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OR, A

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OF

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By A. B U R N S,

Teacher of the Mathematics in TARPORLEY, Cheſhire.

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PREFACE.

The CONTENTS.

TO

INTRODUCTION.

IN this TREATISE I have laid down (*Part* I.) plain, concise, and easy Rules, with many useful Directions, how to measure, lay out, and divide Land both accessible and inaccessible, with *the Chain only*, and also to cast up the Dimensions by the Pen, and afterwards to plan the same, from which a Map may be obtained, with peculiar and ornamental Embellishments, which will undoubtedly answer and fulfil the Desires and Expectations of not only all my Country Readers, but the Public in General.

I have likewise described (*Part* II.) such mathematical Instruments as have been generally made Use of in practical Surveying; with ample Directions how to use them, and to rectify the Errors occasioned by the Needle, *&c.* whether on an horizontal Plane, mountainous or hilly Grounds; so that such Dimensions may be cast up several Ways with the Pen, by which Means the Errors of Estimation that pertain to the Scale and Protractor, are avoided and exploded; together with what ever else that is necessary, in order to render this Treatise every Way compleat.

But as the *Chain alone*, for Expedition and Correctness, claims the Preference to any thing else in Surveying, it is therefore indispensibly necessary to undeceive the Public with regard to the *plane Table and Instruments*, by expatiating

tiating on the many Inconveniencies that unavoidably attend them.

And as to the Chain alone in Practice, with regard to the many Advantages thereto belonging, Mr. *William Hume* hath, in his Introduction to practical Surveying, discussed thereon so very much to the Purpose, that I cannot more fully illustrate the same than by reciting Part of that Gentleman's Introduction relating to Chain Practice, which is thus:

First, True: For what Surveyor can be sure, even with the best Theodolite, or other Instrument, to take the four Angles of a Trapezium so exactly as to be just equal to four Right-angles. or if not, to which Angle will he impute the Error? Now, in this Case, I suppose all will allow, that to take with the Chain one Diagonal, or both if you please, though not always necessary, is the surest Way to correct the Work; and if so, the Angle will hereby be determined, because the three Sides of each Triangle is given; and consequently the Instruments for taking Angles is rendered thereby altogether useless; and the Errors contracted by the Use of Instruments are rectified by the Chain only.

Secondly, It is the most easy both to learn and to practise, since it requires not a Course of Mathematics, nor a thorough Understanding of *Euclid*'s *Elements*; for he that can but add, subtract, multiply and divide, is sufficiently qualified with Arithmetic to attain and practise the Method of Surveying; especially when we consider that the Chain is so common and conspicuously easy of itself, that even any Person of an ordinary Capacity may soon attain unto the practical Parts of Surveying by it; Whereas, on the contrary, the other Instruments aforesaid, require

require not only the best Explanation, but even also an acute Genius and Apprehension, for the ready understanding them in their Use and Application.

3. It is the cheapest Way, seeing it requires no Assistant with the Surveyor but only one to lead the Chain; whereas, in other Cases, there must be (beside the Surveyor and him that leads the Chain) one Man, or more, to attend with the Instruments, which herein may be very numerous and chargeable, though needless; For, as Mr. *Love* and others well observe, what Need is there for a Horse-Load of Brass Circles, and Semi-circles, heavy Ball Sockets, wooden Tables and Frames; and also the three-legged Staves, *cum multis aliis*, unless to amuse the ignorant Countryman to make him more freely pay the Surveyor?

4. It is the most expeditious, there being no Time spent in fixing the Instruments, or waiting for the setting of the Needle and Compass, but the Chain generally kept going, except when the Surveyor is writing.

If any Thing has even the Colour of an Objection, it may be that for want of Instruments to take Angles, we shall be obliged to take all the Diagonals or cross Lines in Trapeziums, or irregular Polygons in the Field.

To which I answer,

If that is not done in the Field, it must be done at Home, for Polygons must be divided into Triangles (or managed some Way equivalent to it) before they can be cast up; so that there is no Time lost, except doing that in the Field which might be done in the House; and if that is an Inconveniency, it is infinitely recompenced

 by

by the Exactneſs of the Work: For a ſmall Error in an obtuſe Angle (of which Polygons generally conſiſt) may cauſe a great Error in the Baſe of one of the Triangles, which being meaſured in the Field is wholly avoided.

From what has been obſerved upon this Head, we may rationally infer, that when Angles are needful to be taken in the Field, they muſt likewiſe be laid down in the Work at Home; but when otherwiſe, diagonal Lines are taken in the Field by the Chain only; then all Protraction by the Semi-circle, or any other Braſs Inſtrument, is intirely needleſs, becauſe Angles are herein neither regarded nor required.

And yet, leſt this Compendium ſhould he thought imperfect, I have ſhewn the Learner how any acute or obtuſe Angle may be occaſionally taken by the Chain, according to the beſt Method extant.

5. It is moſt convenient, for its being, when folded, ſo portable as to be contained in your Pocket; which ſeveral of the other Inſtruments, as above ſaid, require a Perſon to be their Bearer: Yea, not only ſo, but it ſometimes happens that the Surveyor living ſo remote from any City or great Town where thoſe Inſtruments can be had, that if there was no Way to do without them, he muſt ſometimes poſtpone his Work moſt Part of a Summer for want of them, and perhaps loſe the doing of it at laſt; whereas put the Caſe at the worſt, if all Inſtruments, and even the Chain itſelf fail, he muſt have but a ſlender Share of Ingenuity that cannot, upon Neceſſity, make himſelf a Chain, ſeeing there is Wire to be had almoſt in every Market Town; where, likewiſe, he may have a Pole made by a Joyner according to the Directions herein contained; and thereby, without any other Inſtruments, may be enabled to Survey and Map many hundred Acres of Land, according to the Method taught in this Book.

6. It is very advantageous, upon this Consideration, that there are many in the Country that have not had Opportunity or Ability to acquire so large a Share of Mathematics, as to be versed in the Nature and various Uses of Angles; and yet would be glad to be useful to themselves or their Neighbours, if by the Country Education they have had, they could perform the Art of Surveying with as much Safety, Truth, and Expedition, as those that have had a great Charge of Education bestowed upon them: For, indeed, it often happens that those who were born to, or have acquired, such plentiful Fortunes as to allow them a liberal Education, and a genteel Maintenance, are thought above the Slavery of an actual Surveyor; and therefore ingenious Persons, though of lower Circumstances, and whose creditable Living depends upon their Industry, are the likeliest Persons (if they can be thoroughly qualified) to engage in this laborious Undertaking; and for the Use of such, this Enchiridion is chiefly intended, though as to the Truth of the Performance, it is offered to the Examination of the able Mathematicians.

But, secondly, there are many ingenious and industrious Men that understand the Use of Instruments, and live where they may be had, who cannot spare five, six, or eight Guineas for a Theodolite; or fifteen or sixteen for a new invented one; besides plane Tables, Semicircles, Protractors, &c. and yet could spare Money to buy a Chain, or (where they cannot be had) Wire to make one, and also a handsome strong Pole: and these are all the Instruments necessary in Surveying, according to this Essay; which, if well understood, is sufficient to make any Person, though but of a common Capacity, to be a compleat Master of the Art of Surveying, which is the Design of the Book, and of the Author.

Many

Many more Arguments might be urged in Favour of *Chain Practice*, unassisted by Instruments, but what Mr. Hume hath justly observed upon that Head, I presume is sufficient to excite the Curiosity of the Public in the Perusal of this Treatise, wherein they'll find a thorough Specimen of practical Surveying performed by the *Chain*, and also, by Instruments, whose Dimensions are cast up by the Pen.

And as it is absolutely necessary for every one that would become an Artist in measuring Land, to begin with, and be very expert in several Rules in Arithmetic, I have therefore made it the Subject of my first Chapter. The Size of the Book obliged me to be as brief as possible in those preparative Rules that are indispensibly useful in Surveying: In the second Chapter, relating to Geometry, I have also observed the same Caution, by introducing no more than what is needful therein. Thus, by Degrees, I have endeavoured to prepare the ingenious Learner insensibly for *Field Practice*; and where any Proposition (herein contained) requires geometrical Demonstrations, which perhaps some of my Country Readers (for whom this Treatise is principally intended) cannot so immediately comprehend, I shall, for the better Understanding and Satisfaction of all such, lay down such ocular self convincing Proofs, as will not admit the least Doubt of its Truth and Correctness.

And though I have endeavoured, with Care, to answer and fulfil the Expectations and aspiring Hopes of the Unlearned, yet, notwithstanding, as the Whole is founded upon Geometry, I therefore humbly presume to flatter myself, that it will not be unacceptable to the mathematical Practitioner also: But not to trespass too long upon my Reader's Patience by an insipid Prelude at the Door, suffer me to invite him in, that he may partake of the following Entertainment.

The

The PENCE TABLE.

4 Farthings make	1 Penny,	20 Pence is	1 8
12 Pence ——	1 Shilling,	30 ———	2 6
20 Shillings ——	1 Pound.	40 ———	3 4
		50 ———	4 2

A Table of Land Measure.

		60 ———	5 0
		70 ———	5 10
$5\frac{1}{2}$ Yards	1 Pole or Perch,	80 ———	6 8
$30\frac{1}{4}$ Square Yards	1 Square Perch,	90 ———	7 6
40 Square Perches	1 Rood of Land,	100 ———	8 4
4 Roods, or 160 Square Perches	one Acre.		

In this Place, I hope it will not be amiſs to explain what an *Acre*, *Rood*, and *Perch* mean; which will enable my Reader to form a clearer Idea of Land Meaſurement, than what perhaps he can gather from the foregoing Table.

Firſt then, an Acre of Land in moſt Countries is allow'd to contain 160 ſquare Perches; but the Area of a Perch differs in many Places: For Inſtance,

In *Great Britain*, the Statute Pole or Perch contains in Length 5 Yards 1-half; the cuſtomary Pole in ſome Parts thereof contains either 6, 7, or 8 Yards, *to wit*, in *Cheſhire* and *Lancaſhire*, the cuſtomary Perch (or Rood, as they improperly call it) is eight Yards in Length, and conſequently 64 ſquare Yards are contain'd in ſuch a ſquare Perch, and therefore one *Cheſhire* Acre is 560 ſquare Yards, more than two Statute Acres, *&c.*

The Statute Pole or Perch in *Ireland* contains ſeven Yards in Length, or 49 ſquare Yards, 40 Poles one Rood, and 4 Roods one Acre, which they call Plantation Meaſure.

An

An Explanation of certain Characters made use of in this Book.

A denotes *Acres.* R *Roods.* and P *Poles.*

Alſo, *l.* denotes Pounds. *s.* Shillings. and *d.* Pence.

$+$ *Plus*, the Sign or Character of Addition; and when placed between two Numbers, ſignifies they are to be added together; as $3+4$ denotes that 3 and 4 are to be collected into one Sum.

$-$ *Minus*, leſs, or the Sign of Subtraction; and when it ſtands between two Numbers, denotes that the latter is to be ſubtracted from the former; as $4-3$ is 4 leſs 3, and ſignifies that 3 is to be taken from 4.

$\times$ is the Sign of Multiplication; and when placed between two Numbers, ſignifies that they are to be multiplied together: Thus 3×4, denotes that 3 is to be multiplied by 4.

$=$ the Sign of Equality; and, when placed between two Quantities, denotes they are equal between themſelves: As $3+4=7$, that is, the Sum of 3 and 4 is equal to 7.

: denotes to, and :: ſo is; thoſe Marks are frequently uſed in Proportion, implying that the Numbers they are placed between are proportionable: As 3 : 6 :: 9 : 18, ſignifies as 3 to 6, ſo is 9 to 18.

CHAP.

Geodæſia Improved:

CHAPTER I.

SECTION I.

NUMERATION.

BY Numeration, we learn to read, write, and expreſs the Value of Figures: Which that you may do, obſerve the following

TABLE.

Hundreds of Millions	Tens of Millions	Millions	Hundreds of Thouſands	Tens of Thouſands	Thouſands	Hundreds	Tens	Units
								1
							2	1
						3	2	1
					4	3	2	1
				5	4	3	2	1
			6	5	4	3	2	1
		7	6	5	4	3	2	1
	8	7	6	5	4	3	2	1
9	8	7	6	5	4	3	2	1

In the above Table each Figure to the Left Hand exceeds the former ten Times the Value, and is thus read: Nine hundred eighty-ſeven Millions, ſix hundred fifty-four Thouſand, three Hundred and twenty-one. In reading Figures or Numbers, it is proper

ADDITION of MONEY.

Example I.

In Addition of Money, take Care to place Pounds under Pounds, Shillings under Shillings, and Pence under Pence, &c. And for every four Farthings carry one Penny, for every twelve Pence carry one Shilling, and for every twenty Shillings one Pound

	l.	*s.*	*d.*
Lent	762	17	9 ¼
More	647	16	8 ½
Sum lent	1410	14	5 ¾

In the foregoing Example, begin with the Farthings, and say, 2 and 1 is 3, which set in the Place of Farthings; then proceed to the Pence, saying, 8 and 9 is 17, which is one Shilling and five Pence; therefore set down 5, and carry 1 for the Shilling, and say, 1 and 6 is 7, and 7 is 14; set down 4, and carry 10 to the Tens, saying, 1 and 1 is 2, and 1 is 3, *to wit*, 3 ten Shillings is 1*l.* 10*s.* set one in the Tens Place, which makes 14, and carry 1 to the Pounds, saying, 1 and 7 is 8, and 2 is 10, set down a Cypher, and carry 1 to the next Place, and then proceed as in whole Numbers, and the Sum is 1410*l.* 14*s.* 5*d.*¾.

More Examples

l.	*s.*	*d.*
79	17	8 ½
27	16	11 ¼
14	19	7 ¾
122	14	3 ½

l.	*s.*	*d.*
167	19	11 ½
76	16	7 ¾
7	14	8 ¾
2	14	3 ½
0	6	4 ½
0	0	6 ½
255	12	6

l.	*s.*	*d.*	*qr.*
2	7	6	1
0	9	7	2
0	7	3	3
0	2	6	2
0	1	7	1
0	9	6	3
0	16	7	1
0	2	10	1
0	1	10	2
0	4	10	1
5	4	4 ¼	

If your Sum in the Pence Row, be very long, you may either point at every 60, which is 5 *s.* otherwise divide it into Parts, and sum up those Parts, and collect their different Sums together, which will be equal to the Whole.

ADDITION of LAND MEASURE.

Example I.

A.	R.	P.
76	1	24
14	2	29
91	0	13

Begin with the Poles, and say, 9 and 4 is 13; set down 3, and carry 1 to 2 which makes 3, and 2 is 5, which as it is in the Tens Place, makes 50, and take 40 out of it for one Rood, because 40 Poles make 1 Rood; and set down the remaining 10 to the 3, makes 13, and 1 that you carry to 2 is 3, and 1 is 4; and as 4 Rood is 1 Acre, set down 0, and carry 1 to the Acres, saying, 1 and 4 is 5, and 6 is 11; set 1 down, and carry 1 to 1 is 2, and 7 is 9; and as it is the last Figure, set it down also; and the Sum is 91 0 13.

More Examples.

A.	R.	P.
37	1	31
14	2	12
3	1	33
55	1	36

A.	R.	P.
967	1	27
74	1	37
8	3	17
1050	3	1

A.	R.	P.
71	2	14
9	1	35
0	3	17
0	1	28
6	3	14
1	2	39

Let to the following Persons, MEADOWING, *viz.*

		A.	R.	P.
To John Tentwell,	—	2	3	14
To James Croft,	—	1	1	27
To Andrew Fielding,	—	4	1	13
To Jacob Cartwell,	—	2	0	34
To Thomas Stubbs,	—	4	1	13
The Amount,		15	0	21

Proof

Proof of ADDITION.

To prove Addition, add your Numbers downwards, contrary to the common Way, carrying as usual, which will prevent Mistakes; if both Ways agree, you are right, otherways not.

The foregoing Examples I hope will be sufficient to perfect the young Learner in Addition of Land Measure: Otherwise, if he chuses to try more Examples, he may set himself some Questions herein, after the same Manner, and in like Form with the preceding, until he is perfect in the same.

SUBTRACTION.

BY SUBTRACTION the Difference of any two Numbers is discovered; the lesser being placed under the greater, and taken therefrom, the Difference will appear.

SUBTRACTION of INTEGERS.

Take Care to place Units under Units, Tens under Tens, &c. and in case of Want in Subtraction, borrow 10, and for every 10 so borrowed, pay, or carry 1 to the next Place.

Example.

	Acres.
From	7969
Take	2797
	5172

To work this Example, begin with the Units, and say, 7 from 9 and there remains 2, set down 2, then 9 from 6 you cannot, and therefore must borrow 10, (as above directed) but 9 from 16 and there remains 7; set down 7 and carry 1; 1 to 7 is 8, 8 from 9 and there remains 1, which set down; and lastly, 2 from 7 and there remains 5; set down 5, and the Difference is 5172.

From	7196	Also from	4790213
Take	2789	Take	2789674
	4407		2000539

SUB-

SUBTRACTION of MONEY.

I shall omit (as I have done in Addition) Subtraction of divers Denominations, (Money and superficial Measurement only excepted) as nothing else have any Connection with the following Treatise.

Subtraction of Money differs very little from that of Integers; only observe to place your Numbers right; Pounds under Pounds, Shillings under Shillings, and Pence un er Pence, &c. you must in case of Want in the Farthings, borrow 4 or 1 Penny, and in the Pence 12, or 1 Shilling, and in the Shillings borrow 20, or 1 Pound: always remembering to pay what you borrow in the next Place, by calling the lower Figure one more than it is.

Note, In Subtraction of Pounds, Shillings, and Pence, proceed as directed in whole Numbers; or when the Subtrahends are less than your uppermost Number, add in your Mind 4 to Farthings, 12 to the Pence, and 20 to the Shillings; and then subtract, but remember to carry 1 from the Farthings to the Pence, from the Pence to Shillings, and from the Shillings to the Pounds.

Otherwise you may perform your Subtractions thus,

Example,

	l.	*s.*	*d.*
Lent,	32	2	$3\frac{1}{4}$
Receiv'd,	17	13	$7\frac{3}{4}$
Remains unpaid,	14	8	$7\frac{1}{2}$

Begin with the Farthings, and say, 3 from 1 I cannot, but 3 from 4 and 1 remains; 1 and 1 is 2, set down 2 or $\frac{1}{2}$, then go to the Pence, and say, 1 that I borrowed and 7 is 8, from 3 I cannot, but 8 from 12 and 4 remains, 4 and 3 is 7, which set down, and carrying 1 to 13 makes 14; 14 from 2 I cannot, but 14 from 20 and 6 remains, 6 and 2 is 8, set down 8 and carry 1 to the Pounds, saying, 1 and 7 is 8 from 2 I cannot, but 8 from 12 and 4 remains, set down 4 and carry 1 to 1 is 2 from 3 and 1 remains; so that the Sum remaining is 14*l.* 8*s.* 7*d.*$\frac{1}{2}$ as appears above.

More Examples,

	l.	s.	d.
From	967	17	9
Take	273	14	8½
Remains	694	3	0½

	l.	s.	d.
From	742	10	0
Take	278	16	2
Remains	463	13	10

	l.	s.	d.
Lent	2762	16	3
Receiv'd	1796	19	7
Remains	965	16	8

	l.	s.	d.
Lent	2700	0	0
Receiv'd	1476	18	6
Remains	1223	1	6

	l.	s.	d.
Borrowed,	27	6	9
	67	16	11
	27	14	8
Sum borrowed,	122	17	4
Paid in Part,	100	0	0
Remains unpaid,	22	17	4
Proof,	100	0	0

	l.	s.	d.
Borrowed,	73	16	8
Paid in Part,	27	19	7½
Remains,	45	17	0½
Proof,	73	16	8

SUBTRACTION of LAND MEASURE.

In Subtraction of Land Measure, in case of want in the Perches, borrow 10 in the Units Place, and 4 in the Tens Place, and in case of want in the Roods, borrow 4, or 1 Acre; and then proceed as you were directed in Integers: Be careful to place (as in Addition) your Figures properly, that is to say, Acres under Acres, Roods under Roods, and Perches under Perches.

Note, In Subtraction of Acres, Roods, and Perches, you may either suppose, or add in your Mind, 4 to the Roods, 40 to Perches, (if the under Numbers or fractional Parts be greater) and

and then ſubtract as you did in Pounds, Shillings, &c. otherwiſe you may proceed as follows.

Examples,

	A.	R.	P.
From	36	3	31
Take	17	1	38
Remains	19	1	33

Begin with the Perches, and ſay, 8 from 1 I cannot, but 8 from 11 and 3 remains; ſet down 3 and carry 1; 1 to 3 is 4; 4 from 3 I cannot, but 4 from 4 and nought remains; ſet down 3 and carry 1 to the Roods, and ſay, 1 and 1 is 2, from 3, and 1 remains, which I ſet down and go to the Acres, and work as you were taught in Subtraction of Integers; there will remain 19 1 33.

Other Examples for Practice.

	A.	R.	P.		A.	R.	P.		A.	R.	P.
From	7	1	13	From	60	0	0	From	2	0	24
Take	3	0	17	Take	17	1	33	Take	1	1	18
Remains	4	0	36	Remains	42	2	7	Remains	0	3	6

Proof of Subtraction.

To prove Subtraction you muſt add the Difference of your Numbers to the leſſer Number; and if the Sum be equal to the Number from which you did ſubtract, your Work is right, elſe not.

More Examples.

	A.	R.	P.		A.	R.	P.
From	71	1	31	From	62	0	10
Take	27	2	14	Take	14	1	16
Remains	43	3	17	Remains	47	2	34
Proof	71	1	31	Proof	62	0	10

The Proof of the above Examples is ſo exceeding eaſy, that any farther Explanation, I think, would be quite unneceſſary.

MULTIPLICATION.

By Multiplication, one Number is increaſed or multiplied by another, as oft as there are Units in either of the Numbers; and all thoſe that would be Land Meaſurers, ought to be exceeding perfect therein; ſince little or nothing can be performed in ſurveying without the Aſſiſtance of this moſt uſeful Rule.

In Multiplication are three Numbers to be particularly noticed.

Firſt, The Multiplicand, or Number to be multiplied.

Secondly, The Multiplier or Number by which we multiply by.

Thirdly, The Product or Number proceeding or produced from both.

In MULTIPLICATION *it holds*,

As 1 : Multiplier : : Multiplicand to the Product.

But e're any Progreſs can be made herein, the Learner muſt be perfectly acquainted with the following Table.

MULTIPLICATION TABLE.

3 Times	3	is	9
	4	—	12
	5	—	15
	6	—	18
	7	—	21
	8	—	24
	9	—	27
4 Times	4	—	16
	5	—	20
	6	—	24
	7	—	28
	8	—	32
	9	—	36
5 Times	5	is	25
	6	—	30
	7	—	35
	8	—	40
	9	—	45
6 Times	6	—	36
	7	—	42
	8	—	48
	9	—	54
7 Times	7	—	49
	8	—	56
	9	—	63
8 Times	8	—	64
	9	—	72
9 Times	9	—	81

To read read the above Table, you muſt begin at the Top, *i. e.*

at

at the Figures 3 and 3, ſaying, 3 times 3 is 9; ſecondly, 3 times 4 is 12, &c. next, 4 times 4 is 16, &c. &c. and laſtly, 9 times 9 is 81.

The foregoing Table contains the Multiplication of the nine Digits, which is ſufficient for our Purpoſe.

