 2698,97000 | 86772 |

| Nũ | Logarithm. | Differ. | Nũ | Logarithm. | Differ. |
|---|---|---|---|---|---|
| 501 | 2699,83773 | 86599 | 534 | 2727,54126 | 81252 |
| 502 | 2700,70372 | 86427 | 535 | 2728,35378 | 81101 |
| 503 | 2701,56799 | 86255 | 536 | 2729,16479 | 80950 |
| 504 | 2702,43054 | 86084 | 537 | 2729,97429 | 80799 |
| 505 | 2703,29138 | 85914 | 538 | 2730,78228 | 80649 |
| 506 | 2704,15052 | 85744 | 539 | 2731,58877 | 80499 |
| 507 | 2705,00796 | 85575 | 540 | 2732,39376 | 80351 |
| 508 | 2705,86371 | 85407 | 541 | 2733,19727 | 80202 |
| 509 | 2706,71778 | 85240 | 542 | 2733,99929 | 80054 |
| 510 | 2707,57018 | 85072 | 543 | 2734,79983 | 79907 |
| 511 | 2708,42090 | 84906 | 544 | 2735,59890 | 79760 |
| 512 | 2709,26996 | 84741 | 545 | 2736,39650 | 79614 |
| 513 | 2710,11737 | 84575 | 546 | 2737,19264 | 79469 |
| 514 | 2710,96312 | 84411 | 547 | 2737,98733 | 79323 |
| 515 | 2711,80723 | 84247 | 548 | 2738,78056 | 79178 |
| 516 | 2712,64970 | 84084 | 549 | 2739,57234 | 79035 |
| 517 | 2713,49054 | 83922 | 550 | 2740,36269 | 78891 |
| 518 | 2714,32976 | 83760 | 551 | 2741,15160 | 78748 |
| 519 | 2715,16736 | 83598 | 552 | 2741,93908 | 78605 |
| 520 | 2716,00334 | 83438 | 553 | 2742,72513 | 78463 |
| 521 | 2716,83772 | 83278 | 554 | 2743,50976 | 78322 |
| 522 | 2717,67050 | 83119 | 555 | 2744,29298 | 78181 |
| 523 | 2718,50169 | 82960 | 556 | 2745,07479 | 78041 |
| 524 | 2719,33129 | 82801 | 557 | 2745,85520 | 77900 |
| 525 | 2720,15930 | 82644 | 558 | 2746,63420 | 77761 |
| 526 | 2720,98574 | 82488 | 559 | 2747,41181 | 77622 |
| 527 | 2721,81062 | 82330 | 560 | 2748,18803 | 77483 |
| 528 | 2722,63392 | 82175 | 561 | 2748,96286 | 77346 |
| 529 | 2723,45567 | 82020 | 562 | 2749,73632 | 77207 |
| 530 | 2724,27587 | 81865 | 563 | 2750,50839 | 77071 |
| 531 | 2725,09452 | 81711 | 564 | 2751,27910 | 76935 |
| 532 | 2725,91163 | 81558 | 565 | 2752,04845 | 76798 |
| 533 | 2726,72721 | 81405 | 566 | 2752,81643 | 76662 |
| 534 | 2727,54126 | 81252 | 567 | 2753,58306 | 76528 |

| Nũ | Logarithm. | Differ | Nũ | Logarithm. | Differ |
|---|---|---|---|---|---|
| 567 | 2753,58306 | 76528 | 601 | 2778,87447 | 72202 |
| 568 | 2754,34834 | 76393 | 602 | 2779,59649 | 72082 |
| 569 | 2755,11227 | 76259 | 603 | 2780,31731 | 71963 |
| 570 | 2755,87486 | 76125 | 604 | 2781,03694 | 71843 |
| 571 | 2756,63611 | 75992 | 605 | 2781,75537 | 71725 |
| 572 | 2757,39603 | 75859 | 606 | 2782,47262 | 71607 |
| 573 | 2758,15462 | 75727 | 607 | 2783,18869 | 71489 |
| 574 | 2758,91189 | 75595 | 608 | 2783,90358 | 71371 |