Note, When any Number is given to be multiplied by another, ſet down the greater Number uppermoſt, which is call'd the Multiplicand; and under that the Multiplier, in the ſame Order as in Addition, &c. viz. Units under Units, and Tens, &c. then draw a Line under the Numbers, and begin at the Right Hand, and multiply every particular Figure of the Multiplicand, by every Figure ſeverally in the Multiplier.

Example I.

How much is 6 times 369?

369	Multiplicand,
6	Multiplier,
2214	Product.

Here I ſay, 6 times 9 is 54; I ſet down the 4, and carry 5 to the next Place, ſaying, 6 times 6 is 36, and 5 that I carry is 41, the 1 I ſet down and carry 4; and laſtly, 6 times 3 is 18, and 4 makes 22, which, as it is the laſt, I ſet down 22, and the Work is done. So that you ſee in the Example, that 6 times 369 is 2214.

More Examples in Multiplication.

Multiply	373	Alſo,	96734	Alſo,	7967009	
By -	9	By -	8	By —	7	
	3357		773872		55769063	Product.

When the Multiplier conſiſts of more Figures than one, then there muſt be as many ſeveral Products as there are Figures in the Multiplier; being placed in Order under each other, and added together, the Total is the Product required; but always obſerve to place the firſt directly under the Figure you multiply by, and in ſo doing, you move one Place towards the Left Hand in every ſeveral Product, though there were ever ſo many Figures.

Example;

Example,

How much is 32 times 761?

761
32
1522
2283
24352

The Numbers being placed in Order, as above, having drawn a Line under them, begin with the firſt Figure in the Multiplier, namely 2, ſaying, 2 times, or twice 1 is 2, which place under 2; then twice 6 is 12, ſet down 2 and carry 1, and twice 7 is 14, and 1 is 15, which ſet down, you have done with the Figure 2; then proceed to the ſecond Figure in the Multiplier, viz. 3, and multiply all the Figures in the Multiplicand by it alſo; ſaying, 3 times one is 3, which ſet down under the Figure 3 directly, being one Place to the Left Hand; then 3 times 6 is 18, ſet down 8 and carry 1, and 3 times 7 is 21, and 1 is 22, which alſo ſet down, then you have done with this Figure alſo; laſtly, draw a Line under thoſe two Products, then add them together, and their Sum is 24352.

More Examples.

Multiply	708967	Alſo,	73896
By —	697	By	7064
	4962769		295584
	6380703		443376
	4253802		5172720
Anſwer,	494149999		522001344

As I do not intend to write a Treatiſe upon Arithmetic in this Book, ſince the Size thereof will not admit of it, am therefore obliged to be as brief as poſſible in each Rule, until I come to the Branch propoſed, wherein I ſhall be very particular; however, as Multiplication is in general the moſt uſeful Rule, not only in Arithmetic as well as in many Branches of the Mathematics, but

but more particularly in this new Method of Surveying. I shall therefore dwell something longer thereon than I intended, as it behoves every Learner to be exceeding ready therein; and that he may be certain his Work is right, let him be careful to observe the following Directions.

To prove Multiplication.

1. The Method generally used in Schools is performed by the Cross, which every one that hath any Knowledge in Figures will readily grant to be no ways infallible or correct; so that I would not recommend it here; however, I can assure the young Learner, that if any Sum be right, it will appear so by the Cross. Notwithstanding, it makes a Sum often right that is absolutely false; which is owing to the Figure 9 being call'd Nought or Cypher, when the Nines are cast out of the Multiplicand, &c. so that it is not to be relied on for a certain Proof: An Example herein is quite unnecessary.

2. The most sure Way of proving Multiplication is by Division, viz. the Product divided by the Multiplier quotes the Multiplicand; but we are not come to that yet.

3dly. There is another Way very correct, but rather too tedious, namely, the Multiplier being multiplied by the Multiplicand, if the Product be the same Figures as before, it is right, otherways not.

Example.

Let it be required to multiply 736 by 72 both Ways.

736	72
72	736
1472	432
5152	216
	504
52992 Product.	52992 Product as before.

The Learner may perceive by the foregoing Example, that this Way of proving Multiplication is very perfect or just; but as I think it too troublesome as well as prolix, I shall here shew him another less tedious Method, that will answer the same End: When the Multiplier and Multiplicand consist of more Figures each

than

than one, let him caſt the Nines out of the Multiplicand, and ſet down the Remainder apart, and multiply it by the firſt Figure in the Multiplier (that ſtands in the Units Place) caſt the Nines out of the Product, and ſet apart the Remainder; then caſt the Nines out of the firſt Line in the Products, and ſee if the Remainder agree with the former; if not, it is moſt certainly wrong: Perhaps you'll ſay, though it did agree it may notwithſtanding be ſtill wrong, I'll grant it, but if ſo, that will appear when the Nines are caſt out of the Sum of all the Products collected at the Bottom; you muſt proceed in like Manner with the ſecond Line in the Products, caſting the Nines out as before, and alſo multiplying the Figure remaining in the Multiplicand (firſt ſet apart) by the ſecond Figure in the Multiplier, and when the Nines are caſt out of the ſecond Line of the Products, the Remainder muſt agree as before, otherways it is alſo wrong. Thus you muſt proceed with every Figure in the Multiplier reſpectively, and if there be Errors committed in the Multiplication, this Method will undoubtedly diſcover it; but be careful in adding your Numbers together, and you may depend upon the Reſult to be right. A few Examples will render it eaſy.

Examples.

remains.

Multiply 7367——5 Again, 5 Again, 5
By 384 by 4 By 8 3

29468—2 20—9's=2 40—9's=4 15—9's=6
58936—4
22101—6

2828928

When the Nines are caſt out of the Multiplicand, there remains 5 and when they are caſt out of the Multiplier there remains 6

30—the 9's=3

The Nines caſt out, there remains 3, which proves the Work.

To

To prove the foregoing Example, caſt the Nines out of the Multiplicand thus, 7 and 3 is 10, all above 9 is 1, otherwiſe ſay 7 and 3 is 10, 1 and 6 is 7, and 7 is 14; ſet down 5 apart, and multiply it by the firſt Figure in the Multiplier, namely, 4; ſaying 4 times 5 is 20; the Nines caſt out reſts 2: then caſt the Nines out of the firſt Line in the Products, viz. 29468, ſaying, 2 and 4 is 6, and 6 is 12, 3 and 8 is 11, all above 9 is 2, which agrees with the former.

Secondly, multiply the ſecond Figure in the Multiplier, viz. 8 by 5=40, or 4 when the Nines are caſt out, and caſt the Nines out of the ſecond Line in the Products, viz. 58936, ſaying, 5 and 8 is 13, 4 and 3 is 7, and 6 is 13, 4 which alſo agrees with the former.

Thirdly, multiply the third Figure in the Multiplier by the ſame 5 which remained, when the Nines were caſt out of the Multiplicand, and ſaying, 3 times 5 is 15, 6; then caſt the Nines out of the third Line in the Products, viz. 22101, ſaying, 2 and 2 is 4, and 1 is 5, and 1 is 6, which likewiſe agrees with the former 6.

Laſtly, caſt the Nines out of the Multiplier 384, and there remains 6, which multiply by the ſame 5, and caſting the Nines out of their Product, viz. 30, there remains 3; then caſt the Nines out of the Products collected at the Bottom, and there alſo remains 3, which proves the Work.

When the Learner is ready in this Way of proving his Multiplications, he may do it as faſt almoſt as Thought, with as much Correctneſs as if he made uſe of Diviſion; there will be no Occaſion to ſet down any Figure, except the Figure that remained when the Nines were caſt out of the Multiplicand; and then proceed, as is directed in the following Examples:

Multiply	3246—the Nines, 6 remains.	
By	234—ditto———0 ditto.	
	0	
	12984—6 right.	
	9738 ditto	See the Remainders ſumm'd
	6492——3 ditto.	up make 9, nothing.
	759564 0 ditto.	

More Examples.

Multiply	71362—1		Also	9007—7	7
	2876—5		By	1030—4	4
	428172			270210 right.	28—1
	499534			90070 ditto.	
	570896			9277210 ditto—1	
	142724				
	205237112	ditto.			

The Learner may see by the foregoing Examples, that a Dash or Point with a Pen may do as well as Figures; and if he finds that any Line in the Products disagree with the foregoing Directions, he must strictly examine the same until he discovers the Mistake.

Note, If you were to cast the Nines out of any Numbers, as 38 or 76, &c. you must not say how often 9 in 38, or in 76, but say, 3 and 8 is 11,—2; or 7 and 6 is 13,—4.

Note also, When the Nines are cast out of the Multiplicand, or out of the Multiplier, and nought should remain in either, consequently there will remain nothing when the Nines are cast out of the Product; also for this sufficient Reason; If you multiply nothing by something, or something by nothing, the Product of Course must be nothing also.

And lastly, I shall shew by Multiplication a ready Way of answering numberless Questions, that frequently occur in Surveying, &c. When the Price of a Perch, Rood, or Acre, is given, by this Rule you may know how to find the Value of many such Things at that Rate; which shews that Questions in the Rule of Three may be performed in a much more concise Manner, and by such easy Rules and Directions, that any one who understands Addition of Money, may as readily cast up by this Way, as work a Sum of Pounds, Shillings, and Pence; for there is nothing more required here, than to carry from one Demonination to the next; it may therefore be truly affirm'd, that this Rule performs the Work of many Additions.

Example,

Example.

What would 5 Perches of Potatoe Ground come to, at 1*s.* 3*d.* per Perch?——See the Work:

s.	*d.*
1	3
	5
6	3

The Rule. Multiply the Price by the Quantity, and the Product is the Anſwer.

In the above Queſtion ſay, 5 times 3 is 15, that is 15 Pence, or 1*s.* 3*d.* ſet down 3 Pence, and carry 1 to the next, ſaying, 5 times 1 is 5, and 1 you carry is 6, ſet down 6 alſo, which makes 6*s.* 3*d.* the Anſwer.

More Examples.

What does 9 Perches come to at 1*s.* 10*d.* Alſo 8 Perches at 2*s.* 2$\frac{1}{2}$*d.*?

See the Work.

	s.	*d.*
	1	10
		9
Anſwer,	16	6

See the Work.

	s.	*d.*
	2	2$\frac{1}{2}$
		8
Anſwer,	17	8

What does 10 Perches at 1*s.* 1$\frac{1}{2}$*d.*? And alſo 7 of any Thing elſe, at 3*s.* 11*d.* each?

	s.	*d.*
	1	1$\frac{1}{2}$
		10
Anſwer,	11	3

	l.	*s.*	*d.*
	0	3	11
			7
Anſwer,	1	7	5

If 1 Acre is let for 1*l.* 2*s.* 6*d.* what will 5 Acres amount to at that Rate.

	l.	*s.*	*d.*
	1	2	6
			5
Anſwer,	5	12	6

If 1 Acre of Land be ſet for 18*s.* 4*d.* What will 8 Acres come to at that Rate?

	l.	*s.*	*d.*
	0	18	4
			8
	7	6	8

Here ſet down the Figures in Order, as before, and ſay, 8 times 4 is 32 Pence, or 2*s.* 8*d.* ſet down the 8 and carry 2 to the next Place, namely, the Shillings, ſaying, 8 times 8 is 64, and 2 makes 66; ſet down 6 and carry 6 for the 60, or 6 Tens, and ſay, 8 times 1 is 8, and 6 is 14, that is 14 Tens or Angels; then take the half of 14 (becauſe 2 Angels make 1 Pound) viz. 7, and ſet it down in the Pounds Place.

But if the Sum of the Angels had been an odd Number, as ſuppoſe 15, then you muſt take half as before, and ſet down the odd 1, ſaying the half of 15 is 7, which ſet in the Place of Pounds, and the odd Angel or 10 Shillings, ſet in the Place of Shillings, ſo that inſtead of 7*l.* 6*s.* 8*d.* it would become 7*l.* 16*s.* 8*d.*

If 1 Acre of Land be ſet for 1*l.* 13*s.* 8*d.* What will 12 Acres amount to at that Rate?

	l.	*s.*	*d.*
	1	13	8
			12
Anſwer,	20	4	0

If 1 Acre of Land coſts 36*l.* 17*s.* 2*d.* What will 8 Acres coſt at the ſame Rate?

	36	17	2
			8
Anſwer,	294	17	4

Here Note, That when the given Quantity exceeds 12, you muſt find what two Numbers, multiplied by each other, will make the ſame, and then multiply the Rate by one of thoſe Numbers, and that Product by the other, and the laſt Number is the Anſwer.

Example,

Example.

What will 24 Poles of Land come to, at 2*s.* 5*d.* per Pole?

See the Work both Ways,

	l.	*s.*	*d.*		*l.*	*s.*	*d*
	0	2	5	Or thus,	0	2	5
3 times 8 or 4 times 6 is 24.			3				4
	0	7	3		0	9	8
			8				6
Anſwer,	2	18	0	Anſwer,	2	18	0

If 1 Acre of Land be let for 19*s.* 8*d.* What will 42½ Acres come to at that Rate?

In this Example 6 times 7 is 42, which Numbers being ſeverally multiplied by 19*s.* 8*d.* viz. firſt by 6, the Product is 5*l.* 18*s.* which being multiplied by 7, the Product is 41*l.* 6*s.* to which add, 9*s.* 10*d.* the Value of half an Acre, and the Sum gives the Anſwer, viz. 41*l.* 15*s.* 10*d.*

	l.	*s.*	*d.*
	0	19	8
6 times 7 is 42			6
	5	18	0
			7
	41	6	0
Half an Acre comes to	0	9	10
Anſwer,	41	15	10

If 1 Acre of Land ſet for 21*s.* 6*d.* what will 24 Acres, 2 Roods, and 20 Perches come to?

In this Example put down 21*s.* 6*d.* thus, 1*l.* 1*s.* 6*d.* and multiply it by 4, and that Product by 6, becauſe 6 times 4 is 24, equal to the Number of Acres propoſed.

	l.	*s.*	*d.*
	1	1	6
			4
	4	6	0
			6
	25	16	0
Half an Acre,	0	10	9
20 Perches,	0	2	8¼
Anſwer,	26	9	5¼

But

But there ſtill remains unvalued, 2 Roods, 20 Perches, which you may thus find:

Firſt, Two Roods being half an Acre, for which take the half of 21*s.* 6*d.* equal to 10*s.* 9*d.* and place it under 25*l.* 16*s.* as above.

Secondly, 20 Poles being the 4th Part of two Roods, take alſo the 4th Part of 10*s.* 9*d.* equal to 2*s.* 8*d* ¼, which you muſt alſo place under 10*s.* 9*d.* then add your Numbers together, and their Sum makes 26*l.* 9*s.* 5*d.* ¼, the Value of 24 Acres, 2 Roods, and 20 Perches.

Note, By the Help of the Golden Rule you may find the Value of any Number of Perches or Roods, when the Value of an Acre be given, &c. which ſee.

DIVISION.

FIRST, Diviſion is a Rule, by which we diſcover how often one Number is contain'd in another; as if it were aſked how often 6 is contain'd in 24, the Anſwer would be 4 Times.

Secondly, This Rule conſiſts of four Parts, three certain, and one uncertain, viz.

1. The Dividend, or Number to be divided.
2. The Diviſor, or Number given to divide by.
3. The Quotient, or Number ariſing from the two former, which ſhews how often the Diviſor is contained in the Dividend.
4. The Remainder (after the Work is done) is always of the ſame Quality with the Dividend, and muſt be leſs than the Diviſor, elſe the Work is wrong.

Thirdly, Diviſion is either ſingle or compound; ſingle when the Diviſor conſiſts of 1 Figure only, and the Dividend of two or more; this Kind is performed by the Multiplication Table;

as

as if 48 was to be divided by 6, the Anſwer would be 8; here 48 is the Dividend; 6 the Diviſor; and 8 the Quotient.

Fourthly, Compound Diviſion is when both the Diviſor and Dividend conſiſt of more Places than one, as if 160 (the Perches in an Acre) were to be divided by 6, then 160 is the Dividend, 6 the Diviſor, and 10 the Quotient.

See the Work.

Diviſor, Dividend, Quotient,
6) 160 (10
16

0

A General RULE *to work Queſtions by,*

Obſerve well, { 1ſt. Seek, 2d. Multiply, 3d. Subtract.

You ſee that this Rule comprehends three of the foregoing, and is allowed to be the hardeſt of the five; however I ſhall endeavour to make it appear as eaſy as poſſible, by ſeveral Examples.

Example I.

Divide 3489 by 4. Firſt, place your Numbers as in the laſt Example,

Thus, 4)3489(872
32..

28
28

..9
8

1 remains.

Here

Here seek how many Times 4, the Divisor, is contained in 34, the first two Figures in the Dividend, (for you cannot get 4 in 3, the first Figure,) and you'll find it to be 8 times; place 8 in the Quotient, saying, 8 times 4 is 32, which being set under 34, subtract 32 there from 34, or 2 from 4 and there rests 2. Secondly, bring down the next Figure in the Dividend, namely, 8, and place it to the right of the 2 remaining, which makes 28; then seek how many Times 4 in 28, answer 7, which place in the Quotient, and say, 7 times 4 is 28, set down 28 under 28, and then subtract as before, saying, 8 from 8 and nought remains, 2 from 2 nothing also remains, for which make two Points. Lastly, bring down the 3d or last Figure in the Dividend, and seek how often the Divisor 4 in 9, the Answer is 2, which set down in the Quotient, saying, twice 4 is 8, which being set under 9, subtract 8 from 9, there remains 1, and the Work is done, as appears by the Example; wherein you find that 4 is contain'd in 3489 just 872 Times, and only 1 remaining.

Example II.

Let it be required to divide 8467 Acres of Land among 7 Men equally.

See the Work.

```
7)8463(1209 Answer. Each Man must have 1209 Acres.
  7···                                       7
  ----                                    ----
  14                         Proof —— 8463
  14
  ----
  ·63
  ·63
  ----
    o
```

Note, There is another Method of dividing by a single Figure, commonly called, *Short Division*; which is much readier, and performs the Work with less Trouble than the above: For Instance,

Suppose

Suppose the preceding Example was to be performed by this Method, the Figures being placed as before, *viz.*

7)8463

1209 Anſwer.

Here ſee how often 7 in 8, and you'll find it 1, which ſet down, and ſay 7 from 8 and 1 remains, which is 10 in the next Place, and 4 makes 14, how oft 7 in 14, two Times, which alſo ſet down, ſaying 14 from 14, and there remains Nothing; then proceed to the next Figure in the Dividend, *viz.* 6, and ſay how oft 7 in 6, nought Times, ſet down 0 and carry 6, which, in the next Place, is 60, and 3 makes 63; and then ſay, how oft 7 in 63, 9 Times, which being placed, ſay 9 Times 7 is 63; 63 from 63, and there remains Nothing; thus the Work is done with leſs Figures than before.

Note, When any Number of Figures are to be divided by a ſingle Figure, as above, always remember, that every 1 remaining is 10 in the next Place.

Example III.

Divide 16344 by 9

See the Work.

9)16344

1816 Anſwer.

Example IV.

8)71964

Anſwer 8995——4 remains.

To prove Diviſion.

Diviſion is commonly proved by Multiplication, *viz.* The Quotient being multiplied by the Diviſor, the Product is the Dividend if it be right: But obſerve, when there is a Remainder, you muſt take it in, or add it to the Product.

Example V.

4)169674267426

Anſwer 42418566856 — 2 remains.
4 Diviſor.

Proof 169674267426

Example VI.

5)6496747673

Anſwer 1299349534 — 3 remains.
5 the Diviſor.

Proof 6496747673

When the Diviſor conſiſts of ſeveral Figures, then ariſes all the Difficulty that there is in Diviſion. I could wiſh that the Size of this Book would permit me to remove every trifling Obſtacle that may occur in the Work of Diviſion; notwithſtanding I ſhall be particular in giving or ſhewing plain and eaſy Directions, in a little Compaſs, ſufficient to comprehend or ſurmount all ſeeming Difficulties.

Example VII.

Let it be required to divide 769420 by 365.

See the following Work.

Having placed your Numbers as in the Work, make a Point under the 9, the third Figure in the Dividend, becauſe you cannot get 365 in the firſt or ſecond Figures thereof.

365)769420(2108

730

394
365

2920
2920

Then

Then see how oft the first Figure in your Divisor is contained in 7, the first Figure in the Dividend; the Answer is two Times; then put 2 in the Quotient, and multiplying the Divisor thereby, the Product is 730, which place under 769, then subtract, and the Remainder is 39; point and bring down the next Figure (of your Dividend) 4, then say how oft 3 in 3, that is to say, how oft 365 in the new Dividend, *viz.* 394, Answer once; place 1 in the Quotient, and multiply your Divisor thereby, saying, once 5 is 5, once 6 is 6, and once 3 is 3, which you must place under 394, and subtract as before, *viz.* 365 from 394, and there remains 29, to which point and bring down your next Figure in the Dividend, to wit, 2, and see how oft your Divisor 365 in 292, or how oft 3 in 2, Answer 0 Times; then, to this new Dividend, as it is less than the Divisor, you must bring down another Figure of your Dividend, namely the last, to wit, 0, saying how oft 365 in 2920, or how oft 3, the first Figure, in 29, the two first Figures in the new Dividend, the Answer will be 9, because 9 Times 3 is 27, but then 9 Times 365 is 3285, which you cannot take from 2920, therefore you must try a less Figure. Suppose 8 before you proceed further, multiply (in your Mind) the second Figure in your Divisor by 8, or any other likely Figure, and by so doing you will find how many you will have to carry to the first Figure in the Divisor; thus, 8 Times 6 is 48, so that you can have no less than 4 to carry to the next or first Figure; then 8 Times 3 is 24, and 4 makes 28, which is less than 29, therefore you will get it 8 Times, which you place in your Quotient, then multiply the Divisor by this last Figure, namely 8, and the Product is 2920, which place under 2920, subtract as before and there rests 0, and your Work is finished, so that your Quotient is found to be 2108. This Question is the same as if one should ask in 769420 Days, how many Years?

Example VIII.

Let it be required to divide 1769479241 by 6789.

See the Work.

6789)176947241(25916

13578
―――――
40167
33945
―――――
62222
61101
―――――
11214
6789
―――――
44251
40734
―――――
3517

The Manner of working this Example being the same as the last, I shall omit the Explication thereof; for the Operation by two or three Figures, being well understood, the Work in any other will be easy. In this Example, after the Division is finished, you see there is a Remainder of 3517, which is the Numerator of a Fraction, and the Divisor is a Denominator thereunto, so that the right or exact Quotient is 25916 $\frac{3517}{6789}$, but as we shall have no Manner of Occasion for Vulgar Fractions in this Treatise, I shall therefore forbear saying any thing concerning the Value thereof.

Note, That after any Subtraction, the Remainder must always be less than the Divisor, otherways the Work is most certainly wrong, as already observed, and must be rectified (before you can proceed farther) by increasing the last-found Figure in the Quotient until the Remainder be less.

Note also, You must never bring down, from the Dividend, more than one Figure at a Time, and for every Figure so brought down, you must place or put a Figure or Cypher in the Quotient.

Of

Of Contractions in Division.

First, When your Divisor is an Unit with any Number of Cyphers annexed, separate or cut from your Dividend the same Number of Places to the Right-hand, the Remainder will be the Quotient, and those cut off will be a Decimal Fraction; so if 46769 Acres were to be divided equally amongst ten Men, every Man's Share would be 4676 Acres and nine Tenths of an Acre: if among 100 Men, every Man's Part would be 467 Acres and the sixty-ninth Part of an Acre, which Fraction is equal to 2 Roods, 30 Perches and nearly a Half.

Secondly, When your Dividend and Divisor also consists of Cyphers to the Right hand, cut off an equal Number thereof from each, and proceed with the Remainder according to the Rules before given; so if 636000 were to be divided by 4000, cut off three Cyphers in each, $\frac{1}{4}$ Part of the Remainder, to wit, 159, is the Quotient sought.

Thirdly, If your Divisor has Cyphers annexed, and your Dividend none, cut off as many Figures from your Dividend as there are Cyphers in your Divisors; with the Remainder proceed as before.

As if 46498 were to be divided by 800, the Quotient would be 58. $\frac{98}{800}$.

See the Work.

8|00)464|98

58 $\frac{98}{800}$

I might, in this Place, amuse the Learner with sundry other Remarks in Contractions, but I can assure him that those already delivered, are sufficiently edifying for our Purpose.

REDUCTION.

REDUCTION.

REDUCTION is intirely performed by Multiplication and Division, and teaches how to change Numbers of one Denomination to another without the least Alteration of Value,

And consists of two Parts, *viz.* ascending and descending.

First, Reduction descending is performed by Multiplication, as if it were required to reduce or bring Pounds into Shillings or Pence, &c.

Secondly, Reduction ascending, is performed by Division, and brings Farthings to Pence, Shillings to Pounds, &c. also Perches to Roods or Acres.

Of these in their Order.

Question I.

In 10 l. how many Shillings, Pence and Farthings?

£.	
10	
20	Shillings make a Pound.
200	Shillings — Answer.
12	Pence in a Shilling.
2400	Pence — Answer.
4	Farthings make one Penny.
9600	Farthings — Answer.

In the above Question it is required to bring Pounds into Shillings, Pence, and Farthings, accordingly it is performed by Reduction descending, or Multiplication. So that you multiply 10 l. by 20, the Shillings in a Pound, and the Product is the Shillings in 10 l. Then multiply those Shillings by 12, the Pence in 1 Shilling, and the Product is the Pence in 10 l. and lastly, multiply thofe by 4, the Farthings in a Penny, and the Product is the Farthings in 10 l. and the Anfwer to the Queftion, as may be feen by the preceding Work.

By the above Method, all Kinds of Reduction defcending is performed, that is, from great Denominations to leffer, whether it be Money, Weight, or Meafure.

Queftion II.

In 96 l. 17 s. 6 d. how many Pence?

See the Work.

	l.	s.	d.
	96	17	6
	20		
	1937		
	12		
Anfwer	23250	Pence.	

In the foregoing Queftion multiplv 96, the given Pounds, by 20, in order to bring them into Shillings, and then take in the 17 Shillings. which makes 1937 Shillings, which multiply by 12, and take in the 6, and the Product is 23250, which is the Pence in 96l. 17s. 6d. and the Anfwer to the Queftion.

Queftion III.

In 841 Acres of Land, how many Perches? Anf. 134560.

See the Work.

	841	
	4	Roods in an Acre.
	3364	Roods in 841 Acres.
	40	
Anfwer	134560	Perches.

Queftion

Question IV.

A. R. P.
In 145 3 17, how many Perches? Answer 23337.

See the Work.

```
 A.  R. P.
 145 3 17
   4
 ----
 583
  40
 -----
Answer 23337 Perches.
```

The two last Questions are so exceeding easy, that I think any other Explications are quite unnecessary, since all such Questions are reduced in like Manner.

REDUCTION Ascending.

Reduction ascending, is when a lesser Denomination is brought into a greater; as Farthings to Pounds, Perches to Acres, *&c.* as before-mentioned.

Question I.

In 134560 Perches, how many Acres?

See the Work.

```
4|0)13456|0
   --------
  4) 3364
     ----
Answer 841 Acres.
```

In this Question you divide 134560 Perches by 40, because 40 Perches make 1 Rood; and the Quotient is 3364, which divide by 4, because 4 Roods make 1 Acre, and the Quotient is 841 Acres, the Answer to the Question.

Question

Question II.

In 23337 Perches, how many Acres?

See the Work.

4|0)2333|7

4)583 17

Anſwer 145 3 17 Acres, Roods and Perches.

Question III.

In 9600 Farthings, how many Pounds?

See the Work.

4)9600

12)2400

2|0) 20|0

Anſwer 10 Pounds.

Question IV.

In 23250 Pence, how many Shillings and Pounds?

See the Work.

12)23250

2|0)193|7 6 Shillings, Anſwer.

Anſwer 96 17 6

Question V.

In 9476942 Halfpence, how many Pounds?

See the Work.

2)9476942
12)4738471
2|0)39487|2 7

Anſwer 19743l. 12s. 7d.

Let it be required to prove the above Queſtion.

19743l. 12s. 7d.
20
394872
12
4738471
2

Proof 9476942 as appears above.

Note, By the laſt Operation, the Learner may ſee, that to prove the Work in aſcending, he muſt uſe Multiplication, that is, multiply by what he divided by; and in Queſtions deſcending, divide by what he multiplied by, and it will prove the Work if right.

In

A. R. P.
In 96 1 17 Statue Measure, how many Acres of Cheshire, and also Plantation Measure?

64 Square Yards in 1 Cheshire Pole, and 49 Square Yards in 1 Plantation Pole, as observed in the Introduction.

```
     96 1 17
      4
    -----
    385
     40
    -----
  15417  Poles.
  30.25  Square Yards in a Pole.
  -----
  77085
 30834
46251
---------
466364.25  Square Yards.

49)466364.25      40)95176
   441...           --------
   ---              4)237 37½
    253             ---------
    245              59 1 37½
    ---
     86
     49
     ---
     374
     343
     ---
      312
      294
      ---
       18
```


64)

```
                   40)
64)466364.25     (72816.95
   448           ---------
   ---         4)182 6.95
    183          ---------
    128           45 2 6¾ Answer, Cheshire Measure.
    ---
    556
    512
    ---
     444
     384
     ---
      602
      566
      ---
       365
       320
       ---
        45
```

Answer 96 1 17 Statute Measure, is equal

to { 45 2. 6¾ Cheshire, / 59 1 37½ Plantation } Measure.

Note, The Learner may pass over the above Question until he learns Multiplication of Decimals.

The GOLDEN RULE.

IT is commonly called the *Rule of Three*, because there are always three Numbers given to find a fourth, which must bear such Proportion to the third, as the second does to the first.

The greatest Difficulty lies in stating the Question, but that you may do by observing the following Rule:

The

The Golden Rule hath always Numbers three,
First and third must in their Names agree;
The Middle Number hath another Name,
Like the Demand must ever be the same:
Two of those Numbers, when multiplied true,
The third divides, and quotes the Answer too.

Question I.

If 3 Acres of Land cost 42s. per Ann. what will 24 Acres come to at that Rates?

A. S. A.
Thus stated: If 3 : 42 : 24

Here you see the first and third Numbers are Acres, and the middle Number Shillings. Now, to know whether the first or third Number must be the Divisor, observe this Rule.

When the third Number requires more than the first, the less Extreme must be the Divisor.

But when the third Number requires less, the greater Extreme must be the Divisor.

Note, The first and third Numbers are called Extremes.

See the Work of the foregoing Question.

A. S.
If 3 : 42 : : 24
24
———
168
84
———
3)1008
2|0)33(6 Shillings.
———
16l. 16s. 0d. Answer.

Having stated the Question as above, you may readily perceive, that the third Number requires more than the first; and consequently the less Extreme must be the Divisor; therefore multiply 42, the middle Number, by 24, the last Number, and the Product is 1008, which divide by the less Extreme, namely 3, and the Quotient is 336 Shillings, equal to 16l. 16s. 0d. the Answer.

Question

Note, Before you can state any such like Question as the foregoing, your Numbers must be reduced severally to the lowest Denomination, namely, Acres to Perches, and Pounds, *&c.* to Pence, as above.

See the Work.

```
     P.     D.     P.
If 5897 : 6412 : 160
              160
           ------
           384720
             6412
           ------                    d.    s. d.
5897)1025920(173 + 1 = 174 = 14 6
           5897
           -----
           43622
           41279
           -----
            23430
            17631
            -----
             5739 Remainder.
              158 Remainder in Question III.
             -----
Add      5897)5897(1
           5897
           ----
           ...
```

These Questions are, by most Authors, esteemed to be in the Rule of Three Direct, but as I have given a general Rule to find the Divisor in all Cases throughout the Golden Rule, I therefore think there is no Necessity to amuse and confound the Learner with such needless Distinctions between the Rule of Three Direct, and Inverse. In the above Question, say, If 5897 P. require 6412 Pence, how many Pence would 160 Perches require or get? It is reasonable to conclude that 160, will get less than 5897, and consequently, by the general Rule, the greater Extreme, *viz.* 5897 must be the Divisor; so that you must multiply the middle Number by the less Extreme, divide by the greater, and the Answer is 4, as in the Work.

Question

Question V.

If 32 Yards of Cloth cost 4 l. 2 s. 2 d. what would $4\frac{1}{2}$ Yards come to?

First, Prepare your Numbers for the Station thus:

32 Yards.	l.	d.	d.	Yds.
2	4	2	2	$4\frac{1}{2}$
——	20			2
64 half Yards.	——			——
	82			9
	12			
	——			
	986			

$\frac{1}{2}$ Yds. D. $\frac{1}{2}$ Yds.
Then, If 64 : 986 : : 9
9

64)8874(138 Pence = 11 s. 6 d. $\frac{1}{2}$ $\frac{24}{64}$ Anf.
64..
——
247
192
——
554
512
——
42 remains.
4
——
168
128
——
40

The RULE of FELLOWSHIP.

THE Rule of Fellowship not only concerns Merchants and other Traders, but likewise is very useful for Land-holders, &c. When Commoning, or other Lands are to be divided amongst a certain Number of Gentlemen or others, every one's Proportion thereof must be according to his Estate, Purchase, or Rent, and must be so divided by the Surveyor.

Fellowship is divided into two Parts, commonly called Single and Double; the latter we have no Occasion for here.

First, In single Fellowship, having the Rent of a Parcel of Town-field Land, and each Man's respective Share therein, to know their Rents severally, observe these general Rules.

Rule I.

First, As the Contents of the Land (whether rented, purchased, &c.) is to the whole Rent or Purchase, &c. So is each Man's appointed Share to his respective Rent or Purchase, &c.

Rule II.

Secondly, When Land is rented or purchased by two or more Persons, each one paying a certain Sum, to know their respective Shares of the said Land, observe,

As the whole Rent or Purchase is to the Contents of the Land, so is each Man's Rent, or Purchase, to his respective Share of the Land.

Question I.

Two Men, A. and B. Rent a Farm containing 180 Acres, at 60 l. per Annum, of which A must pay 25 l. and B. 35 l. they are resolved to divide the same according to their Rents, I demand each Man's Dividend, or Proportion.

See

See the Work.

```
         £.   £.    A.       £.
A's Rent 25 as 60 : 180 : : 25
B's ditto 35         25
          --        ---                 £.    A.       £.
          60        900              As 60 : 180 : : 35
                   360                           35
                   ----                         ---
               6|0)450|0                        900
                   ----                        540
                    75                         ----
                                           6|0)630|0
                                               ----
                                               105
```

Anſwer, A's Dividend is 75 Acres.
B's ditto — 105

Proof — 180

Question II.

Three Graziers, *viz.* A, B, and C, rent an Eſtate containing 292 Acres, 3 Roods, 17 Perches, at 200 l. per Annum, of which A pays 60 l. B 65 l. and C 75 l. they have agreed that the Eſtate ſhall be divided in Proportion to their Rents, I demand each Man's Dividend or Proportion.

See the Work.

	£.
A's Rent	60
B's ditto	65
C's ditto	75
	200

£. P. £.
As 200 : 46857 : 60
60

200)2811420(14057.1
200 ....

811
800

1142
1000

1420
1400

200
200

A.	R.	P.
292 :	3 :	17

4

1171
40

46857

£. P. £.
As 200 : 46857 : : 65
65

234285
281142

200)3045705(15228.525
200 ....

1045
1000

457
400

570
400

1705
1600

105 remains, equal to .525 in decimal Fractions.

$$\begin{array}{rl} & \text{£.} \quad \text{P.} \quad \text{£.} \\ \text{As } 200 : 46857 :: 75 & \\ 75 & \\ \hline 234285 & \\ 327999 & \\ \hline 200)3514275(17571.375 & \\ 200 & \\ \hline 1514 & \\ 1400 & \\ \hline 1142 & \\ 1000 & \\ \hline 1427 & \\ 1400 & \\ \hline 0275 & \\ 200 & \\ \hline 75 & \end{array}$$

		Perches.		A.	R.	P.
Answer,	A's Dividend	14057.1	=	87	3	17
	B's ditto —	15228.525	=	95	0	28
	C's ditto —	17571.375	=	109	3	11
	Proof	46857	=	292	4	16
	The Remainders come to					.1
			Proof	292	3	17

The Learner may see by the Work of the foregoing Question, that single Fellowship differs very little from the Single Rule of Three.

Note, In the above Question I have omitted the fractional Parts of a Perch in each Man's Quantity.

Question

Question III.

Three Men, *viz.* Joseph, John, and James, rent an Estate containing 360 Acres, at 240 l. per Annum, of which Joseph holds 90, John 120, and James 150 Acres; each Man to pay Rent in Proportion to his Holding, I demand each Man's respective Rent?

See the Work.

	A.
Joseph's Holding	90
John's ditto —	120
James's ditto —	150
	360

A. Rent. A.
As 360 : 240 : : 90
90
360)21600(60 l. Joseph's Rent.
2160
. . . 0

A. Rent. A.
As 360 : 240 : : 120
120
360)28800(80 l. John's Rent.
2880
. . . 0

A. Rent. A.
As 360 : 240 : : 150
150
12000
2400
360)36000(100
360
. . . 00

Answer, Joseph's Rent is 60 l.
John's ditto — 80
James's ditto - 100

Proof 240

Decimal

Decimal ARITHMETIC.

NUMERATION.

A Decimal Fraction is such, whose Denominator is not expressed but understood; and is an Unit with as many Cyphers annexed, as there are Places in the Numerator; so that $\frac{5}{10}$ will be expressed thus .5; also $\frac{1}{4}$ or $\frac{25}{100}$ thus .25, and $\frac{3}{4}$ or $\frac{75}{100}$ thus .75, &c. And in order to distinguish Decimals from Integers, or whole Numbers, they have always a Point (like a Period) prefixed before them.

Note 1, A Cypher placed to the Left-hand of an Integer, or to the Right-hand of a Decimal, neither increaseth nor decreaseth the Value thereof; but placed to the Right-hand of an Integer, and to the Left-hand of a Decimal, it increaseth and decreaseth the same in a ten-fold Proportion; that is to say, it increaseth the Integer, and decreaseth the Decimal; which appears in the following Table:

Integers.			Decimals.
Five — —	5 .	5 —	Five Tenths
Fifty — —	50 .	05	Five of a Hundred
Five Hundred	500 .	005	Five of a Thousand
Five Thousand	5000 .	0005	Five of ten Thousand.

By this Table you may perceive how a Cypher before a Decimal decreaseth the Value, &c.

2. A Cypher before an Integer, and after a Decimal, is of no Value, since 03. Integers is but 3. and .30 in Decimals, is but .3 &c.

The

The TABLE.

9	Hundred of Millions.
8	Tens of Millions.
7	Millions.
6	Hundreds of Thousands.
5	Tens of Thousands.
4	Thousands.
3	Hundreds.
2	Tens.
1	Units.
.	
1	Part of Ten.
2	Parts of 100
3	Parts of 1000
4	Parts of 10,000
5	Parts of 100,000
6	Parts of 1,000000
7	Parts of 10 000,000
8	Parts of 100 000,000
9	Parts of 10,000,0000.

Integers. . Decimals.

By the Help of the above Table, the Learner may make himſelf acquainted with, and alſo know how to expreſs the Value of a decimal Fraction.

Example.

Suppoſe it were required to expreſs the decimal Fraction .02307, I begin to numerate as in whole Numbers, ſaying, Units, Tens, Hundreds, Thouſands, Tens of Thouſands, the next Riſe, or Step, would be Hundreds of Thouſands; and therefore the expreſs Value of the above Decimal is two Thouſand three Hundred and ſeven of a hundred Thouſand.

I ſhall (though contrary to moſt Authors) proceed in Decimals as in whole Numbers, being determined not to confound the Learner with unneceſſary Queſtions.

ADDITION in Decimals.

ADdition of Decimals is performed like Addition of whole Numbers, but be careful to place Units under Units, &c. and the Parts of Ten in the tenth's Place, the Parts of a Hundred in the hundredth's Place, &c.

Example.

Example I. *and* II.

To .769, add .47367,

Your Numbers placed thus: $\left\{\begin{array}{r}.769\\.47367\end{array}\right.$

Anſwer, the Sum is 1.24267

Alſo, to 33.6347, add the following Numbers *viz.*

7.3 x .963 x 176.9

Place your Numbers thus:

33.6347
7.3000
.9630
176.9000

The Sum will be 218.7977

Note, You may prefix Cyphers, at Pleaſure, to the Right hand of your Decimals, as they neither increaſe nor decreaſe the Value thereof, which will prevent Miſtakes in your Addition, &c.

Example III.

Let it be required to add the following Numbers together, *viz.* 7.9674 x 4 of a Hundred x .76 of a Million, and 174 of a hundred Millions.

Place your Numbers thus:

7.96740000
.04000000
.00000760
.00000174

And the Sum will be 8.00740934

Subtraction in Decimals.

SUbtraction in Decimals, differs very little from Subtraction in whole Numbers; but in placing your Numbers you must, as in Addition, keep Units under Units, &c. in whole Numbers, and Tenths under Tenths in the Decimals.

Example I. *and* II.

From	2.79	Also from .967 take .026	
Take	1.98	Placed thus: From	.967
		Take	.026
The Remainder is	.81	The Remainder is	.941

Note, If the decimal Parts in either Number have fewer Places than the other, the Vacancy must be supplied by annexing so many Cyphers as will make them equal, or by supposing them to be annexed.

Example III.

Cyphers annexed.		Cyphers supposed annexed.	
From	17.600	From	17.6
Take	2.767	The same Numbers	2.767
Remains	14.833	The Remainder	14.933

Note also, The above Numbers are supposed to be of the same Denomination.

Multiplication

Multiplication in Decimals.

1. MUltiplication in Decimals, both in placing your Figures, and the Work itself, differs not from Multiplication of Integers; but be careful to point off, in your Product, as many decimal Places, as there are decimal Parts in your Multiplier, and Multiplicand; but in case of Want in your Product, annex Cyphers to the Left-hand thereof.

2. In Multiplication of Decimals, as in whole Numbers, make that Number the Multiplier that contains the least Number of Figures, though perhaps more or less in Quantity, it is not material.

Note 1. If your Multiplier and Multiplicand be Decimals, your Product will be a Decimal also.

2. If your Multiplier and Multiplicand be mixt Numbers, that is, Integers and Decimals, the Product will be mixt.

3. But if one of your Numbers be mixt, and the other a Decimal, the Product will sometimes be mixt, and sometimes a Decimal.

Example I.

Let it be required to multiply .6753 by 12.15 the Product will be 8.448003

.67 53	Multiplicand is Decimals.
12.51	Multiplier is mixt.
6753	
33765	
13506	
6753	
The Product is 8.448003	Answer.

In the foregoing Example, I count the Number of decimal Parts in the Multiplicand, and find them to be four, and two in the Multiplier make six. I then point off six (to the Right-hand) in the Product, and the Work is done.

Example II.

Multiply	.75
By —	.25
	375
	150
	.875

Example III.

Multiply	.125
By —	.05
	.00625

Example IV.

Multiply	7.5
By —	.7
	5.25

Example V.

Multiply	8.6
By —	55
	430
	430
	473.0

This Rule is so very easy, that I hope the above Examples are sufficient to remove any seeming Difficulty which may appear in common Multiplication: However, that the Learner may become perfectly acquainted with Multiplication in Decimals, I shall, for his Benefit, propose a few more Questions herein.

Question I.

Let it be required to multiply 2s. 6d. by 2s. 6d. one Shilling being the Integer; as 6d. is half of 1 Shilling, I call it .5 Tenths,

	S.
	2.5
Thus:	2.5
	125
	50
Answer	6.25 = 6s. 3d.

Also,

Alſo, let it be required to multiply 6s. 3d. by 9s. 9d. one Shilling being the Integer.

The Decimal of 9d. is .75, and 3d. reduced to a Decimal, is .25

Thus: 9.75
6.25
———
4875
1950
5850
———
60.9375 = 3l. 0s. 11d. ¼ Anſ.
12.
———
11.2500
4.
———
1.0000

Queſtion II.

Multiply 2s. 6d. by 2s. 6d. a Pound being the Integer.

Note, 2s. 6d. is the ⅛ of a Pound in Decimals, equal to .125, which being multiplied by itſelf, as follows:

.125
.125
———
625
250
125
———
Anſwer .015625 equal to Twopence Halfpenny, and the two Tenths of a Farthing.
20.
———
.312500
12
———
3.750000
4.
———
3.000000

By which you may observe, that as Multiplication of Decimals decreases their Value, so Division of Decimals increases the Value, contrary in both Cases to the Nature of Integers.

This last Example is the same as if it were required to divide 15 Shillings by Three-pence, the Quotient will be found to be 60 Pounds. Multiplication will make it appear.

For if you multiply 3d. or .0125, the Decimal of 3d. (one Pound being the Integer) by 60. Pounds, the Quotient will be .75 Pounds, or 15 Shillings, as you may see by the Work.

```
.0125
   60
-----
.7500 = 15 Shillings.
```

Example IV. *and* V.

Where the Dividend is an Integer, and the Divisor a Decimal, it will sometimes produce a mixt Number, and sometimes not.

First, Divide 1425.0 by .6252

```
.6252)1425.0(22792706
      12404
      -----
      17460
      12504
      -----
       49560
       43764
       -----
        57960
        56268
        -----
         16920
         12504
         -----
          44160
          43764
          -----
           39600
           37512
           -----
Ad infinitum  2088
```

Note,

Note, Before Division can well be made, you must add a Cypher to the Dividend as you proceed in the Work; you must also add Cyphers to each Remainder. But if you require only the integral Part of the Quotient, you may prefix as many Cyphers to your Dividend at first, as your Divisor consists of, and the Quotient will be Integers: But when decimal Parts are required, you must count every Cypher to your Dividend you prefix to your Remainders, and point your Quotient accordingly.

Secondly, Divide 5. by .25

See the Work.

```
.25)5.00(20. Answer.
    50
    --
     00
```

Example VI.

Where the Dividend is mixt, and the Divisor a Decimal,
Divide 529.125, by .425

See the Work.

```
.425)529.125(1245. the Quotient. Ans.
     425
     ----
     1041
      850
      ----
      1912
      1700
      ----
       2125
       2125
```

Example VII.

Let it be required to divide .04 by. 6.

See the Work.

6).040(666, &c.
36

40
36

40
36

4 would still remain, which shews it to be an imperfect Decimal.

Note 1, When any decimal Fraction, or mixt Number is to be divided by an Unit with any Number of Cyphers annexed, you must remove the Separatrix so many Places towards the Left-hand, as there are Cyphers annexed to the Unit.

So if 17.28 was given to be divided by an Unit.