| 575 | 2759,66784 | 75464 | 609 | 2784,61729 | 71255 |
| 576 | 2760,42248 | 75333 | 610 | 2785,32984 | 71137 |
| 577 | 2761,17581 | 75203 | 611 | 2786,04121 | 71021 |
| 578 | 2761,92784 | 75072 | 612 | 2786,75142 | 70905 |
| 579 | 2762,67856 | 74943 | 613 | 2787,46047 | 70790 |
| 580 | 2763,42799 | 74814 | 614 | 2788,16837 | 70675 |
| 581 | 2764,17613 | 74685 | 615 | 2788,87512 | 70559 |
| 582 | 2764,92298 | 74557 | 616 | 2789,58071 | 70445 |
| 583 | 2765,66855 | 74430 | 617 | 2790,28516 | 70332 |
| 584 | 2766,41285 | 74302 | 618 | 2790,98848 | 70217 |
| 585 | 2767,15587 | 74175 | 619 | 2791,69065 | 70104 |
| 586 | 2767,89762 | 74048 | 620 | 2792,39169 | 69991 |
| 587 | 2768,63810 | 73923 | 621 | 2793,09160 | 69878 |
| 588 | 2769,37733 | 73796 | 622 | 2793,79038 | 69767 |
| 589 | 2770,11529 | 73672 | 623 | 2794,48805 | 69654 |
| 590 | 2770,85201 | 73547 | 624 | 2795,18459 | 69543 |
| 591 | 2771,58748 | 73423 | 625 | 2795,88002 | 69431 |
| 592 | 2772,32171 | 73298 | 626 | 2796,57433 | 69321 |
| 593 | 2773,05469 | 73175 | 627 | 2797,26754 | 69210 |
| 594 | 2773,78644 | 73053 | 628 | 2797,95964 | 69101 |
| 595 | 2774,51697 | 72929 | 629 | 2798,65065 | 68990 |
| 596 | 2775,24626 | 72807 | 630 | 2799,34055 | 68881 |
| 597 | 2775,97433 | 72685 | 631 | 2800,02936 | 68772 |
| 598 | 2776,70118 | 72564 | 632 | 2800,71708 | 68663 |
| 599 | 2777,42682 | 72443 | 633 | 2801,40371 | 68555 |
| 600 | 2778,15125 | 72322 | 634 | 2802,08926 | 68447 |

| Nũ | Logarithm. | Differ | Nũ | Logarithm. | Differ |
|---|---|---|---|---|---|
| 634 | 2802,08926 | 68447 | 667 | 2824,12583 | 65063 |
| 635 | 2802,77373 | 68339 | 668 | 2824,77646 | 64966 |
| 636 | 2803,45712 | 68231 | 669 | 2825,42612 | 64868 |
| 637 | 2804,13943 | 68125 | 670 | 2826,07480 | 64772 |
| 638 | 2804,82068 | 68018 | 671 | 2826,72252 | 64675 |
| 639 | 2805,50086 | 67911 | 672 | 2827,36927 | 64579 |
| 640 | 2806,17997 | 67806 | 673 | 2828,01506 | 64484 |
| 641 | 2806,85803 | 67700 | 674 | 2828,65990 | 64387 |
| 642 | 2807,53503 | 67594 | 675 | 2829,30377 | 64294 |
| 643 | 2808,21097 | 67490 | 676 | 2829,94670 | 64197 |
| 644 | 2808,88587 | 67384 | 677 | 2830,58867 | 64102 |
| 645 | 2809,55971 | 67281 | 678 | 2831,22969 | 64008 |
| 646 | 2810,23252 | 67176 | 679 | 2831,86977 | 63914 |
| 647 | 2810,90428 | 67073 | 680 | 2832,50891 | 63820 |
| 648 | 2811,57501 | 66969 | 681 | 2833,14711 | 63726 |
| 649 | 2812,24470 | 66866 | 682 | 2833,78437 | 63633 |
| 650 | 2812,91336 | 66763 | 683 | 2834,42070 | 63540 |