By	10.	The Quotient will be	1.728
	100.		.1728
	1000.		.01728
	10000.		.001728
	100000.		.0001728

By the foregoing Examples it may be observed, that if the Dividend be greater than the Divisor, the Quotient will either be an Integer, or a mixt Number; but if the Divisor be greater, the Quotient will be a Decimal.

2. Multiplication and Division in Decimals, as in Integers, interchangeably prove each other.

3. To prove Multiplication, the Product divided by the Multiplier, quotes the Multiplicand. And,

4. To prove Division, the Quotient multiplied by the Divisor, produces the Dividend; or by the Dividend, produceth the Divisor.

5. Before

5. Before this Rule is closed, I'll beg Leave to recommend to the Learner, the Solution of two excellent Problems, which, perhaps, may be of great Use to him.

The first is, Having a Multiplicator to find the Divisor, divide an Unit with Cyphers by the Multiplicator, and the Quotient will be the Divisor sought.

Example.

What Divisor is that, by which dividing 7315, shall give a Quotient equal to the Product of the same Number multiplied by that Number.

See the Work.

```
  7315          125.)1.000).008)7315(914375
   125                1000      72..
 ------               ----     ----
 36575                ...       11
14630                            8
7315                           ----
-------                         35
914375                          32
                               ----
                                30
                                24
                               ----
                                 60
                                 56
                                ----
                                  40
                                  40
```

Here you may observe, that the Product and Quotient are the same.

The second is, having the Divisor to find the Multiplicator: This is the Reverse of the former, for if you divide Unity with Cyphers annexed, by the given Divisor, the Quotient will be the Multiplicator sought.

Example.

What Multiplicator is that, by which multiplying 7315, shall give a Product equal to the Quotient of the same Number divided by .008?

See the Work.

.008)1.00(125 Answer, the Multiplicator.
8

20
16

40

Reduction in Decimals.

BY Reduction, we find the Decimal of any fractional Part of Coin, Weight, Measure, &c. and, on the contrary, reduce any decimal Fraction, to its equivalent fractional Parts of Coin, Weight, Measure, &c.

PROPOSITION I.

Any vulgar Fraction given, to reduce the same into a decimal Fraction of equal Value.

To perform which, you must add a competent Number of Cyphers to the Numerator, and divide by the Denominator, the Quotient is the decimal Fraction required.

Example I.

Let it be required to find the decimal Fraction of $\frac{3}{4}$; also $\frac{1}{4}$, and $\frac{1}{2}$.

See the Work.

4)3 0(.75 Answer	4)1.00(.25 Answer	2.)1.0(.5 Ans.
28	8	10
20	20	
20	20	

Note,

Note, The Directions given in Division, must be observed, and the Work will be easy.

Example II.

Reduce $\frac{1}{8}$ into a decimal Fraction.

See the Work.

$$\begin{array}{l} 8.)1.0(.125 \text{ Answer.} \\ \quad\ \ 8 \\ \hline \quad\ \ 20 \\ \quad\ \ 16 \\ \hline \quad\ \ \ 40 \\ \quad\ \ \ 40 \\ \hline \end{array}$$

Example III.

Reduce 9. Pence, into the decimal Fraction of a Shilling.

See the Work.

$$\begin{array}{l} 12)9.0(.75 \text{ Shillings.} \\ \quad\ \ \ 84 \\ \hline \quad\ \ \ \ 60 \\ \quad\ \ \ \ 60 \\ \hline \end{array}$$

RULE.

Divide the given Number, by the integral Parts of the required Decimal reduced to the same Denomination, and the Quotient is the Answer required.

Suppose the foregoing Question was to be reduced to the decimal Fraction of a Pound Sterling. Seeing that 240 Pence is 1 Pound, 9 Pence is equal to $\frac{9}{240}$, which reduce as before directed.

See the Work.

```
240)9.00(.0375 the Decimal required.
    720
    ----
    1800
    1680
    -----
     1200
     1200
     -----
```

Example IV.

Reduce 15s. 6d. into the Decimal of a Pound Sterling.

See the Work.

```
    s.
20.)15.5(.775 Facit.
    140
    ---
     150
     140
     ---
      100
      100
      ---
```

But the Decimal anſwering any Number of Shillings, may more readily be found by halving the Shillings given; ſo that $\frac{1}{2}$ of 15, is 7. and 1 remains, that is, 1 Shilling, to which ſuppoſe a Cypher annexed, makes 10, the Half thereof is 5, to wit, .75 —Then 6d. is $\frac{6}{240}$, which reduced, is .025, to which adding .75, gives ·775, as above.

```
 s.
·75  =  15  Shillings.
·025 =   6  Pence.
----
·775
```

Example

Example V.

Reduce 32 Perches to the decimal Fraction of an Acre, 32 Perches being $\frac{32}{160}$.

See the Work.

160.)32.0(.2 Answer.
320

Example VI.

Reduce 136 ½ Perches, to the decimal Fraction of an Acre.

See the Work.

160)136.5(.85325 Answer.
1280
8500
800
500
480
400
320
800
800

These Examples being well considered and understood, are sufficient to reduce any other Measures, *&c.* so we will conclude this Proposition.

P R O P. II.

To find the Value of a decimal Fraction, in the known Parts of the Integer, as of Coin, Measure, *&c.* to perform which observe the following Rule:

RULE.

RULE.

Multiply the Decimal given, by the Number of Parts of the next inferior Denomination, cutting off as many Figures from the Product as the given Decimal consists of; the Remainder, if any, multiplied by the next inferior Denomination, cutting off as before. Thus must you do until the given Decimal be brought into its lowest Parts, and the Parts signified by the Decimal, will be thrown over the Separatrix.

Example I.

What is the Value of .125 of a Pound Sterling.
20 Shillings in a Pound.

2,500
12 Pence in a Shilling.

6.000

Answer 2s. 6d.

Example II.

What is the Value of .696875 of a Pound Sterling?
20. Shillings in a Pound.

13.937500
12 Pence in a Shilling.

11.250000
4.

1.00000

Facit 13s. $11\frac{1}{4}$

Example III.

What is the Value of .75 of and Acre?
4. Roods in an Acre.

Facit 3.00 Roods.

Example

Example IV.

What is the Value of .6275 of an Acre?

```
      .6275
          4.  Roods in an Acre.
      ------
     2.5100
         40   Poles in a Rood.
     ------
    20.4000   remains leſs than a Pole,
              ſomething better than ¼.
```

	A.	R.	P.
Facit	0	2	20¼

Example V.

What is the Value of .98765 of an Acre?

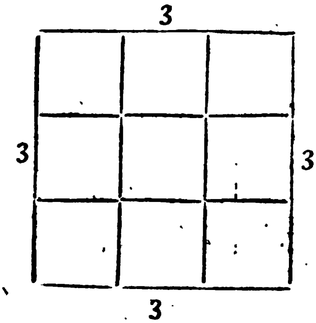
```
     .98765
          4.
     ------
    3.95060
         40
    -------
   38.02400
```

	A.	R.	P.
Facit	0	3	38

Theſe Examples are ſo eaſy, that I hope it is needleſs to give any more in this Rule, ſince the above, being well underſtood, is ſufficient for our Purpoſe. It follows next to ſay ſomething of the *Rule of Three in Decimals* in this Place; but, as the Rule of Three, or the Single Golden Rule in whole Numbers, was ſufficiently explained before, I think it unneceſſary to introduce it. For, ſeeing *the Rule of Three in Decimals*, it is the ſame both in working and ſtating of the Queſtion, as in the Rule of Three before taught, (Reſpect being had to the Rules in Decimals aforegoing) any Queſtion of the Golden Rule, though conſiſting of the moſt difficult fractional Parts, will be as eaſily ſolved, as if the Queſtion was compoſed of Integers only. I ſhall therefore omit it here, and proceed to the Square Root, for without a competent Knowledge therein, there is no arriving to Perfection in the Art of Surveying: And, as I am determined to ſpare no Pains in rendering this Treatiſe complete, I ſhall therefore recommend this neceſſary Rule to the Learner, and then conclude this Chapter.

Extraction of the Square Root.

A Square is that which is contained under two equal Numbers, and the Root thereof is one of them; so that the Way to know the Square Root of any Number, is to discover or find out a lesser Number, which being multiplied by, or into itself, shall produce the Number propounded. As for Example: Suppose 49 be a Number given to find the Root thereof, I say 7 is the Root of it, because 7 multiplied into itself, *viz.* 7 Times 7 is 49, the Number given; therefore, the two equal Numbers that the Square 49 are comprehended under, are 7 and 7; and the Square Number 9, is contained under 3 and 3, which plainly appears in the following great Square:



The above Figure represents a great Square, containing 9 lesser Squares, any one of which is the Root of the great Square; but how to discover this readily, in any Number, is what I intend to shew you next. The Roots of all square Numbers under 100, you have in the Multiplication Table: However, as it is proper for you to keep them in your Mind, observe the Table following:

Roots

Roots -	1	2	3	4	5	6	7	8	9
Squares	1	4	9	16	25	36	49	64	81

Here you ſee the Root of 9 is 3; the Root of 49 is 7, and ſo of the Reſt.

So far as 100 in whole Numbers, your Memory will aſſiſt you to find the Root; but if the Number propoſed, whoſe Root you ſeek, exceed 100, then put a Point over the firſt Figure on the Right-hand, which is the Place of Units, and ſo proceed to the Left-hand; miſs the ſecond Figure, and Point over the third; then miſſing the fourth, point over the fifth, and ſo on (if there be ever ſo many Figures in the given Number) to the End, pointing every other Figure, as you ſee here:

$$\dot{1}2\dot{9}8\dot{7}6\dot{5}4\dot{3}$$

And ſo many Points as there are, ſo many Figures your Root will conſiſt of, which is very material to remember: Then begin at the firſt Figure on your Left-hand that has a Point over it, which will always be the firſt or ſecond Figure, and find the Root thereof, and when you have found it, or the nigheſt leſs to it, (which you may do by the foregoing Table, or your own Memory) proceed by the following Directions:

"The Root of your firſt Period you
"Muſt place in Quote, if you work true;
"Whoſe Square from your ſaid Period then
"You muſt ſubduct; and to th' Remain,
"Another Period being brought,
"You muſt divide, as here is taught,
"By th' double of your Quote, but ſee
"Your Units Place you do leave free;
"Which Place will be ſupply'd by th' Square
"Of your next quoted Figure there:
"Next multiply, ſubtract, and then
"Repeat your Work unto the End;
"And if your Numbers be irrational,
"Add Pairs of Cyphers for a Decimal."

Note, Irrational Numbers, are all such Squares whose Roots cannot be discovered by Art exactly, (neither in whole Numbers, nor Fractions) but something will still remain, there being no Proportion (as yet found) betwixt an irrational Number and its Root.

Example.

Let it be required to find the square Root of 208849.

See the Work.

```
   .  .  .
  208849(45
  16
  ----
 85)488
    425
    ----
    6349
```

Having pointed it as in the Work, the Root will consist of three Places.

1. Seek the greatest Root of your first Period, *viz* 20, which, by your Table you will find to be 4, which place in your Quotient, and the Square thereof, under the 20, your first Period, and subtract 16 from it, rests 4. This is your first Work, and is no more to be repeated.

2. To the Remainder bring down your next Period 88, which makes 488 for a Dividend, as may be seen in the Work.

3. Double your Quotient makes 8, then seek how oft 8 in 48, (reserving the Units Place for the Square of your sought Figure) and you will find it to be 5, which you must place in the Quotient, and to the Right-hand of the Divisor also, making it 85, then multiply that 85 by 5, and the Product place under the new Dividend, as you may see.

This

This Work is every Time to be repeated.

85)48849(45
425
—————
907)6349(7
6349
—————
....

4. Subtract 425, from 488, rests 63, to which bring down the third and last Period 49, then you will have 6349 for another new Dividend.

5. Double the Quotient 45 = 90 for a new Divisor. Then see how oft 90, or 9 in 63, Answer 7 Times (still reserving the Unit's Place in the Divisor) which place in the Quotient, and also in the Unit's Place of the Divisor, making it 907, then multiplying 907 by 7, the Product 6340, place under the last Dividend, and seeing they are equal, and that nothing remains, by which it appears that the given Number was a Square rational Number, and its Root is 457, which see.

)208849(457
16 ...
—————
85)488
425
—————
907)6349
6349
—————

After this Manner the Square Root of any Number may be found.

But if the Number to be extracted has a Remainder, and the Root cannot be got exact; notwithstanding, by adding Cyphers, you may come as near the Truth as you please.

Example

CHAP. II.

Containing ſo much Geometry as Surveying requires.

See Plate I.

GEOMETRICAL DEFINITIONS.

I.

A Point is that which hath no Parts, as A, *fig.* 1.

II.

A Line, is a Length without Breadth, not having any commenſurable Thickneſs, as AB, *fig.* 1, and being generated from a Point, admits of only three Varieties, which follow.

III.

A right Line lieth evenly between its Extremes, and is the ſhorteſt Diſtance between two Points, as the Line AB, being ſhadowed by its Extremes; but if a Point be moved, or carried in an uniform Motion, and equally diſtanced from a certain Point, it is called a circular Line, as CD; but if it moves unevenly, to wit, ſome places higher, and others lower, ſo that the Extremes cannot ſhadow all the middle Parts thereof, it is then called a Curve, or compound Line. *See fig.* 1.

IV.

The Extremes, Limits, Terms, or Ends of a Line, are Points.

V.

A Superficies hath Length and Breadth only.

VI. The

VI.

The Extremes of a plane Superficies, are right Lines.

VII.

An Angle is formed by the Inclination of two Lines, AB and AC, one towards another, meeting in a Point A, and forming the Angle A. *fig.* 2.

VIII.

And that Point A, is called the angular Point.

IX.

When a right Line AB, ſtandeth upon a right Line DC, making the Angles CAB and DAB on each ſide equal, the Line AB ſo ſtanding, is perpendicular to the Line CD upon which it ſtandeth. *fig.* 3.

X.

Otherwiſe, if the Line AB, inclined to either C or D, it would then form both an acute and an obtuſe Angle.

XI.

A Right-Angle contains 90^{o}. as DAB in the third Figure.

XII.

An Acute-Angle leſs than 90, as CAB. *fig.* 4.

XIII.

And an Obtuſe-Angle, more, as DAB. *fig.* 4.

XIV.

A plane Triangle, is a Figure comprehended under three right Lines, as ABC. *fig.* 5.

XV.

There are three Sorts or Kinds of plane Triangles, *viz.* An Iſoceles, a Scalenum, and an equilateral Triangle. *See fig.* 6, 7, 8.

XVI.

A Square, is a plane Figure, comprehended under four equal Right-lines, containing four Right-angles, as ABCD. *fig* 9.

XVII.

A Rect-angle, is vulgarly called an oblong, or long Square, whose opposite Sides are equal and parallel, but longer than it is broad, containing four Right-angles. *See fig.* 10.

XVIII.

A Rhombus, is a Square out of Form, whose Sides are equal and parallel, containing no Right-Angle. *See fig.* 11.

XIX.

A Rhomboides, is a Rect-angle out of Form, whose opposite Sides are equal and parallel, but longer than it is broad, containing no Right-angle. *See fig.* 12.

XX.

All other four-sided Figures, are called Trapeziums. *fig.* 13.

XXI.

A Diagonal Line, is a Right-line drawn from or between the opposite Angles in all quadrangle Figures, as the Line I. G. *fig.* 28.

XXII.

Multangular, multilateral, and polygonical Figures, are such as are comprehended under many Lines. *fig.* 14.

A Circle, is a plain Figure comprehended under one Line, called a Periphery, or Circumference, into which all Right-lines drawn from a Point within the Circle, are equal. *fig.* 15.

XXIII.

And that Point is called the Centre of the Circle, as A. *fig.* 15.

XXV.

XXIV.

The Diameter of a Circle, is a Right-line passing through the Centre, and terminated on both Sides by the Periphery, as CB. *fig.* 15.

XXV.

A Semi-circle, is that Part of Circle that is comprehended under the Diameter, as CFB. *fig.* 15.

XXVI.

A Quadrant is the fourth Part of a Circle, or 90 Degrees, as CFA. *fig.* 15.

XXVII.

An Arch of a Circle, is any Part of the Periphery, as EB in the same Figure.

Geometrical Problems.

PROBLEM I.

TO bisect a given Line into two equal Parts.

Example.

Suppose the given Line be AB, *fig.* 16, it is required to bisect the same.

Open the Compasses, or Dividers, to any thing more than half the given Line, and then with one Leg or Foot in the Point B, describe the Arch D e, above the Line AB, and also below it; then shift your Dividers, and, with one Leg in the Point A, describe two Arches with the same Extent as before, that shall croſs or interſect the two former Arches in the Points F and C, from which draw a Line, and it will biſect the Line AB in the Middle thereof. *fig.* 16.

PROB. II.

To erect a Perpendicular at the End of a given Line.

Example.

Let DC, *fig.* 17, be the Line, and at the Point C, it is required to erect the Perpendicular CB.

Open the Compaſſes to any ordinary Extent, and ſetting one Foot in the Point C, let the other fall at Pleaſure (its not material where) above the ſaid Line DC, as at the Point o; then, without altering the Extent of the Compaſſes, one Foot being in the Point o, deſcribe the Arch LL, and alſo an other Arch that will croſs the Line DC in I; point the Interſection, then lay a Ruler to the Point I and o, and draw the pricked Line IG. Laſtly, from the Point C, through the Interſection G, draw the Line CGB, which will be perpendicular to the Line DC.

PROB. III.

To erect a Perpendicular at a Point in a given Line.

Example.

The Line given is AB, *fig.* 18, and at the Point F, it is required to erect a Line which ſhall be perpendicular to AB.

Open the Compaſſes to any convenient Width, ſetting one Foot in the given Point F, with the other make a Mark in the Line AB, as at EE, then take up your Compaſſes and open them ſomething wider than before, fixing one Foot in either of theſe Points E, deſcribe an Arch above the Line; then remove your Compaſſes to the other Point with the ſame Extent, and deſcribe an Arch that ſhall interſect the former Arch, through the Point of Interſection and the given Point F, draw a Line, and it will be perpendicular to the given Line AB.

PROB.

PROB. IV.

To let fall a Perpendicular from a Point that is not in a given Line.

Example.

The given Line is AB, *fig*. 19, and the Point is at C, from which it is required to let fall the Line C, that ſhall be perpendicular to AB.

In the given Point C, ſet one Foot of the Compaſſes, and with the other Foot deſcribe an Arch that ſhall croſs the Line AB, in the Point *c* and *e*, and, by the firſt Problem, biſect the Diſtance between *c* and *e*, through which Point of Biſection, and the Point *c*, draw a Line, and it will be perpendicular to the given Line AB.

PROB. V.

To draw a Line parallel to a given Line, through a Point given.

Example.

AB, *fig*. 20, is the given Line, and it is required to draw the Line CD, through the Point E, that ſhall be parallel to the Line AB.

From any Part of the Line AB, (ſuppoſe at F) take the Diſtance in the Compaſſes between F and B, then ſetting one Foot in the Point E, with the Diſtance FB, deſcribe the Arch GG; then take in your Compaſſes the Diſtance between F and E, and ſetting one Foot in the Point B, croſs the Arch GG, in the Point *i*, through which, and the Point E, draw the Line CD, and it will be parallel to AB.

N. B. There are ſeveral other Ways to draw parallel Lines, but none ſo correct as the above.

The foregoing Problems come in continual Uſe and Practice in any thing that relates to planning, and therefore ought to be ready to, and well underſtood by, every Learner, ſince very little can be performed in the following emblematical Schemes, without having Recourſe to one or more of theſe five preceding.

PROB.

PROB. VI.

To make a Triangle of three given Lines, provided any two taken together be greater than the third. 22 *Euclid*, Book I.

Suppose the given Lines were 6, 7, and 8. *See fig.* 21.

EXPLANATION.

To construct this, or any triangular Figure (when three Sides are given) you must first draw a Line with Scale and Compasses parallel to your Breast, and lay thereon one of your given Lines, as from A to B.

Secondly, Take in your Compasses another given Side, and fixing one Foot in A, describe an Arch above the Line; then remove your Compasses to the Point B, with the Extent of the third given Line, describe an Arch that shall intersect the former in the Point C. And,

Lastly, Draw Lines from A to C, and from B. to C. so shall you have the Triangle constructed.

PROB. VII.

To make a Geometrical Square.

Suppose AB, *fig.* 22, be a Line given, and it is required to construct a Square whose Side shall be equal to the Line AB.

CONSTRUCTION.

First, Draw a Line equal to the given Line, as from A to B; at the Point B, by *Prob.* II. erect the Perpendicular BC, making BC equal to AB; then with one Foot of your Compasses in A, with the Distance AB, describe the Arch D. Secondly, with the same Extent in your Compasses as before, and one Foot in C, describe an Arch that shall intersect the former Arch in the Point D. And lastly, draw Lines from the Point D, to A and C, and the Square is compleated.

PROB.

PROB. VIII.

To make a Rect-angle, or Long-square.

This Problem is not much unlike the former; admit then, that two Lines be given, *viz.* 3 and 6, and it be required to make a Rect-angle of them.

CONSTRUCTION.

First, Lay down the longest Line, to wit, 6, and at the end thereof, *viz.* B, erect the perpendicular Line BC, by *Prob.* II. equal to 3 (your shortest Line) then placing one Foot of your Compasses in C, with the Distance AB, or 6, describe an Arch, then remove your Dividers, and placing one Foot in A, with the Distance BC, or 3, describe another Arch that shall intersect the former in the Point D. And lastly, draw Lines from D to A and C, which forms the Rect-angle ABCD.

PROB. IX.

To construct or make a Rhombus, or an equilateral Parallelogram.

Example.

Let it be required to make a Rhombus whose Sides shall be equal to the Line AB. *fig.* 24.

CONSTRUCTION.

First, make an Angle at A or B (by *Defi.* 7, *fig.* 2.) it is not material how small or great the Angle is; and make the Line BC, equal to AB, then placing one Foot of your Compasses in C, with the Distance CB, describe an Arch, and with the same Extent place one Foot of the Compasses in the Point A, describe another Arch that shall intersect the former Arch in the Point D, and draw Lines from D. to A, and it is done.

PROB. X.

To make a Rhomboides, or a Rect-angle out of Form. The Construction of this Figure, differs but little from Problem the IXth.

Let then the Lines AB, and CD, *fig.* 25, be given to constitute a Rhomboides.

CON-

CONSTRUCTION.

First lay down AB, and at the End thereof make an obtuse Angle at Pleasure, by drawing a Line = DC, then proceed as you were directed in Problem VIII.

PROB. XI.

To construct a quadrilateral Figure, containing one obtuse, one acute, and two right Angles, three Lines only being given, *viz.* the Base and the two Perpendiculars, which contain the Right-angles.

Example.

Let the Lines given be 2, 3, and 4, *fig.* 26, and it be required, with them, to construct a quadrilateral, or four-sided Figure, together with a fourth unknown Line.

CONSTRUCTION.

Let the Line AB be laid down equal to the given Line 4, and at the Points A and B, erect the Perpendiculars AD and BC, by the second Problem, making AD equal to the Line 2, and BC equal to 3; and lastly draw a Line from D to C, and it is done.

PROB. XII.

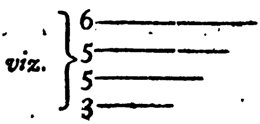
To construct a Trapezium two different Ways.

First, with four given Lines, *viz.* 3, 4, 5, 6, the Sides of the Trapezium.

Secondly, with three given Lines, *viz.* the Diagonal and the two Perpendiculars.

The first Way.

Let it be required to make a Trapezium of the four following Lines. *fig.* 27.



CON-

CONSTRUCTION.

First, lay down any one of the Lines from A to B, suppose the Line 6, then, at the Point B, make an acute Angle at Pleasure, by drawing the Line BL, equal to the Line 5; then placing one Foot of your Compasses in the Point L, with the Distance of the Line 4, describe the Arch *nn*; take up your Compasses and place one Foot in the Point A, with the Distance of the Line 3, describe another Arch that shall intersect the former in the Point O; draw the Lines AO, and LO, and it compleats the Trapezium AB LO.

Note, A Trapezium made after, or by this Method, may be variously or differently represented, provided the Angles are not given.

By the foregoing Method of constructing or planning a Trapezium, the Learner (if he chuses to make Experiments) will find, that not only the Form thereof will each Time change, but the Area differ also; though, notwithstanding, some modern Authors are pleased to affirm that the Area would be unalterably the same.

However probable this Assertion may appear to some, I will not pretend to say, but shall beg Leave to observe what is universally granted, *viz.* any geometrical Square is allowed to be more spacious than a Rhombus constructed upon the same Base; and differs therefrom more or less, according as the Angles in a Rhombus are more or less acute or obtuse. Hence it follows, that the remoter the several Angles (in any quadrilateral Figure) are from 90 Degrees, the Areas of all such decrease more and more; and the nearer each Angle in a Trapezium is to a right one, the greater the Area thereof; therefore the Area of all such Figures increaseth or decreaseth, according as the Angles are therein more or less acute. Q, E, D.

But to prevent all such Consequences, the Dimensions of a Trapezium must be particularly taken, and entered as follows:

Method the Second.

Placed in Figures thus: *See fig.* 28.

At 0	————————	0	no Breadth.
4	————————	2	Left-hand.
6	————————	4	Right-hand.
9	————————	0	no Breadth.

In Words thus:

First, At the Beginning, that is no Length, it is no Breadth. Secondly, at 4, it is 2 on the Left-hand. Thirdly, at 6, (that is upon the Diagonal) it is 4 to the Right-hand. And lastly, at 9, it is nothing, to wit, no Breadth. From these Dimensions, a Trapezium may be constructed with Expedition and Correctness, without regarding the Angles, which must be considered in the first Method, otherwise the Result will admit of unlimited Variety.

CONSTRUCTION.

First, At Pleasure draw a Line with your Compasses, and lay thereon your Diagonal IG = 9.

Secondly, At 4, or *n*, (your Diagonal being perpendicular to your Breast, or how you will, upon the Left-hand Side lay down the Perpendicular *n* E = 2; and at 6, or *m*, lay down the Perpendicular 4 = *m* P, to the Right-hand.

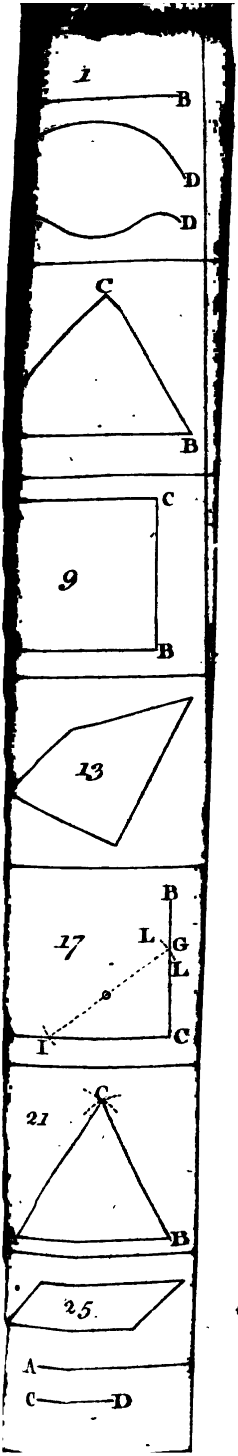
Lastly, join the Points IE, EG, GP, and PI, together, and it is done.

Note, The above Dimensions are more briefly entered,

	0	————————	0	
Thus:	4	————————	2	L. Hand.
	6	————————	4	R. Hand.
	9	————————	0	

This Method saves much trouble in Writing, though as fully expressed.

Thus



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expressed.

Thus have I given my Reader a Deſcription of ſuch right-lined geometrical Figures as are neceſſary to be underſtood, before he can (with any Grounds of Certainty) enter the Fields, in order to practiſe which, I propoſe ſhall be the Subject of the ſucceeding Chapter; but, in the mean Time, muſt intreat the Learner to advance no farther herein, until he be expert and ready in conſtructing all the foregoing Problems; otherways his Hopes of becoming a compleat Meaſurer will moſt certainly be fruſtrated, ſeeing he learns by Halves, and therefore can have but an imperfect Idea, or a confuſed Notion thereof; for, as in common Arithmetic, ſo in all the Branches of the Mathematics, comparatively ſpeaking, for whoever is a Stranger to Multiplication, of courſe muſt be a Stranger to the next ſucceeding Rule (Diviſion) alſo.

I hope the above Hint will have the deſired Effect upon all thoſe that would reap any Benefit from this Book.

CHAP. III.

Containing the Nature of long and superficial Measure, the Chain described; with useful Directions and Cautions to young Practitioners in the Fields, &c.

SECTION I.

Of MEASURE.

AND first of *Long-Measure*, which is either Inches, Feet, Yards, Perches, or Chains, *&c.* A Table of what is necessary you have in the Introduction. But as Land is generally measured by Chains, I shall chiefly insist upon, and recommend that Instrument, it being not only most in Use among Surveyors, but also the very best for such like Purposes; though there are several Sorts of Wheels, or Machines, lately constructed to measure Land, as well as Distances: However correct those Wheels may seem to the Gentlemen that encourage them (with regard to Surveying) I will not pretend to say, but shall appeal first to any Farmer in *Great-Britain*, whether it is possible for such Wheels, in measuring plow'd Land wherein the Ridges are very high, and Furrows deep, (such as I have often met with in low and wet Lands) to ascertain the true Length and Breadth thereof, exclusive of the Errors that will unavoidably occur when the Bounds are irregular. I dare affirm, that any such Machine, in some uneven Ground, would measure a Field to 13 or 14 Acres, that is no more than 10. I'll grant you, that the measuring Wheel is exceeding ready, and indifferently exact in measuring Roads that are horizontal (though such are not often met with) to which Purpose alone it is properly adapted; wherein if it should (as most certainly it does) make some Lines longer (by reason of the Earth's uneven Surface) than others, the Consequence

ſequence is trifling in Compariſon to what a Tenant muſt ſuffer who pays a great Rent for Land (the Wheel meaſured to him) which he hath not.

There are ſeveral Sorts of Chains, as a four Pole, a two Pole, and a one Pole Chain, *&c.* but that which I would recommend as the moſt expeditious, is the four Pole Chain; it is univerſally allowed to be preferable to all others, being decimally divided into 100 Links, but the Length of the Link differs according to the eſtabliſhed Meaſure of the ſeveral reſpective Counties wherein it is uſed: For inſtance, in *England* the Statute Chain (commonly called *Gunter's*) contains 22 Yards, divided into 100 Links, each Link 7 $\frac{92}{100}$ Inches; and though this Chain is by Law eſtabliſhed the Standard for Engliſh Meaſurement, notwithſtanding, there are other four Pole Chains adapted reſpectively to the cuſtomary Meaſure of ſeveral Counties therein, to wit, in *Cheſhire* the Chain is 32 Yards divided into 100 Links. In ſome Parts of *England* the Chain is 24 Yards; and in other Parts the Chain is 28 Yards, each divided into 100 Links; and though the above Chains all differ in Length, the Reſult of their reſpective Dimenſions, is commonly reduced to the Statute-Meaſure of *Great-Britain*, when the Dimenſions are therein taken, namely, 5 $\frac{1}{2}$ Yards, one Pole or Perch; four Poles one Chain, as above.

How CHAINS are marked.

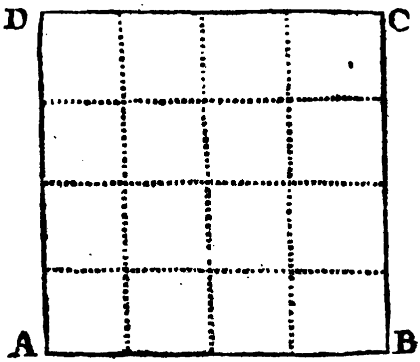
Chains are differently divided by Marks for the more ready reckoning the Links thereof; ſome are marked with Braſs Rings, others with ſmall Plates of Braſs, at 10, 20, 30, 45, and 50 Links; the Middle of the Chain, the other Half, or Part of the Chain, is marked in like Manner, ſo that either End may go firſt. Some are marked at 25, *&c*, *&c.*

Planometry,

Planometry, or Superficial Measure.

BY the Definition of a Superficies, it appears to have Length and Breadth only, without any commensurable Thickness; and therefore, to find the Area of all superficial Spaces (whether comprehended under curved, circular, or right-lined Extremes or Boundaries) is the Point in Question. And, in order to effect this, though the Space or Superficies be ever so irregular, it must be reduced to a Number of small Squares (according to the Tenor of the Case) as a square Foot, Pole or Chain, &c. and the Contents of all such Superficies are known when the Number of the Squares it containeth are discovered.

As for Example: Suppose ABCD was a square Piece of Land, and the Side AB thereof, was 4 Poles, or 1 Chain; I say that Piece of Land contains 16 square Perches, as appears in the following Figure, every small Square being one Perch or Pole, that is, having a Pole or Perch for its Length, and also for its Breadth.



Now Land, with regard to the general or common Measure, is surveyed and returned in Acres, Roods and Poles, or Perches. An Acre contains 160 square Perches, such as the above little Squares, and therefore it is not material in what Form the Acre lies, provided it contains just 160 Perches, as in a rect-angular Paral-

Parallelogram, 16 Perches long, and 10 broad, contains an Acre; also 20 long and 8 broad, and 40 long, and 4 broad, contain an Acre; by which it appears, that having the Length of any Field, you may readily find the Breadth for an Acre, or any other Quantity, thus: Divide the given Quantity of Land, by the Length of the Field, and the Quotient will be the true Breadth for such a Quantity.

Example.

Suppose it were required to find the Breadth of an Acre, or any other Quantity, in a Field whose Length is 13 Chains, 56 Links; the Answer would be nearly 74 Links. *See the Table, Chap.* VIII. *Part 1st.*

SECT. II.

Of MEASURE.

HAving introduced the Chain, I shall, in this Place, give some necessary Directions how to use it in measuring Lines.

Let the Chain-Leader be provided with ten small Arrows about a Foot long; though ten small Wire Pins (made sharp at one End, to enter the Ground readily, and a Noose at the other End, to which a small Piece of red Cloth should be fastened, that it may thereby be more easily found in Grass, *&c.*) would be much better in many Respects: Let them be ten Inches long, and let him that follows the Chain, see that the Leader always puts down his Arrow perpendicular, and in a direct Line with the Object he is going to, or bound for, which he may do by making him, at the End of every Chain (before he puts down the Arrow) cover or intercept the Mark he is going to; for if he swerves from a right Line, it will makes the Distance longer than it really is, a right Line being the shortest Distance between two Points.

The Chain-Leader, and Follower cannot be two careful in reckoning their Arrows to each other at the End of every Line, and every Change; that is to say, the Measurer, or Chain-Follower, must count ten Arrows to the Leader at the End of every Change; but if any should be missing, it is impossible to know who lost it, and therefore they must not only go back and find

find the lost Arrow or Arrows, but also measure the same Line over again.

Mr. *John Love*, in his Treatise, very justly observes the dangerous Consequence of such Mistakes, thus: " Be sure that they " who carry the Chain, mistake not a Chain either over or " under, for if they should, the Error would be very consi- " derable; as suppose you were to measure a Field that you " you knew to be exactly square (*though such is seldom met with*) " and therefore need measure but one Side of it; if the Chain- " Carriers should mistake but one Chain, and tell you the Side " was but 9 Chains, when it was really 10, you would make " of the Field but 8 Acres and 16 Perches, when it should be " 10 Acres just: And if in so small a Line so great an Error " does arise, what may be in a greater you may easily imagine." But to prevent all such Mistakes, let him that leads the Chain, take all the Arrows in his Left-hand, and the Chain upon the two first Fingers of his Right-hand; then let him take one of the Arrows into his Right-hand with the Chain, and proceed to the Place directed; and at the End of the Chain let him stick the Arrow down he held in his Right-hand, and take another out of his Left hand; thus proceed until all the Arrows are done; then the Measurer, or Chain-Follower must carefully count the Arrows to the Leader, and if the Line be any longer, proceed as above directed, always remembering the Changes you have in each Line, and at every Change count the Arrows, as above directed. If it be Roads you measure, *note*, that 80 Statute Chains, make 1 Mile.

SECT. III.

Directions and Cautions to Chain-Followers, and young Practitioners in the Fields.

FIRST, Upon the Chain-Follower depends all the Care of measuring, remarking, and noting down Dimensions, *&c.* *&c.* and therefore it absolutely behoves every one that would be a Surveyor, to be not only particularly careful in his Entries, and correct in his Dimensions, but also very circumspect in his Observations, with regard to the Situation of Buildings, Timber, Water-

Water-ponds, Brooks and Dingles, whereby he may draw a perfect Plan from the Field-Notes, if required, when in his Chamber: And that all seeming Difficulties herein may be removed, I have recommended, in the following Chapter, such a familiar, easy Method, as doubtless the weakest Capacity may immediately comprehend.

Secondly, When the young Practitioner enters the Field or Inclosure that he intends to measure, let him carefully observe those Hedges or Fences that are next, if they are strait, curved, or circular, and proceed as directed in the fifth Chapter; always remembering to leave a Mark, at the Beginning, in the Fence or Hedge, that will appear, if required, at a sufficient Distance: Direct your Chain-Leader to observe the Motion of your Left-hand, which is to guide him in a right Line, to the Place bound for, by moving your Hand to the Right or Left, according as he is wide of the Mark you are going to; and when you have got him in a right Line, that is, directly between you and the Mark, stoop down instantly and take up the Arrow that your Foreman or Leader put down, with the same Hand that you hold the Chain in, laying hold of the Arrow close to the Ground; and let the Chain-Leader stick down an Arrow at the same Time that you take up your's, with the Chain at full Stretch: Observe (when you direct your Leader, or Chainman, to keep in a right Line with your Mark) to place your Eye and Chain-Hand directly over the Arrow that sticks in the Ground; and as soon as he has put his Arrow down, let him fix his Eye upon the Mark he is going to as he moves forward, which will save you a vast deal of Trouble in keeping him straight; for it is not very possible for him to swerve from a right Line, provided he keeps the Mark in View as he moves forward. In hilly Ground, if the Measurer loses Sight of the Mark he is to go to, he must stand over his Arrow, and the Leader must turn and move himself till he gets the Measurer between him and the Mark departed from.

Thirdly, At your Peril never attempt to draw or form a Balancing-Line, upon any Consideration whatsoever; for it is most certainly attended with notorious Errors, notwithstanding such random Work, for Ages past, has been too much practised; which affords us one Reason for the general Discord amongst old Practitioners.

Note, A Balancing-Line is either real or imaginary, to wit, real in the Chamber, and imaginary in the Fields; in each Case, this Line is instituted by the Practitioner to avoid Trouble, and consequently Accuracy also. *See the Explanation thereof in the last Article of this Chapter.*

Fourthly, Observe (in the Boundaries of the Estate you are to measure and map) the Hedges and Ditches, that is, to whom they belong: And here note, that if the Ditch is between the Field you must measure and the Hedge, that Ditch belongs to the neighbouring Gentleman's Land, and therefore you must allow 4 Feet, or 6 Links, from the quick Roots in the Hedge, that is to say, you must not measure within 6 Links off the Hedge; but if the Hedge is between the Field you are measuring and the Ditch, then it must be measured therewith. The Allowances for Ditches differ in many Countries, *viz.* some allow but 3, some 4, some 5, and some 6 Feet; however, I think 4 Feet sufficient, (except where Lands are joined by Commonings) for which see the Directions at the End of the Chapter. And as for the Hedges and Ditches within the Estate, measure the Ditch to one Field, and the Hedge to the other, when you are to map.

Fifthly, Let all the Off-sets you take up, be as near the Fence, and as small or narrow, as possible; and when (or before) you begin to take up an Off-set, remember always to look along the Fence or Hedge that it lies up to, and remark where abouts in the Fence your first Perpendicular should rise to; and when you have taken the same, stand at the End thereof, and look again along the Fence where the second should rise to; and in this Manner you must do at the End of every one that you erect. Be careful that you take your Perpendiculars so, that if a right Line was drawn from the End of any one, to the next, that Line would neither include the Neighbour's Ground, nor exclude any Part of that you are about to measure.

Sixthly, See that you don't go with your Chain into the Fields to measure, without a Staff about 5 Feet 4 Inches long, made sharp at one End to enter the Ground readily; and a small round Brass Plate, or Wood, between 5 and 6 Inches Diameter, fixt on the Top thereof with a Screw, or how you will. If the

the Head of your Staff be Brass, let there be put thereon 4 small Studs at the End of the Diameters: So that if two Lines were drawn from the opposite Stud or Points, they would pass through the Centre of the Plate, and cross each other at right Angles. But if the Head thereof be Wood, two Saw-nicks, a quarter of an Inch deep in the Board, at right Angles, will answer the same End.

The Use of the above Staff, is as follows: When chaining in the Field, if you have Occasion to raise a Perpendicular to any assigned Point or Corner, your Eye can inform you if you are near the Place it should be; then stick down your Staff perpendicularly, that is, upright, and fixing one of the Lines that are thereon, directly over your Chain, and parallel thereto, as it lies on the Ground; apply your Eye to the End of the other Line (on the Staff-head) and looking along the same, if you perceive the assigned Point in a direct Line with that which you look along, you have found the Place; but if the Mark lies to the Left or Right, you must remove your Staff, and place it accordingly.

Having explained the Chain, and Cross-Staff, it follows next to say something of the Field-Book.

SECT. IV.

Of the FIELD-BOOK, and Directions in the Fields, &c.

HAving now particularly described the Chain, Measuring-pins, Cross staff, &c. I propose here to shew how to prepare the Field-Book, and also the Method of entering the Field Notes or Dimensions, with all imaginable Exactness, by a Pen, and not with black or red Pencils, lest the same should be effaced by the rubbing of the Leaves, which often happens.

First, Of the Field-Book.

1. Let your Field-Book resemble that of a common Pocket-one, with a Clasp on one Side of the Cover; which, when you have made an Entry, being placed between the Leaves, the Book may be returned to the Pocket, without Obliteration.

2. Each Page therein must be divided into two equal Parts or Columns, by a black Line; and if you are to map the Field which you are about to measure, let the first Column in each Page, have wrote on the Top thereof, the Field's Name; under which the Dimensions of the same must be inserted, as hereafter: The Right-hand Column must be reserved to contain necessary Remarks, which frequently occur, such as Timber, Ponds, Pits, Plantations, Buildings, Gates, and Styles; together with the Bearing of remote Objects remarkable, as Steeples, Windmills, Towns, Cities, *&c.* which being properly represented (if Room permit) in a Map, will be an additional Embellishment thereto. But if the Land which you are about to measure, is not to be mapped, then there will be no Necessity for appropriating the Right-hand Column to any such Remarks.

Observations.

1. Remember to express therein the Owner's Name, *&c.* of the Estate that you are to survey, thus:

Dimensions of an Estate (Demesne or Manor, *&c.*) in the Parish of———, in the County of——— belonging to C——— D———, Esq; and now held by——————. Here mention the Tenant or Tenants Names, if more than one; and where you begin, enter the Tenant's Name above your Dimensions; do so in each distinct Tenement.

2. The Reader will find the Form of this Book claims the Preference to all others used in this Science; as it is not only plain and concise, but absolutely compleat also, and is intirely new to any thing of the Kind ever attempted before. However, I am not insensible, that there are scarcely three Surveyors in the Kingdom that have exactly the same Method of entering their Field Notes: Some that I have seen were not only intricate, but confused also; whilst others were both numerous, tedious, and full of writing, which induces me to recommend to Practice, the Use of the following Form, as it is peculiarly adapted to Dimensions taken by the Chain.

The

The FORM of a FIELD-BOOK.

John Ancker's holding

Dairy-Field.

South Off-set, &c.

At 0	——	0
3.67	——	17
4.90	——	1.62
7.84	——	74

East Off-set, &c.

Note, This Method of entertering Dimensions, shall be more fully explained in a proper Place.

REMARKS.

A Pond of Water on 6 Chains, Right-hand Perpendicular.

15 Timber Trees on South Side *Dairy-Field*, equal Distance.

Thus expressed, 15 T.T. eq. D.

Note, If you would distinguish the Timber, you may observe the following Characters, *viz.*

a — Ash, A, large Ash.
o — small Oak: O, large ditto.
p — poplar, &c.

A few Days Practice in the Fields will render such Remarks both familiar and easy.

More Directions to young Practitioners in the Fields.

First, In measuring by the Chain only, or taking exactly the Dimensions of any Field, or enclosed Piece of Ground, it is most methodical to begin at some remarkable Place, *viz.* House, Gate, Style, Tree, &c. and for want of such, fix a Mark at your starting Place, as directed in the first Section of this Chapter; and from thence proceed orderly according to the Situation of the Field, *viz.* If a four-sided irregular Field, first straighten the Boundaries thereof, by taking up the Off-sets, as hereafter taught; and the Body of the Field you may take up in a Trapezium, or Rect-angle, whichever seems convenient.

Secondly, It is not material in measuring with the Chain, whether you go to the Right-hand or Left, that is to say, with or against the Sun.

Thirdly,

Thirdly, It will not be amiss for the young Tyro (ere he is perfect in Field Practice) at his Entrance into the Field, to observe, if possible, its Form, and with a Pen or Pencil draw (at Adventure) a Figure that may somewhat resemble the same, which will enable him to plan, when in his Chamber, the Dimensions thereof with less Hesitation: But when he is ready in the practical Part of Surveying, such Delineations will be unnecessary.

Fourthly, When you are accidentally obstructed in measuring any Line by the Interposition of Pits, Ponds, or any thing else, you may, at the Brink of the Pond, or Pit, stretch the Chain to the Right or Left (which ever is most convenient) at right Angles to the Line you are measuring; and at the End of that Chain, &c. you may proceed parallel to your first Line, until you are past the Pond; then one Chain, &c. at right Angles, on the Side the Pond lies, will bring you in a Direction with your first Line.

Fifthly, When the Field contains a great Number of Sides and Angles, and being bounded on one Side by a Brook, or River, your first Care must be to streighten the Hedges, Brook, &c. as directed in Chapter VI and VII, then measure the Body of the Field as therein directed.

Note, In mapping old Brooks, which generally have numberless Turnings, and curved Windings, it is extremely difficult (I might have said impossible) to express the same when taken from a small Scale; notwithstanding, you must, in taking the Dimensions thereof, always be very particular (*see Example* II. *Chap.* VII.) howsoever all Brooks, and whatever Branches of Rivers which you meet with in your Survey, should be expressed, and particularly where they run into the main River, provided the Estate you are measuring conjoins, or is situated near the same.

Sixthly, If you chuse, you may remark in your Map (provided the Size of your Vellum will admit thereof) all contiguous Edifices, *i. e.* Castles, Halls, Houses, Mills, Churches, and Objects of Note; which, if well finished, will be a great Ad-

dition

dition to its Beauty, to perform which, you have Directions in the second Part of this Book.