| 651 | 2813,58099 | 66661 | 684 | 2835,05610 | 63447 |
| 652 | 2814,24760 | 66558 | 685 | 2835,69057 | 63355 |
| 653 | 2814,91318 | 66457 | 686 | 2836,32412 | 63262 |
| 654 | 2815,57775 | 66355 | 687 | 2836,95674 | 63170 |
| 655 | 2816,24130 | 66254 | 688 | 2837,58844 | 63078 |
| 656 | 2816,90384 | 66153 | 689 | 2838,21922 | 62987 |
| 657 | 2817,56537 | 66052 | 690 | 2838,84909 | 62896 |
| 658 | 2818,22589 | 65952 | 691 | 2839,47805 | 62804 |
| 659 | 2818,88541 | 65853 | 692 | 2840,10609 | 62714 |
| 660 | 2819,54394 | 65752 | 693 | 2840,73323 | 62624 |
| 661 | 2820,20146 | 65653 | 694 | 2841,35947 | 62533 |
| 662 | 2820,85799 | 65554 | 695 | 2841,98480 | 62444 |
| 663 | 2821,51353 | 65455 | 696 | 2842,60924 | 62354 |
| 664 | 2822,16808 | 65357 | 697 | 2843,23278 | 62264 |
| 665 | 2822,82165 | 65258 | 698 | 2843,85542 | 62176 |
| 666 | 2823,47423 | 65160 | 699 | 2844,47718 | 62086 |
| 667 | 2824,12583 | 65063 | 700 | 2845,09804 | 61998 |

| Nū | Logarithm | Differ. |
|---|---|---|
| 701 | 2845,71802 | 61909 |
| 702 | 2846,33711 | 61822 |
| 703 | 2846,95533 | 61733 |
| 704 | 2847,57266 | 61646 |
| 705 | 2848,18912 | 61558 |
| 706 | 2848,80470 | 61471 |
| 707 | 2849,41941 | 61385 |
| 708 | 2850,03326 | 61298 |
| 709 | 2850,64624 | 61211 |
| 710 | 2851,25835 | 61125 |
| 711 | 2851,86960 | 61039 |
| 712 | 2852,47999 | 60954 |
| 713 | 2853,08953 | 60868 |
| 714 | 2853,69821 | 60783 |
| 715 | 2854,30604 | 70698 |
| 716 | 2854,91302 | 60614 |
| 717 | 2855,51916 | 60528 |
| 718 | 2856,12444 | 60445 |
| 719 | 2856,72889 | 60361 |
| 720 | 2857,33250 | 60276 |
| 721 | 2857,93526 | 60194 |
| 722 | 2858,53720 | 60110 |
| 723 | 2859,13830 | 60027 |
| 724 | 2859,73857 | 59944 |
| 725 | 2860,33801 | 59861 |
| 726 | 2860,93662 | 59779 |
| 727 | 2861,53441 | 59697 |
| 728 | 2862,13138 | 59615 |
| 729 | 2862,72753 | 59533 |
| 730 | 2863,32286 | 59452 |
| 731 | 2863,91738 | 59370 |
| 732 | 2864,51108 | 59289 |
| 733 | 2865,10397 | 59209 |
| 734 | 2865,69606 | 59128 |

| Nū | Logarithm | Differ. |
|---|---|---|
| 734 | 2865,69606 | 59128 |
| 735 | 2866,28734 | 59047 |
| 736 | 2866,87781 | 58968 |
| 737 | 2867,46749 | 58887 |
| 738 | 2868,05636 | 58808 |
| 739 | 2868,64444 | 58728 |
| 740 | 2869,23172 | 58649 |
| 741 | 2869,81821 | 58570 |
| 742 | 2870,40391 | 58490 |
| 743 | 2870,98881 | 58413 |
| 744 | 2871,57294 | 58333 |
| 745 | 2872,15627 | 58256 |
| 746 | 2872,73883 | 58177 |
| 747 | 2873,32060 | 58100 |
| 748 | 2873,90160 | 58022 |
| 749 | 2874,48182 | 57944 |
| 750 | 2875,06126 | 57808 |