Note, If any thing of the above occurs in the Estate you are surveying, see that you neglect not to notify the same; and place it in your Map accordingly.

Seventhly, In measuring a Base-line adjoining a Hedge, it sometimes happens that you are prevented chaining so near the same as you should, by the Obstructions of Briars, Thorns, Pits, Bushes, or other Things intercepting; in this Case you must measure a straight Line at some convenient Distance parallel (if you think proper) to the Hedge; and from thence erect Perpendiculars to each Turning, (as directed in *Problem* I. *Chap.* VII.) noting the same down as an Off-set; whether on the Right-hand or Left-hand, it matters not with its Situation, as suppose a South-East Off-set, Left-hand, (with the Field's Name right over it) thus:

Dairy Field,
S.E. Off. L. h.

The Notes in the foregoing Field-Book explained.

First, At 0, that is, at no Length, it is the first Perpendicular, provided you don't begin in the Corner of the Field, otherways it would be at 0, it is 0, that is to say, at no Length, to wit, the Beginning it is no Breadth, &c. This is effectually explained in the following Chapter; but herein carefully observe, that when you come to the Hedge where the Mark is fixt to which you measured, if the Ditch be in the Field, suffer your Chain-Leader to go no farther than the nearer Side of the Ditch, else allow four Feet, or six Links, (*see the following Section*) for a Ditch, the Ditch being the Property of the next Field: And if it should happen, as it often does, that there is not quite a Chain between the last Arrow, or Pin, and the Hedge or Ditch you are to measure to, let the Chain-Leader fix the Chain End at the Ditch Side, and hold it there till the Measurer (laying down the Chain straight) comes to the last Arrow, and laying hold of the Chain thereat, take it up, and count the Links by the Help of the Brass Marks before-mentioned, which must be inserted with the

the Chains that the ſaid Lines meaſure to: As for Inſtance, ſuppoſe you are ſtanding at the laſt Arrow, and diſcover it to be one, two, or three Tens, and ſome odd Links paſt, or more than 50, which muſt be reckoned to 50, and the Sum will make 60, 70, or 80, together with the odd Links.

The like is to be obſerved in all other Examples of this Kind in Chaining: One Day's Practice in the Fields with the Chain, will render you much more perfect in counting the odd or ſurplus Links, than ſeveral Pages filled with Explanations thereof.

Secondly, As you are chaining your Baſe-line, and a Turn or Bend in the Hedges appears, which you find directly oppoſite to 3 Chains 67 Links, you then meaſure with your Staff, being 8 Links in Length, (the Chain lying on the Ground at full Length) the Diſtance between 67 Links and the Corner, being juſt 17 Links, which you muſt thus enter in Figures: At 3.67——.17, and then proceed with your main Line, and oppoſite 4 Chains 90 Links, another Turn appears in the Hedge, which you muſt alſo meaſure as above directed, and enter it likewiſe down thus: at 4.90————————1.62. When ſtanding at this laſt Corner, you obſerve the Hedge to be ſtreight to the End, and therefore there will be no Neceſſity for any more Perpendiculars till you finiſh the Line, and then you take up the laſt, *viz.* at 7.84————————.74.

Here note, The Word *at*, is always underſtood, but never expreſſed for Brevity ſake.

An Off-ſet, and how taken, explained.

Thirdly, An Off-ſet is an irregular Space of Land, intercepted between a Baſe Line, and the ſubtending Limits of an Incloſure, to every Corner of which, Perpendiculars are, or ſhould be, raiſed. *See Example the 2d, Chap.* V.

Fourthly, The Situation of an Off-ſet, reſpects the cardinal or chief Points of the Compaſs, by ſome called the Mariners Compaſs, *i. e.* Eaſt, Weſt, North and South; but when Land is to be meaſured only, and not mapped, there will be no Neceſſity to regard the Bearing or Plan thereof; and as there are Numbers of Country People whoſe Ambition aſpire no higher than to

meaſure

measure a Field or *so*, I therefore would advise all such, unless they chuse it, not to burthen their Memory with this Article: However, for the Edification of the young Tyro whose Inclination is fully bent to become a complete Surveyor, I shall endeavour to gratify his craving Desires, by a thorough Explanation of every Thing that appertains to Field Practice. And,

First of the Compass, which contains 32 Points with regard to Navigation, but in Surveying they are reduced to 8, namely, the 4 cardinal or chief Points, as East, West, North and South; and four compound, *viz.* North East, North West, South East, South West; which are abbreviated in the Field-Book, and may be expressed by their initial Letters, to wit, E. W. N. S. NE. NW. SE. SW. *See Example 1st, Chap.* VI.

And that the Learner may not be at a Loss, when in the Field, how to adjudge the Bearing of each Off-set therein, let him call that Side of the Field next the Sun's rising East, the opposite Side will be West; and in chaining from the West towards the East, he'll have the North on the Left-hand, and South on the Right: But if he should chain any how between the above-mentioned chief Points, that is to say, between the North and East, (*See the Field* O, *Example 5th, Chap.* VI.) and an Off-set should occur on either the Right or Left-hand, that upon the Right will be a South East one; and the Left-hand Side must be called, or entered, a North West Off-set. As this Method of Entry with regard to Off-sets, is most useful and new to any thing heretofore published, I shall beg Leave to be something more particular, since the Progress or Proceeding in the Field hath an absolute Dependence thereon.

First then, When the young Tyro enters a Field, let him observe, with Care, the Situation, with regard to the East, West, North or South Sides thereof; and whatever Lines he measures when straightening the Sides, or otherwise, he must enter the same as above directed; i. e. if an Off-set occurs to the Right or Left-hand of the Base Line, (then in chaining) the Side that subtends to the North, is called a North Off-set; if the West, it is called a West one; if the South, a South one; and if it subtends any how to the North West, it must be called, or entered a North-West Off-set, &c. &c. as already above directed.

N Secondly,

Secondly, But if, in his Conjecture of the Field's Situation, he should vary a Point or two, it is not very material; however he must be careful to correct the Mistake ere he leaves the Field, or returns a Map thereof, which he may perform thus:

Let him observe when the Sun is full South, that is, when it is Noon or Mid-day; and whatever Line he has taken in the Fields that points thereto, is a Meridian Line, by which the Situation may be accurately corrected: But if any of the Lines be at right Angles thereto, it is then an East and West Line, by which also the Meridian is found.

Thirdly, It happens sometimes in hazy Weather, when the Sun don't appear, that a Surveyor will be at a Loss to form an Idea of the Land's Situation; in those Cases an Opportunity must be embraced when the Sun shines at Noon, to observe what Hedge or Line points thereto, which when found will be a Meridian Line.

Fourthly, Here note, you'll have no Occasion to regard the Variation of the Compass, when you have obtained the Meridian Line by the Help of the Sun.

Note also, If you cannot obtain the true Situation by Reason of the Sun's Obscurity, or otherwise, and a horizontal or direct Sun-Dial be erected in any Part of the Premises, the Gnomon, or Style thereof, always (if truly erected) points to one or other of the above-mentioned chief or cardinal Points, by which the true Situation may be found.

Fifthly, *An Off-set upon an Off-set*, is when on a Perpendicular an Off-set occurs, in *Example 2d, Chap.* VII. On the third Perpendicular to the Brook an Off-set presents itself, which see; and also the Method of Entry.

Sixthly, In mountainous or hilly Grounds, measure the Superficies thereof, and return the same, being represented as such in your Map, as directed hereafter; but be careful not to encroach into, or upon the adjacent Inclosures, but fix the Hill or Mountain on its true Foundation, which you may do by the Help of

plane

plane Trigonometry, by taking the Hill's Altitude. *See the second Part of this Treatise.*

Seventhly, If your Orders be to return an Account of the Timber in the Survey, first plan the Whole; and if you think proper you may take the Plan into the Fields afterwards, and note down, with a lead Pencil, not only the Number of Trees as they grow in the Hedges respectively, but also whatever else is remarkable, as Pits, Ponds, Roughs, Gates, Styles, or any notable or remarkable Thing omitted in your Dimensions, by which Means you'll have a perfect Plan to compleat a Map by.

Eighthly, When you have measured the Timber according to the Directions given in the Appendix, if the Land is to be sold, you should prefix an Account thereof in some vacant Place of your Map; or rather give an Account of the same upon a Slip of Paper to your Employer, which will enable him, if necessary, to dispose of the same, perhaps, to better Advantage.

Ninthly, If a woody, marshy, watry, or other inaccessible Piece of Ground be enclosed on each Side with open and clear Land, you need only measure and plan the circumjacent Land, and the inclosed will appear. *Otherwise see Problem* II. *Chap.* X. *Part the first.*

Tenthly, When you are to survey a Manor or Lordship, where there are Houses, Yards, Gardens, Orchards and Folds, or other small Inclosures, it is best to begin with the large open Fields; and if you chuse your mean Line may pass near the same, by which Means you may take up the same between two adjacent Perpendiculars; (*See Plate the Second*, wherein you'll find an Instance given for your Improvement) for it often happens, by Reason of Dunghills, Ponds, Buildings, &c. you cannot conveniently come at or to them to measure; but when you have got the same between any two Perpendiculars, by taking up the Off-sets herein after explained, you'll have them represented in their proper Place.

Eleventhly, And although the Cautions and Directions to young Practitioners now recited, seem to open a Sluice to Explanations peculiar to Field Practice, yet, nevertheless, all the succeeding Examples must be carefully considered, and duly regarded, otherwise the young Learner will find himself greatly deficient when he comes to real Practice.

Thus, Having compleated the Dimensions, Remarks on Timber, Situation, Woods, Bogs, Hills, Rocks, Fountains, Moors and Marshes, with every other Material proper to be remarked or noticed; the next Care will be to draw a fair Map of the Whole, according to the Directions laid down in the last Chapter, *Part the first.*

Note, Here follows a few more Directions to young Practitioners in the Fields, very necessary to be understood, concerning the Boundaries of Land, and what Breadth is generally allowed for Ditches, &c.

But here observe, All Countries differ some little in these following Articles, and consequently the prevailing Law of Custom must take Place; nevertheless, I hope it will not be taken amiss to lay down a few Directions whereby the young Learner may be enabled to use such discretionary Means as corresponds with the peculiar Custom of each Place: In many Places the Surveyor measures the Boundaries no farther (for their own Ease) than where the Quicks are or should be planted: I'll admit this Rule within the Bounds very proper, otherwise very uncertain.

Of the Boundaries of Land, and what Breadth is commonly allowed for Ditches adjoining Commoning, &c.

First, When any Part of the Estate you are to measure lies contiguous or adjoining to Forests, Commons, or waste Land, you must allow four Feet and a Half, or seven Links, for all Ditches adjoining thereto; and four Feet between Gentleman and Gentleman.

Secondly, All Roads, whether private or public (Foot Paths excepted) should not be measured upon any Tenant who pays for his Holding by the Acre. There is no Gentleman will insist upon Payment from a Tenant for Land that is promiscuously the Property of the Public: I look upon it as the most unreasonable Thing in Life,

A Tenant to pay for what others possess!

(the Case in *Ireland*) which undoubtedly is owing to an Error in the Judgment of the Surveyor. This Mistake, I imagine, has been first introduced in that Country through the Cheapness of Land, perhaps some hundred Years ago, when good Land was let at Eighteen pence or two Shillings an Acre, so that the King's Road (*as they call it, though in Fact it is the poor Tenants who pay for it*) passing through a Farm, could not amount to an extraordinary Sum at so small a Trifle per Acre; but now-a-days, as Land *there* sets for between 20 and 30 Shillings, it would be very hard upon a poor Tenant to find the Public a Road which costs him yearly, perhaps, six, eight, ten, or twelve Pounds. I am positively certain, that if every Measurer *in that Country* would represent the Unreasonableness of the above Custom to the Gentlemen who employ them, the same would be immediately redressed, and that severe Practice would be utterly abolished, to the great Comfort and Satisfaction of the poor Pains-taking Tenant, who, perhaps, labours under the heavy Burden of a Rack-rent, and a helpless growing Family, whose Prayers would undoubtedly attend every Surveyor by whose interesting Means such Grievances were removed.

I would not be understood, that Roads should not be measured: No, my Intention is foreign to any such Thing; for I would have them measured and mapped accurately, and returned as such, and not as arable Land, *&c.* which is too often the Case.

Thirdly, When the Estate, or any Part thereof, is bounded by a River or running Brook, measure no farther upon the Tenant than to the Water Side; but in your Map be careful to represent the Brook, or River, as before-mentioned, (*See the 4th Section of this Chapter*) and half the Area thereof should be returned with the Roads, *&c.* thus: Roads, Brooks, *&c.* contains——————————

Fourthly, when the Boundaries are Stone, or Brick Walls, measure no farther than the Outside thereof.

Fifthly,

Fifthly, If a Turnpike-Road should pass through any Part of the Estate, allow 30 Feet for the Breadth thereof, that is, measure within five Yards of the Road's Centre, unless the Fence on either Side proves closer together, and then you must measure up thereto.

Sixthly, If Moors, Marshes, Bogs, Heaths, Shallows, Pools of Water, Shrubs or Rocks, belong to, and adjoin the Estate, measure what is improveable first; and if any of the rejected Part will admit of Improvement, measure and return it as such; the Remainder should appear in your Map as unprofitable Ground.

Seventhly, In the Map it will be proper to shew to whom the Land belongs that surround the Estate; which must likewise be observed when taking up the Dimensions; but if you should happen to omit such necessary Remarks in the Field-Book, the Tenant or Person who occupies the Estate can inform you, by the Plan, where such and such a Gentleman's Land commences, and also how far it continues, which you may accordingly enter in your Plan as effectually as if you was directed by your Field Notes. Many more useful Directions might herein be given with regard to Mapping, but as they don't relate to Field Practice, I do not think proper to recite them, although there are Numbers in *Great-Britain* that pretend to map, who are absolute Strangers to the Field Occurrences; for the Surveyor draws the Plan from his Dimensions, by which any Person skilled in Drawing may form an accurate Map therefrom.

And lastly, of *Balancing-Lines*.—Having already observed that those Lines were either real or imaginary, which some Practitioners grossly supposed to give and take equally; however probable or absurd this may seem to the unprejudiced Reader, I'll not pretend to determine, but shall appeal to the discretionary Judgment of the Public.

Of Balancing-Lines in the Fields.

First, The Practitioner institutes these Lines to avoid some Fatigue in chaining, *i. e.* when a curved or circular Hedge or Brook occurs in the Survey, he fixes upon a Place in or near the Corner or Fence thereof; and then (if not before) must have Recourse

courſe to his darling Aſſiſtant *Eſtimation*, by fixing on a Place or Object at the other End of the Fence, within or without the Incloſure, as his judgmatical Eye directs; and then ſuppoſes that if a right Line was meaſured between theſe two Places, it would croſs the intercepting curvilineal Fence in ſuch a Manner, that if the excluded Land on the one Hand were accurately ſurveyed, it would be equal to the included Land on the other, to wit, the Land *this random Balancing-Line* meaſured which belonged to the adjaced Field: I would not be underſtood in this Place to affirm, that ALL modern Practitioners are guilty of this abominable, this erroneous Practice; but am afraid too many are. However, this will readily be granted, *When once a Man's Name is up, he may lie in Bed*, comparatively ſpeaking of thoſe indulgent Practitioners.

Of a Balancing-Line in the Chamber.

Secondly, This is what I term a real Line, it being really drawn upon Paper. In the 430th Page of *Whiſton's Survey*, you'll meet with the Uſe and Application of this fictitious Line, deſignedly illuſtrated, as I ſuppoſe, to prejudice the Unlearned.

Alſo, in the Works of our modern Mathematician, the famous Mr. *Hutton* very ingeniouſly recommends a Horſe-hair to be applied to the irregular Bounds of an Incloſure when planned; by which Means he (Mr. *Hutton*) aſſerts, that the Eye can accurately determine the Equality of all ſuch curvilineal Spaces. I am very ſorry that this Gentleman ſhould trace not only the Footſteps of others, but alſo ſlip into their Errors too. My Sincerity to the Public hath induced, or rather prevailed on me to point out this Sand-bank of Deſtruction, where undoubtly thouſands were hitherto bewildered and loſt.

Doubtleſs, the above Remarks will give ſome little Diſguſt to thoſe who have heretofore relied on the Authenticity of antient and modern Authors. I am not a little concerned that it proved not the Lot of ſome abler Pen-man to explain the Conſequence that muſt unavoidably attend ſuch gueſs Work; however, I muſt confeſs that all ſuch are leſs blameable, than thoſe Authors from whence they learned.

CHAP.

CHAP. IV.

In this Chapter, and the three succeedings ones, I have given plain easy Rules and Directions to measure with the Chain only, and cast up by the Pen, all Manner of Inclosures (though bounded with old Brooks, curved or circular Hedges, &c.) with a full Description of not only the Earth's Superficies, but also Field Occurrences; with both useful and necessary Cautions to young Practitioners therein.

Observation.

IN surveying of Land by the Help of an Instrument, the Surface of the Earth, though uneven, is considered as a Plane: The Meridians (with regard thereto) are supposed to be parallel; but it being obvious to the naked Eye that the Superficies of the terraqueous Globe is both irregular and uneven; hence arises the chiefest Cause of a Disclose and a general Discord, between the Northings and Southings, Eastings and Westings, which too frequently attend the Practice of the Needle: And yet where is the Practitioner that does not impute these Differences to either the Imperfection of the Needle, the Variation of the Compass, or Incorrectness in Chaining, *&c.* However, in a proper Place in this Treatise, I shall endeavour to prove, that the above-mentioned Differences proceed more from the Unevenness of the Earth's Surface, than any thing else, when Care be taken in chaining, *&c.* and here shew plain and easy Rules. First, *To measure and find the Content of any regular Inclosure by the Chain and Pen.*

Having in the last Chapter observed, that my Intention was to avoid all Prolixity, if possible, that I might thereby prepossess the young Learner in Favour of so healthy and delightful a Study, I come now to shew and teach him how to measure with the Chain, *and cast up with the Pen*, the Dimensions of any regular Field, that is to say, to discover how many Acres, Roods and Perches, are contained therein. And first of

SQUARE FIELDS.

Though such are seldom met with; and if by Chance one meets with an Inclosure, that is, a geometrical Square, yet there is a Hazard in taking the Dimensions thereof, and casting them up according to that well-known Rule of multiplying the Side into or by itself, and therefore I shall recommend a more satisfactory (though perhaps in this Case not so expeditious) a Method: And that is, when you come to measure a Field that is supposed to be square, fix your Staff in a Corner thereof; and if the two next Sides are at right Angles, erect a Perpendicular on one Side, leaving your Staff in the Corner standing; and when you have measured the Side, enter it down, and come back to your Staff; then measure the other Side (which if it be a Square, will be equal to the former) and at the End thereof (if the third Side be perpendicular to the Base or last measured Side) measure its Length also: Now if the Base and each of the Perpendiculars be equal, the Field is a true Square, otherways not. If square, you may either multiply the Side by itself, or cast it up, as is taught in the second Problem of this Chapter.

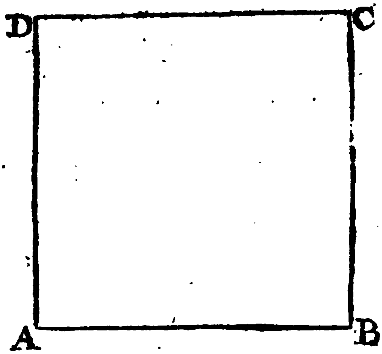
PROB. I.

Let it be required to find the Content of a square Piece of Land.

N.B. The superficial Figures in the four next succeeding Chapters, represent Inclosures laid down by a Scale of 40 Statute Poles, or 10 Chains to an Inch.

Example. I.

Let the Figure ABCD, represent a square Piece of Land, I demand the Content thereof in Statute Measure.



Here note, When the Dimensions of Land (taken by a four-pole Chain) are cast up, the Result is either square or half square Chains, according as the following Rules direct. But if the Dimensions were taken by a one Pole Chain, the Result would be square or half square Poles; and so of any other Dimensions.

First, When you come into the Field ABCD, make for the Corner A (though any Corner in the Field would answer the same End) and there place your Cross-Staff, by which the Side AD will be found to stand or lie perpendicular to AB; then measure the Side AD, and you'll find it to be 16 C. 82 L. which enter as below; come back to the Staff, take it up, and measure the Side AB, which you'll find to be 16 C. 82 L. Also, lastly, fix your Staff in the Corner B, and you'll find that the Side BC is likewise perpendicular to AB, which being chained, will be found to agree with the former, *viz.* 16 C. 82 L. Dubious of the above Figure being a geometrical Square, I thought it expedient to make Entry as follows, *viz.*

The

The Dimensions.

	C. L.
At 0 ————————	16.82
At 16.82 ————————	16.82

In Words thus expressed:

At the Beginning, that is, at no Length, it is the first Perpendicular AD = 16.82. And at the End of the Side AB = 16.82, it is the second Perpendicular BC = 10.82. Now as the Sides are équal, and the Angles equal also, it is therefore evident, by the 46th *Prop.* 1 *Euclid*, that it is a geometrical Square.

RULE.

16.82 } The Side multiplied by itself,
16.82 } gives the Content.

```
    3364
   13456
  10092
  1682
  ---------
  28.29124
         4
  ---------
   1.16496
        40
  ---------
   6.59840
```

	A.	R.	P.
Answer	28	1	$6\frac{1}{2}$

Point off the fifth Figure, the Remainder to the Left-hand are Acres; and the Right-hand Figures are decimal Parts of an Acre.

The Learner may perceive, that to cast up the Dimensions of a square Piece of Land, is attended with no Sort of Difficulty, provided the Dimensions be carefully taken: The Method of working them is so easy, that I think a second Example would be needless.

PROB. II.

Let it be required to find the Content of a rect-angular Piece of Land, commonly called an Oblong, or long Square.

Example.

Let the rect-angular Figure ABDC, represent a Piece of Land, I demand the Content thereof.

D C

B A

Note, Fields of this Kind are oftner met with than the former; so that in measuring this, and all such like Inclosures, you must proceed as you were taught in the last Problem; and if you find the Side AC and BD to be perpendicular to the Side AB, and both equal, you may venture to use the old general Rule in such Cases; to wit, the Length multiplied by the Breadth, gives the Content; but to prevent any Doubts of it's Regularity, fix your Cross-Staff in the Point or Corner A, perpendicular, as before directed, by which you'll discover if the Side AB be at right Angles to AC; then chain the Side AC first; when done, return to the Corner A, and chain AB also. In like Manner you must examine if the Line or Side BD, be likewise at right Angles to AB, which you may know by the Help of your Cross-Staff, chain BD also; and having found the Field rect-angular, enter the Dimensions thereof, thus:

	C. L.	
At 0————————	= 9.54	The first Perpendicular, AC.
At 21.78, or Base	= 9.54	The second Perpendicular, BD.

The

The foregoing Dimensions more briefly entered thus:

0	———————	9.54
21.78	———————	9.54

This Method, I presume, is preferable to any other hitherto published, as there is little or no Time lost in noting down the Dimensions; and yet notwithstanding, the Field Notes are as fully comprehended as if there were ever so much writing made use of therein.

To find the Content of the above, or any such Figure, observe this Rule.—*Multiply the Length by the Breadth, and the Product is the Content.*

21.78				
9.54				
8712				
10890				
19602		A.	R.	P.
20.77812		20	3	4½ Content.
4				
3.11248				
40				
4.49920				

This Problem is not much unlike the former, both in the Dimensions and Work, and therefore it is quite unnecessary to give any more Examples. Seeing then, that the Report of such or such a Field being square, should not have the least Influence upon a Surveyor; and though any one Angle in a Field may appear to contain 90 Degrees, yet, notwithstanding, the remaining Angles may be either acute or obtuse; however, the Cross-Staff will remove all seeming Doubts in regard to Angles therein; and the Chain will discover if the opposite Sides of an Inclosure be equal.

Hence,

Hence, if two equal and parallel Lines, or Sides of a Field, as AD and AC, (*see Example the first*) or as AC and BD, *Example the second*, be joined by two others, those are equal and parallel also, by 33 *Prop.* 1 *Euclid.*

And, by the Corollaries derived from the 32*d* and 34*th* Prop. *Euclid*, 1*st Book*, it is manifest, that if one Angle in a Parallelogram be a right Angle, the remaining Angles are right also; consequently the Areas of Squares or Rect-Angles (by the Rules foregoing) are obtained. *See first Definition, Euclid 2d Book*, &c. wherein you'll find rect-angular Parallelograms defined.

PROB. III.

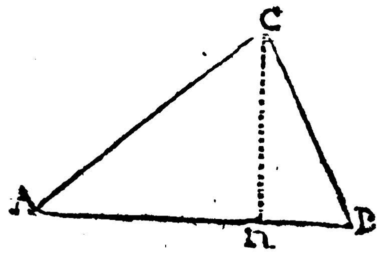
Of Triangles.

Let it be required to find the Content of any plane triangular Piece of Land.

Note, the Area or Content of every Triangle, is equal to half the Rectangle contained under the Base and Perpendicular of the same; that is, the Base multiplied by the Perpendicular, half the Product is the Content. There are several other Methods of finding the Area of Triangles, but this is sufficient for our Purpose.

Example.

Suppose the Triangle ABC represents a Piece or Parcel of Land, I demand the Content thereof.



Now, in order to measure this Triangle, begin at A, and chain towards B; when you come to n, that is, 9 Chains 24 Links,

Links, upon the base Line, you'll find by your Staff, that the Perpendicular n C, will rise at the Point n, which you must chain or measure ere you proceed farther, and you'll find it to be 21 Chains, 36 Links; then return to, and measure from the Staff to the End of the Line or Corner B, always remembering to leave the Arrows with the Staff which belonged to the Side or Base AB, that is to say, those Arrows that you took up before you engaged the Perpendicular; and the Arrows that belong to the Perpendicular return to your Assistant at the End thereof: When you come back to the Staff, retake the former Arrows, and then proceed till you have chained to the End of the Base.

The Dimensions are thus entered:

	Chains.
At 0	0.0
9.24	21.36
33.60	00

See the Work.

The Base AB = 33 60
The Perpendicular n C = 21 36

```
       20160
      10080
      3360
     6720
  2)717.6960
    35.88480
           4
    3.53920
         40
   21.56800
```

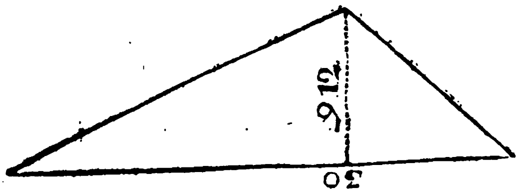
Take half the Product, otherwise when you use a four-pole Chain, multiply the Product by 8, and that last Product will be

square

ſquare Perches, which being divided by 40 and by 4, gives the Content. See the following Examples.

Example II.

Let the annexed Figure repreſent a triangular Piece of Land, I demand the Content thereof.



Dimenſions.

2188¾

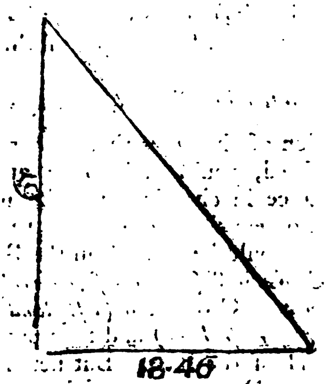
0 ———————————— 0.0
30.00 ———————————— 9.12

```
          9 12
          30.
        ------
        273.60
             8
        ------
    40)2181 8.8
        ------
     4)54  28
        ------
Anſwer  13 2 28¾
```

Example III.

Let the following Figure repreſent a triangular Field, I demand the Content thereof.

Dimenſions



Dimensions.

19.05	18.46

$$
\begin{array}{r}
18.46 \\
19.05 \\
\hline
9230 \\
166140 \\
1846 \\
\hline
2)35.16630 \\
\hline
17.58315 \\
4 \\
\hline
2\ 33260 \\
40 \\
\hline
13.30400
\end{array}
$$

	A.	R.	P.
Answer	17	2	14¼

I hope, that the placing the Dimensions of the two last Examples upon their Bases and Perpendiculars respectively, will be as readily understood as if Letters were prefixed to each angular Point or Corner, as in the first Example of this Problem.

Explanation in the Field, Example II.

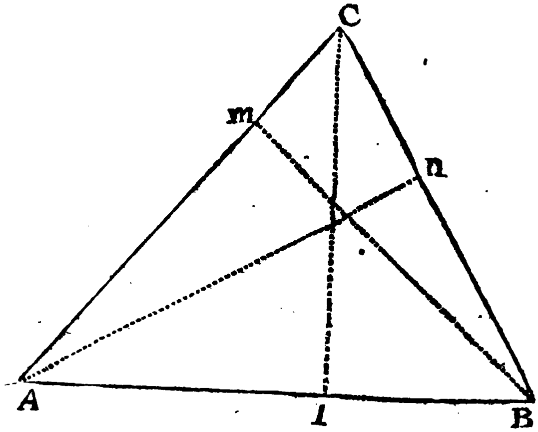
First observe which of the Sides thereof appear to be longest, which, when measured, you'll find to be 30 Chains; but be careful as you advance in chaining, to take up or measure the Perpendicular thereto, equal to 9 Chains 12 Links, the particular Place where it should be erected on the Base, you'll find by the Help of your Cross-Staff *(as heretofore directed*;*)* which when measured, return to your Cross-Staff *(left standing where the Perpendicular arose on the Base Line)* and then proceed till you have measured to the End of the Base. But here note, if the Field should be planned, the Dimensions must be entered thus:

0	——————	0
12.	——————	9.12
30	——————	00

Otherwise it would be impossible to form an accurate Plan from the Dimensions, as the Surveyor could not, with any Certainty, pretend to erect the Perpendicular in the identical Place on the Base where the same was found. But when the Field is not to be planned, it is not material whether or no you take Notice thereof in your Field-Book, and though you did, the Trouble is but trifling; however, I'll leave you to your own Discretion in this Particular; but in all other Cases (as is hereafter taught) you must be exceeding careful to note or enter down every particular Place where you erect such Lines.

Note, That any Side of a Triangle may be measured for its Base, and erect a Perpendicular therefrom to the opposite or subtending Corner, and the Content of the Triangle will be equally the same, as for Instance:

Suppose it were required to measure the Figure ABC, which represents a triangular Field.



First, then, chain the Side AB, and at the Point I erect the Perpendicular IC, and enter it thus:

0	————	0.00
26.51	————	19.40

See the Work.

```
  26.51
  19. 4
 ------
  10604
 23859
 2651
 ------
2)51.4294
 ------
25.7147
      4
 ------
 2.8588
     40
 ------
34.3520
```

 You'll

Secondly, Chain the Side BC, and Perpendicular *n* A, as before, and set down the Dimensions thus:

C.	C.		A.	R.	P.
0 ————————	0.0	The Content	25	2	34
22.00¾ ————	23.37 Perpendicular.				

Thirdly, Chain the Side CA, also the Perpendicular *m* B, and enter the Dimensions thereof thus:

C. L.	C.		A.	R.	P.
0 ————————	00 0	Content, as above	25	2	34
25 08¾ ————	20 50				

	A.	R.	P.
The Content of the foregoing Field, when the Side AB is chained for the Base, is — — — —	25	2	34
BC chained, the Content is — — —	25	2	34
And the Side CA chained, the Content is —	25	2	34

Now, I hope the Learner is satisfied that it matters not which Side of a triangular Field he chains for a base Line, always remembering to raise a Perpendicular thereon, that shall fall into the subtending Corner directly. However, I would recommend to the Practitioner, always to measure the longest Side of any such Field, as the Work is performed with less Trouble, and the Place where the Perpendicular should rise sooner discovered or found, though the contrary has been approved of, and recommended to the Public notwithstanding.

PROB. IV.

Of a Trapezium.

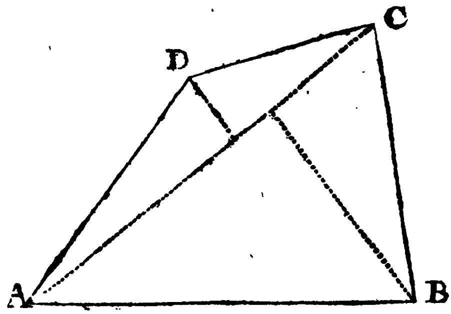
Let it be required to find the Content of a Field that is comprehended under four unequal Sides.

In all such Fields, when the Hedges are straight, I would only recommend two Methods to survey the same; but in this Problem can only mention or shew one; however, my Reader shall have the other before I close this Chapter; and in the mean Time I'll venture to assure him, that it is preferable to this, since it it is done with less Trouble and as correctly as the common Way; but we are not come to that yet.

The common Way then, of measuring a Field of four unequal Sides, is by measuring or chaining from any one Corner to the opposite one, which divides the Field into two Triangles: And in chaining this Line (generally called the Diagonal) you must erect Perpendiculars severally to the other Corners of the Field, as taught in the last Problem; so that as the Diagonal is a Base-Line common to both Perpendiculars, you may add the Perpendiculars together, and multiplying their Sum by the Diagonal, half the Product is the Content.

Example.

Let the Trapezium ABCD, represent a four-sided Field, I demand the Content thereof.



Now to measure the above Field by this common Method, begin at the Corner A, and chain to the opposite Corner, namely, C; and as you proceed you'll find (as before taught) the Perpendicular D to rise first, which measure and enter as below; and where the Perpendicular arises, measure it also, always remembering to leave the diagonal Arrows with the Staff standing where you find the Perpendicular to rise, which will help you to discover where the last Arrow in the Diagonal or Base Line sticks; as also the Arrows that belong to that Line, which must not be mixt with the perpendicular Arrows; (otherways a Mistake may ensue)

ensue) retake the diagonal Arrows and Staff; come up to the standing Arrow, and then proceed; in like Manner you must find the other Perpendicular; return and chain the Line to the End or Corner C, which you'll find to be 23 Chains 12 Links.

Note, *You must not forget, at the End of any Perpendicular, to return the Arrows to your Leader.*

The above Dimensions should be entered in the Field-Book, thus:

At 0 ——— it is ——— 4.45 the first Perpendicular.
23.12 ——— 12.10 the second Perpendicular.

Note also, If the above Trapezium was to be planned, it must be thus entered:

0	0.0	
14.0	4.45	Left-hand Perpendicular.
15.35	12.10	Right-hand ditto.
23.12	00	the Corner or End.

According to the foregoing Rule, add the Perpendiculars — — — } 4.45, 12.10

```
                               4.45
                              12.10
                              -----
                   the Sum    16.55
And multiply by the Diagonal  23.12
                              -----
                               3310
                              1655
                             4965
                            3310
                            --------
                          2)382.6360
                            --------
Half the Product is —     19|1.3180  Acres.
                                4
                            --------
                             .52720
                                 40
                            --------
                           21.08800
```

And

		A.	R.	P.
And the Content, as appears by the Work, is		19	0	21

The remaining Decimals are insignificant.

PROB. V.

To find the Content of any four-sided Field, having two of its Sides parallel though unequal, and a third perpendicular thereto.

SCHOLIUM.

The Area of every such Figure, is equal to half the Rectangle contained under the Perpendicular, and the Sum of the parallel Sides.

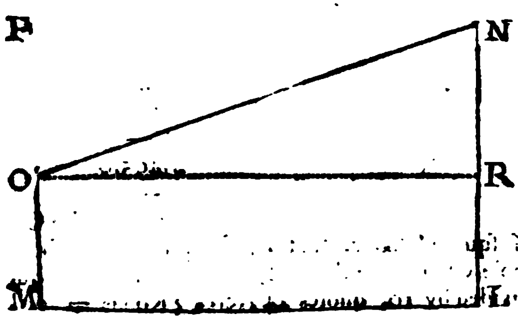
Example.

Let the Figure MLNO represent a Field bounded by four unequal Sides, containing two adjacent right Angles, *viz.* the Angle M, and the Angle L, I demand the Content thereof.

First, By the Cross-Staff you'll find the Line MO to be perpendicular to ML, which measure and enter down thus:

At the Beginning, that is, at no Length, it is the first Perpendicular MO = 7.00 Chains; then chain the Base ML, and the Side LN, which you'll find to be perpendicular to ML also; and enter the Dimensions as before directed, thus:

	C.
0	7.0 or MO.
22.5	15.0 or LN.



A general Rule to find the Content of all such geometrical Figures.

Multiply the Base by the Semi-Sum, to wit, half the Sum of the Perpendiculars, and the Product is the Content.

Otherwise, the Base multiplied by the Sum of the Perpendiculars, half the Product is the Content; I would recommend the latter for its Expedition in this new Method.

See the Work both Ways.

First Method:

First Perpendicular =	7
Second ditto — =	15
	2)22.
Half the Sum —	11
The Base — —	22.5
The Product	247.5 Answer.

Second Method:

	C.
The first Perpendicular =	7
The second ditto —	15
Sum of the Perpendiculars	22
The Base — —	22.5
	11.0
	44
	44
	2)495.0
	247.5 the Content,

which if square Chains, that is, the Dimensions being taken by a four-pole Chain, the Product, as above, is 247.5 square Chains, which divided by 10, quotes 24 Acres 3 Roods = 24.75.

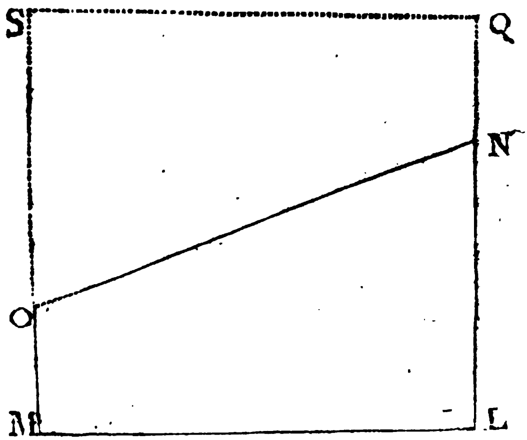
OBSER-

Observation.

When one or any of your Numbers consists of Chains only, there will be no Necessity to prefix Cyphers in the Place of Links, as you may see in the foregoing Example.

The foregoing Figure demonstrated by Numbers, &c.

Draw the Line OR, parallel to ML,——31st *Euclid, Book* I. LR being equal to MO. Hence the Area of the Rect-angle MLRO, is 157.5 square Chains, by *Problem* II. *Chapter* IV, being contained under the less Perpendicular and Base Line, *viz.* $7 \times 22.5 = 157.5$. And $7 - 15 = 8 =$ RN, the Perpendicular to the Triangle ORN, whose Area (by Problem the 3d, Chapter the 4th) is 90 square Chains, found by multiplying half the Perpendicular RN $= 4$ into the Base thus: $4 \times 22.5 = 90$, which being added to the Area of the Rect-angle MLRO $= 157.5$, the Sum will be 247.5 square Chains equal to 24 Acres, 3 Roods, as before.



CONSTRUCTION.

First Produce LN to Q, and MO to S, making NQ equal to MO, and OS equal to LN join SQ. Hence the four-sided Figure MLNO, is equal to the four-sided Figure ONQS; for seeing that LN is equal to OS, and NQ equal to MO, by Construction: Also ML equal to SQ, and the Line ON being common mon to both, it is likewise manifest, that the Angle OML, is equal to the Angles MLN; and if one Angle in a Parallelogram be a right Angle, the remaining Angles are right also; consequently the four Angles M, L, Q, S, are equal the one to the other, each being a right Angle.

Hence the Area of the Rect-angle MLQS, is comprehended under the Base ML; and the Sum of the Perpendiculars, to wit, MO and LN equal by the Construction to LQ, which appears to be double in Area to the Figure proposed, namely MLNO.

I hope the above demonstrated Explanations on the foregoing Figure (with regard to the Rect-angle contained under the Base and Sum of the Perpendiculars) are evidently manifest to every Capacity; but that nothing may be wanting herein to clear up this useful Problem for the Benefit of the ingenious Learner, I shall beg Leave to introduce another Method of proving the same.

DEMON-

DEMONSTRATION.

Let then the Point L be applied to the Point S, the Line ML will coincide with SQ, and the Point O will agree with the Point N. Seeing that MO and QN are equal, and alſo the Line LN, will coincide with the Line OS, hence, if any quadrilateral Figure correſponds in every Reſpect with another, *viz.* when the reſpective angular Points are applied, and the ſeveral Sides coincid reſpectively; thoſe Figures are equal one to the other. For it is granted by the 8th *Axiom*, 1 *Euclid*, that Things which mutually agree, are equal the one to the other. Foraſmuch then as the whole Rect-angle MLQS is contained under the Sum of the Perpendiculars and their intermediate Diſtance: I ſay it is not only equal to the two Figures MLNO, and ONQS, by the 19th *Axiom*, 1 *Euclid*, but alſo double to either one; conſequently half the Rect-angle contained under the Perpendiculars and the intercepting Baſe Line is equal to the Area of all ſuch like quadrilateral Figures, to wit, The Baſe multiplied by the Sum of the Perpendiculars, half the Product is the Content Q, E, D.

I muſt here beg Pardon for treſpaſſing ſo very long (*in this Problem*) upon my Reader's Patience; but as the major Part of the following Work hath an entire Dependence thereon, I therefore thought it an indiſpenſible Duty to be very particular therein.

CHAP. V.

Containing plain and easy Rules to measure with the Chain, and by the Pen to cast up the Dimensions of all Manner of Inclosures that are bounded by right-lined though irregular Hedges.

DEFINITION.

Any Field comprehended under more than four Sides may, with great Propriety be underſtood by the Term Polygon.

HAving in the foregoing Chapter explained and defined all ſuch Fields as are contained under three or four Sides or Hedges, with ſuitable Directions how to meaſure and know the Contents of the ſame, I come, in the next Place, to treat of Fields containing more than four, by ſome called irregular Polygons or Polygrams, but in the geometrical Definitions of this Treatiſe, term'd multilateral or multangular Figures, I have no Objections to the Propriety of the above Appellations, ſince Names are but diſtinguiſhing Characteriſtics *(for the Roſe will ſmell as ſweet by any other Name.)*

And as I have endeavoured to avoid hitherto, every Thing that does not immediately relate to Field Practice, I therefore hope to be excuſed in not giving particular Rules concerning regular Polygons, as they are called: Thoſe Figures are innumerable, being formed by any Number of equal Chord-Lines conjoined in a Circle. They are never met with in practical ſurveying, unleſs in ſome Gentleman's Garden, where Surveyors are ſeldom employed; and though they are, Dimenſions may be taken therein of the moſt regular or irregular Figure, without reſpecting the ſame as a Polygon, which are particularized by ſignificant

ficant Names, according to the Number of Sides that are therein: For Inſtance, a regular Pentagon contains five equal Sides, and as many equal Angles; a Hexagon contains ſix equal Sides, *&c.* a Heptagon ſeven; an Octagon eight; a Nonagon nine; a Decagon ten; an Undecagon eleven; and a Duodecagon twelve. So that in meaſuring any of thoſe Figures with a Chain, the foregoing Method of reducing the ſame into Triangles and Trapeziums, whereby the Area may be obtained, is ſufficient to be underſtood; and therefore it would be great Prolixity to recommend Rules for finding the Content of all ſuch Figures which more properly belongs to another Branch. Though I muſt confeſs, that both ancient and modern Authors have made it their particular Care to treat with great Circumſpection and Formality upon not only Polygons, but Circles, Segments of Circles, and Ellipſis's alſo, *cum multis aliis*, as if ſuch geometrical Figures frequently occured in Field Practice: But let me appeal to the *modern Practitioners*, whether they, during the whole Courſe of their Practice, ever met with any ſuch? If not, conſequently it is unneceſſary to recite any Rules relating thereto, ſeeing the ſame, in this Place, would be looked upon as Tautology in a very great Degree.

Secondly, To meaſure an Incloſure of any Number of Sides more than four, whether a Pentagonal, Hexagonal, or other Form, to wit, of five, ſix, ſeven, eight, or more unequal Sides, the ſame may be performed by diagonal and perpendicular Lines, without having Reſpect to the Equality of the Angles in the Field: To effect which, you are, as before directed, to begin at ſome Corner thereof, always remembering to leave a Mark at the Place of ſtarting, if it be not otherways remarkable by either Houſe, Tree, Gate, Style, *&c.* and from thence proceed to take up the ſame in Triangles or Trapeziums, which ever appear moſt convenient (provided the Hedges be ſtraight, otherways they muſt be ſtraightened by meaſuring a Baſe Line near the ſaid curved Hedge, and erect thereon perpendicular Lines to each and every Turn, or In's and Out's, in the Fence or Hedge contiguous thereto); but be careful to find the Areas of each Triangle and Trapezium reſpectively by the Pen, and not by Scale and Dividers, (the general Method hitherto made uſe of by Practitioners) which Method is moſt certainly attended with the unavoidable Errors of Eſtimation; for, as the Truth of proceed-

ing

ing by Scale and Dividers, to know the Area of an Inclosure, depends upon the Niceness of *Estimation*, it therefore greatly behoveth every one that thus casts up his Dimensions, to be particularly careful and very circumspect in such random Work. However, as measuring by Scale and Dividers is allowed (by the best Judges) to be productive of many different Answers when planned from sundry Scales, (the Result being undeniably false or uncertain). Hence the Necessity of exploding such Practice, is absolutely necessary, when, instead thereof, here is recommended a correct and expeditious Method performed by the Pen, and consequently freed from the apparent, the unavoidable Errors of *Estimation*, which you'll find in the following Chapters.

Thirdly, In planning or mapping, some may have a Desire to take severally the Quantity of the interposing Angles made by every two adjacent Sides in a Field, in this Case you are always to measure regularly round the Field both Sides and Angles, thus; If the Field's Superficies be horizontal, you must place in the Corner where you intend your first angular Point to be, one of your Arrows or measuring Pins perpendicular, and from thence measure two Chains in a right Line with the Mark that you intend to go first to by the Hedge Side; and at the End of the said two Chains stick down another Pin; in like Manner measure two Chains in a right Line with your last Station, or the Hedge which you are to measure last, and there place another measuring Pin likewise, which must be always entered in your Field Book, as hereafter directed; then the nearest Distance between these two measuring Pins being measured exactly in Chains, Links and Inches, and nearer if possible, this last Line is a Chord-line to the Angle sought, and must be accordingly noted down in your Field-Book ere you proceed to measure the Length of the next Side or Hedge. Thus shall you proceed in measuring the intercepting Angles, and the Length of each Side respectively, until you have surrounded and compleated the Field. The particular Manner of effecting the same, will be met with in its peculiar or proper Place in this Chapter, which see.

Observation.