| 751 | 2875,63994 | 57790 |
| 752 | 2876,21784 | 57714 |
| 753 | 2876,79498 | 57637 |
| 754 | 2877,37135 | 57560 |
| 755 | 2877,94695 | 57485 |
| 756 | 2878,52180 | 57408 |
| 757 | 2879,09588 | 57333 |
| 758 | 2879,66921 | 57257 |
| 759 | 2880,24178 | 57181 |
| 760 | 2880,81359 | 57107 |
| 761 | 2881,38466 | 57031 |
| 762 | 2881,95497 | 56957 |
| 763 | 2882,52454 | 56882 |
| 764 | 2883,09336 | 56808 |
| 765 | 2883,66144 | 56733 |
| 766 | 2884,22877 | 56659 |
| 767 | 2884,79536 | 56586 |

| Nũ | Logarithm. | Differ |
|---|---|---|
| 767 | 2884,79536 | 56586 |
| 768 | 2885,36122 | 56512 |
| 769 | 2885,92634 | 56439 |
| 770 | 2886,49073 | 56365 |
| 771 | 2887,05438 | 56292 |
| 772 | 2887,61730 | 56219 |
| 773 | 2888,17949 | 56147 |
| 774 | 2888,74096 | 56074 |
| 775 | 2889,30170 | 56002 |
| 776 | 2889,86172 | 55930 |
| 777 | 2890,42102 | 55858 |
| 778 | 2890,97960 | 55786 |
| 779 | 2891,53746 | 55714 |
| 780 | 2892,09460 | 55643 |
| 781 | 2892,65103 | 55572 |
| 782 | 2893,20675 | 55501 |
| 783 | 2893,76176 | 55430 |
| 784 | 2894,31606 | 55360 |
| 785 | 2894,86966 | 55289 |
| 786 | 2895,42255 | 55218 |
| 787 | 2895,97473 | 55149 |
| 788 | 2896,52622 | 55078 |
| 789 | 2897,07700 | 55009 |
| 790 | 2897,62709 | 54939 |
| 791 | 2898,17648 | 54870 |
| 792 | 2898,72518 | 54801 |
| 793 | 2899,27319 | 54731 |
| 794 | 2899,82050 | 54663 |
| 795 | 2900,36713 | 54594 |
| 796 | 2900,91307 | 54525 |
| 797 | 2901,45832 | 54457 |
| 798 | 2902,00289 | 54389 |
| 799 | 2902,54678 | 54321 |
| 800 | 2903,08999 | 54253 |
| 801 | 2903,63252 | 54185 |
| 802 | 2904,17437 | 54118 |
| 803 | 2904,71555 | 54050 |
| 804 | 2905,25605 | 53983 |
| 805 | 2905,79588 | 53916 |
| 806 | 2906,33504 | 53849 |
| 807 | 2906,87353 | 53783 |
| 808 | 2907,41136 | 53716 |
| 809 | 2907,94852 | 53650 |
| 810 | 2908,48502 | 53583 |
| 811 | 2909,02085 | 53518 |
| 812 | 2909,55603 | 53452 |
| 813 | 2910,09055 | 53385 |
| 814 | 2910,62440 | 53321 |
| 815 | 2911,15761 | 53255 |
| 816 | 2911,69016 | 53190 |
| 817 | 2912,22206 | 53124 |
| 818 | 2912,75330 | 53060 |
| 819 | 2913,28390 | 52995 |
| 820 | 2913,81385 | 52931 |
| 821 | 2914,34316 | 52866 |
| 822 | 2914,87182 | 52802 |
| 823 | 2915,39984 | 52737 |
| 824 | 2915,92721 | 52674 |
| 825 | 2916,45395 | 52610 |
| 826 | 2916,98005 | 52546 |
| 827 | 2917,50551 | 52483 |
| 828 | 2918,03034 | 52419 |
| 829 | 2918,55453 | 52356 |
| 830 | 2919,07809 | 52293 |
| 831 | 2919,60102 | 52231 |
| 832 | 2920,12333 | 52167 |
| 833 | 2920,64500 | 52105 |
| 834 | 2921,16605 | 52043 |

| Nū | Logarithm. | Differ | Nū | Logarithm. | Differ |
|---|---|---|---|---|---|
| 834 | 2921,16605 | 52043 | 867 | 2938,01910 | 50063 |
| 835 | 2921,68648 | 51980 | 868 | 2938,51973 | 50005 |
| 836 | 2922,20627 | 51918 | 869 | 2939,01978 | 49947 |
| 837 | 2922,72546 | 51856 | 870 | 2939,51925 | 49891 |
| 838 | 2923,24402 | 51794 | 871 | 2940,01816 | 49832 |
| 839 | 2923,76196 | 51733 | 872 | 2940,51648 | 49776 |
| 840 | 2924,27929 | 51671 | 873 | 2941,01424 | 49719 |
| 841 | 2924,79600 | 51609 | 874 | 2941,51143 | 49662 |
| 842 | 2925,31209 | 51548 | 875 | 2942.00805 | 49606 |
| 843 | 2925,82757 | 51488 | 876 | 2942,50411 | 49548 |
| 844 | 2926,34245 | 51426 | 877 | 2942,99959 | 49493 |
| 845 | 2926,85671 | 51365 | 878 | 2943,49452 | 49436 |
| 846 | 2927,37036 | 51305 | 879 | 2943,98888 | 49379 |
| 847 | 2927,88341 | 51244 | 880 | 2944,48267 | 49324 |
| 848 | 2928,39585 | 51184 | 881 | 2944,97591 | 49268 |
| 849 | 2928,90769 | 51124 | 882 | 2945,46859 | 49211 |
| 850 | 2929,41893 | 51063 | 883 | 2945.96070 | 49157 |
| 851 | 2929,92956 | 51003 | 884 | 2946,45227 | 49100 |
| 852 | 2930,43959 | 50944 | 885 | 2946,94327 | 49045 |
| 853 | 2930,94903 | 50884 | 886 | 2947,43372 | 48990 |
| 854 | 2931,45787 | 50824 | 887 | 2947,92362 | 48935 |
| 855 | 2931,96611 | 50765 | 888 | 2948,41297 | 48879 |
| 856 | 2932,47376 | 50706 | 889 | 2948,90176 | 48825 |
| 857 | 2932,98082 | 50647 | 890 | 2949,39001 | 48769 |
| 858 | 2933,48729 | 50587 | 891 | 2949,87770 | 48715 |
| 859 | 2933,99316 | 50529 | 892 | 2950,36485 | 48661 |
| 860 | 2934,49845 | 50470 | 893 | 2950,85146 | 48606 |
| 861 | 2935,00315 | 50412 | 894 | 2951,33752 | 48552 |
| 862 | 2935,50727 | 50353 | 895 | 2951,82304 | 48497 |
| 863 | 2936,01080 | 50294 | 896 | 2952.30801 | 48443 |
| 864 | 2936,51374 | 50237 | 897 | 2952,79244 | 48390 |
| 865 | 2937,01611 | 50178 | 898 | 2953,27634 | 48335 |
| 866 | 2937,51789 | 50121 | 899 | 2953,75969 | 48282 |
| 867 | 2938.01910 | 50063 | 900 | 2954,24251 | 48228 |

| *Nũ.* | *Logarithm,* | *Differ* | *Nũ* | *Logarithm,* | *Differ* |
|---|---|---|---|---|---|
| 901 | 2954,72479 | 48175 | 934 | 2970,34688 | 46473 |
| 902 | 2955,20654 | 48121 | 935 | 2970,81161 | 46424 |
| 903 | 2955,68775 | 48068 | 936 | 2971,27585 | 46374 |
| 904 | 2956,16843 | 48015 | 937 | 2971,73959 | 46325 |
| 905 | 2956,64858 | 47962 | 938 | 2972,20284 | 46275 |
| 906 | 2957,12820 | 47909 | 939 | 2972,66559 | 46226 |
| 907 | 2957,60729 | 47856 | 940 | 2973,12785 | 46177 |
| 908 | 2958,08585 | 47803 | 941 | 2973,58962 | 46128 |
| 909 | 2958,56388 | 47751 | 942 | 2974,05090 | 46079 |
| 910 | 2959,04139 | 47699 | 943 | 2974,51169 | 46030 |
| 911 | 2959,51838 | 47646 | 944 | 2974,97199 | 45982 |
| 912 | 2959,99484 | 47594 | 945 | 2975,43181 | 45938 |
| 913 | 2960,47078 | 47542 | 946 | 2975,89114 | 45884 |
| 914 | 2960,94620 | 47489 | 947 | 2976,34998 | 45836 |
| 915 | 2961,42106 | 47438 | 948 | 2976,80834 | 45787 |
| 916 | 2961,89547 | 47387 | 949 | 2977,26621 | 45740 |
| 917 | 2962,36934 | 47334 | 950 | 2977,72361 | 45691 |
| 918 | 2962,84268 | 47283 | 951 | 2978,18052 | 45643 |
| 919 | 2963,31551 | 47232 | 952 | 2978,63695 | 45595 |
| 920 | 2963,78783 | 47180 | 993 | 2979,09290 | 45547 |
| 921 | 2964,25963 | 47129 | 954 | 2979,54837 | 45500 |
| 922 | 2964,73092 | 47078 | 955 | 2980,00337 | 45452 |
| 923 | 2965,20170 | 47027 | 956 | 2980,45789 | 45405 |
| 924 | 2965,67197 | 46976 | 957 | 2980,91194 | 45357 |
| 925 | 2966,14173 | 46926 | 958 | 2981,36551 | 45310 |
| 926 | 2966,61099 | 46874 | 959 | 2981,81862 | 45262 |
| 927 | 2967,07973 | 46825 | 960 | 2982,27123 | 45216 |
| 928 | 2967,54798 | 46773 | 961 | 2982,72339 | 45168 |
| 929 | 2968,01571 | 46724 | 962 | 2983,17507 | 45122 |
| 930 | 2968,48295 | 46673 | 963 | 2983,62629 | 45074 |
| 931 | 296894968 | 46623 | 964 | 2984,07703 | 45028 |
| 932 | 2969,41591 | 46573 | 965 | 2984,52731 | 44982 |
| 933 | 2969,88164 | 46524 | 966 | 2984,97713 | 44934 |
| 934 | 29703 4688 | 46473 | 967 | 2985,42647 | 44889 |

| Nu. | Logarithm. | Differ. | Nu. | Logarithm. | Differ. |
|---|---|---|---|---|---|
| 967 | 2955,42647 | 44889 | 984 | 2992,99510 | 44113 |
| 968 | 2985,87536 | 44842 | 985 | 2993,43623 | 44068 |
| 969 | 2986,32378 | 44795 | 986 | 2993,87691 | 44024 |
| 970 | 2986,77173 | 44750 | 987 | 2994,31715 | 43979 |
| 971 | 2987,21923 | 44703 | 988 | 2994,75694 | 43935 |
| 972 | 2987,66626 | 44658 | 989 | 2995,19629 | 43890 |
| 973 | 2988,11284 | 44612 | 990 | 2995,63519 | 43846 |
| 974 | 2988,55896 | 44566 | 991 | 2996,07365 | 43802 |
| 975 | 2989,00462 | 44520 | 992 | 2996,51167 | 43758 |
| 976 | 2989,44982 | 44474 | 993 | 2996,94925 | 43713 |
| 977 | 2989,89456 | 44429 | 994 | 2997,38638 | 43670 |
| 978 | 2990,33885 | 44384 | 995 | 2997,82308 | 43626 |
| 979 | 2990,78269 | 44339 | 996 | 2998,25934 | 43582 |
| 980 | 2991,22608 | 44293 | 997 | 2998,69516 | 43538 |
| 981 | 2991,66901 | 44248 | 998 | 2999,13054 | 43495 |
| 982 | 2992,11149 | 44203 | 999 | 2999,56549 | 43451 |
| 983 | 2992,55352 | 44158 | 1000 | 3000,00000 | |

## FINIS.