Note, If you are unacquainted with the second Part of this Book, the Contents of those Fields which you measure (as above directed)

directed) by Sides or Lines and Angles, cannot easily be obtained by the Pen, and therefore you must reduce the same to Triangles and Trapeziums in the Field, and measure them accordingly, which is attended with a great Deal of unnecessary Trouble.

Note also, As you are measuring the Length of the Sides in a Field, and the Fence being curved or circular, you must take up the same as directed in Chapter the 6th (which see) and thus enter the Off-set:

An Off. Right or Left-hand — (according as you shall think proper to go round the Field, for it is not material whether you leave the Fence on the Right or Left-hand) first, second, or third Side, &c.

PROBLEM I.

Of irregular Fields, consisting of any Number of Sides and Angles.

How to measure and cast up by the Pen, any Close or Field whose Sides and Angles are both many and irregular.

RULE.

Reduce the Field to Trapeziums and Triangles, and measure each separately; cast up the several Dimensions thereof, and collect their respective Areas, the Sum of which is the superficial Content of the Field.

Example I.

Admit a Field consisting of 7 unequal Sides, *viz.* MNOPQRS, whose Dimensions in Chains and Links are as follow, to know the superficial Content is required.

In this Problem my Reader might have been taught two different Methods of measuring all such-like irregular Fields, *viz.*

First, By Triangles and Trapeziums.
Secondly, By Sides and Angles.

But

But this laſt Method is more properly adapted to mapping, and ſhall be introduced in its proper Place.

Observation.

1. As Surveying admits of an unlimitted Variety of Figures, it is therefore neceſſary to obſerve, that any multilateral Figure of what Number of Sides ſoever, the ſame may be divided into a Number of Triangles leſs by two than there are Sides in the Figure, and conſequently requires ſo many Diagonals leſs by three than the Number of Sides are.

For Inſtance, a five-ſided Figure will have 2 Trapeziums and 3 Triangles; a ſix-ſided, 3 Trapeziums and 4 Triangles; a ſeven-ſided, 4 Trapeziums and 5 Triangles, *&c.* Hence it is, that two being taken from the Number of Sides the Field contains, the Number of Triangles therein remains. And likewiſe 3 being taken from the ſame Number of Sides, the Remainder will always be equal to the Number of Diagonals or croſs Lines therein contained.

2. In meaſuring in a Field by Diagonals, *&c.* it is requiſite to chuſe the longeſt Baſe Line, or Diagonal, for they are not only ſooneſt meaſured, but leſs liable to Error; for the longer the Baſe Line of a Triangle is, the more abtuſe the ſubtending Angle will be, and leſs ſubject to Miſtake, ſince the Perpendicular is ſhorter, and the Place it ſhould riſe much readier found; but, on the contrary, the more remote that Angle is which ſubtends the Baſe, there is more Difficulty in obtaining the identical Place where the Perpendicular ſhould riſe, and the leſs Certainty, which every Practitioner can teſtify; and if you be but one Yard wide of the true Place, you'll certainly make the Land more than it is.

3. It is likewiſe remarkable, in practical Surveying, that a Field or Parcel of Ground (encompaſſed by Hedges) being never ſo often meaſured, will always differ ſomewhat (more or leſs) in the Reſult, for theſe two Reaſons:

1. If any one Practitioner ſhould go nearer the Boundaries than another, or ſink a Link deeper (as we phraſe it) his Dimen-

ſions will of courſe be greater than the other; hence a ſmall Difference may ariſe.

2. The Chain, in taking Lengths, &c. may, more or leſs, (though ever ſo little) deviate from a ſtraight Line to the Right or Left-hand; and otherwiſe by the Unevenneſs of the Earth's Surface, may be more or leſs contracted, &c. However, theſe Differences (with Care in chaining) prove ſo inſignificantly ſmall that they are ſeldom regarded.

These Remarks conſidered as an eſſential Preparative to Field Practice, let us then proceed to work the foregoing Examples, the Dimenſions thereof are as follow.

Dimenſions.

The Trapezium MQRS.

1704.48 C. L.

0 ———————————— 4.45

20.10 ———————————— 6.15

The Triangle MNQ.

262.4

0 ———————————— 0

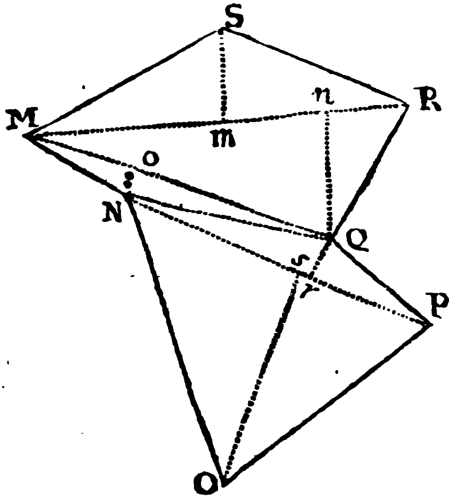
16.0 ———————————— 2.05

The Trapezium NOPQ.

1919.8

0 ———————————— 2.30

16.55 ———————————— 12.20



See the Work.

Trapezium MQRS.

1ſt Perpendicular	4.45
2d Perpendiculars	6.15
Sum of the Perpendicular	10.60
The Diagonal	20.10
	10600
	212000
The double Area	213.0600
	8.
Poles	1704.48

The Triangle MNQ

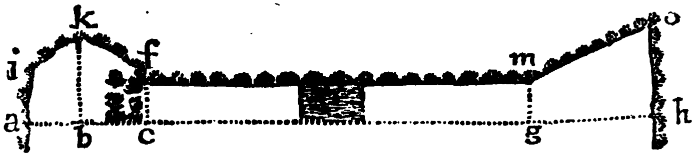
```
Perpendicular  2.05
                16.
               ----
               1230
               205
               ----
              32.80
                 8.
             ------
             262.40
```

Trapezium NOPQ

```
1st Perpendicular   2.3
2d ditto  —   —    12.2
                   ----
                   14.5
Diagonal  —       16.55
                  -----
                    725
                    725
                   870
                  145
                -------
                239.975
                      8
               --------
               1919.800
```

```
Trapeziums }   1704.48
           }   1919.8
Triangle MNQ    262.4
               -------
         4|0)3881|6.68
         ------------
           4)97  6.68
           ----------
           24 1  6.68
```


The



Dimensions.

No.	C.	C. L.
1 —	0	2.31
2 —	1.	4.17
3 —	3.	1 12
4 —	25.	.54
5 —	30.28	4.86

In order to meaſure this Off-ſet, place yourſelf at a, and fix upon a Mark in the oppoſite Hedge at h, then meaſure the Perpendicular a i, and note it down as hereafter taught, return to the Point a, and, as you are chaining the baſe Line ah, take up the ſeveral Perpendiculars b k, c f, g m and h o, by the Help of your Croſs-ſtaff, and enter the ſame in your Field-Book: Obſerve to enter not only the Length of each Perpendicular, but alſo the particular Place on the baſe Line where each was erected, as appears in the above Dimenſions.

Note, the Reaſon of the foregoing Off-ſet being ſo broad, is owing to a large Pit, and a ſmall Plantation on the Left, near the End of the baſe Line, which prevent the Meaſurer coming any nearer the Hedge.

To find the true Area *by the Pen* of all Off-ſets thus taken up, obſerve this general

RULE.

Multiply the Sum of every two adjacent Perpendiculars, by the intermediate Diſtance upon the baſe Line, and half the Product is the Content.

Note,

Note, The intermediate Diſtance upon a baſe Line, is found by ſubducting the foregoing Length or Diſtance from the following; for Inſtance, if it were required to know the intermediate Diſtance between the third and fourth Perpendiculars in this Example.

Firſt, The third Perpendicular riſes on the baſe Line at 3 Chains; and the fourth ditto, riſes at 25 Chains, that is to ſay, 25 Chains from the Beginning at a: Then ſay 3 from 25, and 22 remains for the intermediate Diſtance between the third and fourth Perpendiculars; and in like Manner proceed to find the intermediate Diſtance between every two adjacent Perpendiculars in any Off-ſet whatever.

See the Work.

1ſt } Perpendiculars	—	2.31
2d }	—	4.17
Their Sum	——	6.48
Intermediate Diſtance	-	1.
		6.48

2d } Perpendiculars	—	4.17
3d }	—	1.12
Their Sum	——	5.19
Intermediate Diſtance	-	2.
		10.58

3d } Perpendiculars	--	1.12
4th }	--	.54
Their Sum	——	1.66
Intermediate Diſtance	-	22
		332
		332
		36.52

4th } Perpendiculars	-	.54
5th }	-	4 86
Their Sum	——	5.40
Intermediate Diſtance		5 28
		4320
		1080
		2700
		28.5120

I—

1 ——— 6.48 }
2 ——— 10.58 } The ſeveral Products col-
3 ——— 36.52 } lected.
4 ——— 28.51 }

The Sum 2)82.09 which being thus divided by 2

41.045 quotes 41 ſquare Chains, &c.
4 equal to 4 Acres, 16 Perches
and a half, or nearly three
.4180 Quarters of a Perch.
40.

16.7200

Of the Proof of this Method.

Every Whole being equal to all its Parts taken together: Hence the Area's of the ſeveral quadrilateral Figures, *viz.* a b k i + b c f k + c g m f + g h o m = a h o m f k i c equal to 4 Acres, 0 Roods, 16 ½ Perches. Now, according to the old Method of caſting up Off-ſets by the Pen already obſerved, you'll find the Content of the foregoing Example to vary or differ extremely from what it ſhould be.

See

See the Work according to the old Method.

Perpendiculars.

1 ———	2.31	The Perpendiculars in the foregoing Example summed up.
2 ———	4.17	
3 ———	1.12	
4 ———	0.54	
5 ———	4.86	

5)13.00

The supposed Mean 2.6
The Base Line 30.28

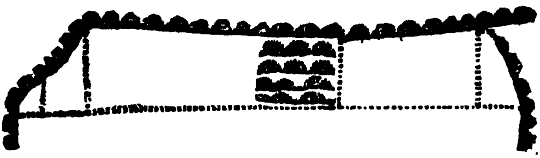
20 8
7852

			A.	R.	P.
Answer	7.8728	square Chains, equal to	7	3	19½
	4	The Off-set contains no more as per other Side, than	4	0	16½
	3.4912				
	40	being too much by	3	3	3
	19.6480	*What an Error in about 4 Acres of Land! nearly as much again.*			

Now to convince the incredulous Reader (provided this Treatise should ever meet with any such, I'll beg Leave to give an Example wherein this old Method of casting up Dimensions will render an Off-set almost as much short of what it really is, as the above is over or more than what it ought to be, whereby my Reader will have an Opportunity of making such Reflections upon the Occasion as shall seem good or meet unto him.

Example. III.

Let the following Figure repreſent an Off-ſet in the Side of a Field, I demand the Content thereof.



Dimenſions of the above Off-ſet.

		C.
At	0	0.25
	2.0	.55
	4.0	4.10
	18.0	3.65
	25.0	3.40
	26.30	.35

See the Work.

.8	4.65	7.75	7.05	3.75		1.60
2.	2.	14.	7.	1.3		9.30
						108.50
1.6	9.30	31.00	49.35	1125		49.35
		77.5		375		.87
		108.50		4.875	2)	173.62
					Acres	8.681
						4
						2.724
						40
						28.960

The

The old Method:

	6)12.30
Mean Breadth —	2.05
Length — —	2630
	6150
	1230
	410
Acres	5.39150
	4.
	1.56600
	40.
	22.64000

	A.	R.	P.
The *true* Content of this Off-set is —	8	2	29
And by the *old Method* it is — —	5	1	$22\frac{1}{2}$
being too little by —	3	1	$6\frac{1}{2}$

From hence, kind Reader, you may infer, that the Incorrectneſs of the old Method, is not only certain, but unavoidable alſo, beyond all Manner of Diſpute.

Observation.

Perhaps ſome of my Readers that are not clear in this Method, may obſerve, that the Difference between the new and old Method is very extraordinary.

And that it is, almoſt impoſſible (*if this new Method be right*) there can be ſuch Difference in ſo ſmall a Compaſs as 4 Acres. Now, to remove Suggeſtions of this Kind, I muſt, (in Vindication of the Truth) implore the Favour of all ſuch (for their own Good) to return to Problem the 5th in Chapter IV, and strictly consider the same.

Some there are, no doubt, being prepossessed in Favour of the old, will, at first Sight of the aforesaid Difference *(in Example the first)* condemn the new, especially the Gentleman of a small Estate, saying, *Away with it, away with it!* mine was always accounted so much; and if it was now measured by this Method, doubtless I should lose near one half of it.

If this Book should ever fall into the Hands of such hasty inconsiderate Gentlemen, let me once more intreat them to examine and ponder over Problem the 5th before-mentioned; and when they have well considered the Purport thereof, they may then proceed to the second Example, wherein they will meet with something that will, undoubtedly, eradicate their Chagrine, and at the same Time afford them an Opportunity of changing their Sentiments.

And then, with greater Reason, they may reflect on their Estates, saying, "Mine were measured and mapped such a Time, when the old Method was universally practised, which now appears in the most gloomy, unfavourable, and worst of Colours." What! to make an Off-set in a Field-side near 8 Acres, that should be but 4 A. 0 R. 16½ P! without Dispute, if the whole Field was measured, the Mistake would be very considerable.

And again, to measure another Off-set in a Field, to only 5 Acres, 1 Rood and 6½ Perches, that should be 8 Acres, 2 Roods, and 29 Perches. Well may old Practitioners disagree in their Measurement, their Method being so incorrect.

However, though I have rendered the Errors in the two foregoing Examples not only considerably great, but likewise made it appear, that the old Method is as liable to make an Inclosure too much, as too little; yet, notwithstanding, I would not seem thereby to indicate, that the Errors in general (which of Course must appertain to such Proceedings) are always so extraordinary: No, no, my Business is to point out the Mistakes its liable to; and also to convince my Readers, that there is no Certainty in, nor depending upon the Truth of such Work. And therefore

fore I flatter myself that I am intitled to the Favour of the candid Reader's good Opinion in behalf of this Treatise, as it claims the Preference to all others for Truth, Correctness, and Expedition.

Note, In all the following Examples, in this first Part, I shall enter the Content of each Off-set at the Top of the Dimensions in Perches, except the next Example, and shall leave the rest for the Learner's Practice.

Note also, Instead of taking half the Product of the Off-set in square Chains, as heretofore taught, multiply the Sum of your Products by 8, and place that Product at the Top of the Off-set to which it belongs: And when you have cast up all the Dimensions belonging to the Field, collect the several Products, and divide that Sum by 160, otherwise by 40, and by 4, and the Quotient will shew the Area in Acres, Roods and Perches.

CHAP.

CHAP. VI.

To measure and find the true Content of any Inclosure, whose Bounds are comprehended under irregular right-lined Hedges.

OBserve the Directions laid down in the three foregoing Chapters, and then you may measure the proposed Field either in Triangles, Trapeziums, Rect-angles, *&c.* as you shall think most convenient; but always remember, wherever you begin to measure, leave or place some conspicuous Mark, as Paper, white Linen, Cloth, Handkerchief, *&c.* *Here note*, your first Care must be to go straight to the Fence, by taking up the Off-sets as already directed, and afterwards proceed as above. But if the Superficies thereof be very uneven or hilly, so that you cannot possibly behold the Boundaries of the same from any one Place, nor the Marks which you may have therein placed or set up, when the right-lined Off-sets were taken; in all such Cases, first measure what you can conveniently see on any Side of the Hill or Mountain; which, when done, you may, perhaps, measure the Remainder in one Figure, if you can behold the Marks prefixed when the Off sets were measured, otherwise you are not confined to one or more.

Most Surveyors, when they have measured a mountainous or hilly Field, return the Foundation * thereof for the Superficial Area, alledging, at the same Time, that no more Trees, Corn, &c. can be planted upon a Hill or Dale than if the same Space were horizontal, and confined to the same

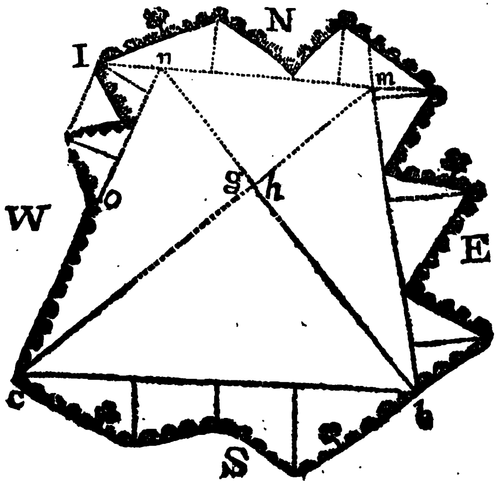
* The Foundation of a Hill is horizontally parallel to the adjoining Valley.

Foun-

Foundation; I'll readily grant the Justness of this Observation with regard to Plantations; but Grass being of another Quality, very seldom hath one Blade in a thousand vertical. I hope it will be as readily granted, that (as the spontaneous Production of Vegetables respects not one particular Position, as some grow up, some down, and some parallel to the Horizon, &c.) arable Hills or Dales should be measured, and the superficial Content thereof returned. In Part the second I have been something more particular upon this Head, which see.

Example.

Let it be required to measure and cast up the Content of the following Figure, which represents an Inclosure comprehended under unequal, though many right-line Sides.



The

The Dimensions.

North Off-set, Left-hand.

441.$\frac{1}{4}$

0	0
5.40	3
9.80	.40
12.25	3.20
17.	0

East Off-set, Left-hand.

464.

0	0
.70	3.
4.50	0
5.80	4.
10.80	0
14.80	4.10
16.	0

South Off-set, Left-hand.

831.$\frac{3}{4}$

0	0
6.20	4.50
10.40	2.70
14.60	3.40
20.55	0

West Off-set, Left-hand.

209.$\frac{1}{2}$

0	0
9.	0
12.70	2.90
15.	.20
16.20	3.0
17.70	0

Trapezium.

4000.$\frac{1}{2}$

00		0.0
7.70	L.H.	7.60
790	R. H.	16.10
21.10		00

Directions to take the Dimensions of this Field.

First, Fix a Mark at I, in the West Side of the Field, and then begin with, and take up the North Off-set, by chaining the base Line I *m*; and when you come to the Place *n*, set up a Mark or Stake, but be careful to take up the Perpendiculars that arise

arise from this Base to the subtending Corners. When you have chained as far as m, you may perceive two of the East Corners of the Field to lie in a right Line with the Place m, there leave a Mark or Stake standing, to which Place return after you have finished this Off-set.

Secondly, straighten the East Side thereof, which you may do by fixing upon a Mark in the South Side of the Field at b: But here note, If there is nothing remarkable in the Hedge at or near that Place, you may send your Chain-man to fix or set up a Mark thereat, otherwise, if you can perceive a Tree, House, or any other Thing remarkable and immoveable, behind, and in a right Line with the two Corners *(already mentioned)* in the East Side, though at a Mile or ten Miles Distance, by fixing upon the same as a Mark of Direction, *(in this and all other Cases of the Kind)* will prove as effectual as if a Mark was actually set up at b, and will save not only a deal of Trouble, but also enable you to proceed with greater Expedition, having taken up the East Off-set as you chained the base Line m b, by raising Perpendiculars to the subtending Corners. *See the Dimensions E. Off. L.H.*

Thirdly, As the South Side is likewise irregular, chain from b to the Corner c, and measure the South Off-set also; but forget not to leave a Mark in the Hedge at b.

Fourthly, Straighten the West Side by chaining from the Corner c, to the Mark left standing at n: And as there is no Off-set upon this last base Line till you have measured to o, to wit, 9 Chains from c: Thus at o ———————————— o, and at 9.———————————— o also; *(See the Dimensions, W. Off. L. H.)* and proceed as before till you have finished the same; then is the Body of this irregular Field reduced to four unequal Sides, which measure as you were directed in Problem the 4th, Chap. IV.

Lastly, having finished the West Off-set at n, chain the Mark at b, for a diagonal Line, to the Trapezium n m b c, and as you advance omit not to take the Perpendiculars on the Right and Left-hand found by your Staff, that is to say, the Place where they should be raised, namely, at 7 Chains, 70 Links upon the base Line at g; a Perpendicular will fall into, or upon the Mark at m, which being meafured, return to your Staff, and 20 Links farther, upon the fame Chain-line, another Perpendicular muft be likewife raifed to the Corner or Mark left in the Hedge at c, which being meafured and entered *(as already directed)* return to the Staff, and finifh the diagonal Line n b, then are your Dimenfions compleated, and the Field furveyed. But here fuffer me to remind the young Practitioner, that Care and Correctnefs muft be his conftant Guide or Attendant not only in the Fields, but when he cafts up his Dimenfions alfo. As no Perfon is allowed to be infallible, confequently the moft judicious and complete Surveyor may as inadvertently commit a Miftake *(if Care be neglected)* as the greateft Stranger to Field Practice. But from what I have already obferved in the foregoing Chapters, I hope this Caution will not be forgot by the Learner, who having prepared the Dimenfions of this Field for the Pen, the Content thereof may be found as follow.

See the Work of each Off-fet, and the Trapezium alfo.

North Off-fet, Left-hand.

5.4	4.4	2.4	4.8
3.	3.4	3.6	3.2
16.2	176	144	96
	132	72	144
	14.96	8.64	15.36

14.96
16.20
8.64
15.36

55.16 half fquare Chains.
8

441.28 Perches.

East

East Off-set, Left-hand.

.70	3.8	1.3	5.	4.	1.2
3.	3.	4.	4.	4.1	4.1
.21	11.4	5 2	20	16.4	12
					48
					4.92

.21
11.4
5 2
20.0
16.4
4 92

58.02 half square Chains.
8

464.16 Perches.

South Off-set, Left-hand.

4.5	7.2	6.1	3.95
6.2	4.2	4.2	3.4
90	144	122	2380
270	288	244	1785
27.90	30.24	25.62	20.230

27.90
30.24
25.62
20.23

103.99 half square Chains.
8.

831.92 Perches.

West Off-set, Left-hand.

2.9	3.1	3.2	1.5
3.7	2.3	1.2	3.
203	93	3.84	4.5
87	62		

10.73
7.13
3.84
4.5

26.20 half square Chains.
8.

209.60 Perches.

The Trapezium.

23.7 the Sum of the Perpendiculars,
21.1 the Base.

237
237
474

500.07 Half square Chains.
8.

4000.56 Perches

Note, The above Dimensions are cast up according to the Directions laid down in the last Chapter, to wit, in each Off-set respectively every two adjacent Perpendiculars are added together, and their several Sums are multiplied by the intermediate Distance found by deducting or subtracting every foregoing Length on the base Line, from the next succeeding one, for a Multiplier.

See the North Off-set cast up as follows.

0	0.0
5.40	3 0
9.80	.40
12.20	3.20
17.0	0

First, Add 3 (the Perpendicular) to 0, which being multiplied by 5 Chains 40 thus: 3. × 5.40 = 16.20, the Product set apart.

Secondly, Add .40, the second Perpendicular, and 3. the first together, the Sum is 3.40, then subtract 540. (the foregoing Length on the base Line) from 9.80, thus:

9.80 — 5.40 = 4.40, which multiply by 3.40, the Product is 14.96; set this also under the former Product.
Thirdly, Add 3.20 (the third Perpendicular) to .40, the Sum is 3.60; and take 9.80 (the preceding Length on the base Line) from 12.20, there remains 2.40, which multiply by 3.60 (the Sum of the two adjacent Perpendiculars) and the Product is 8.64, which place under the former Products.

16.20
14.96
8.64
15.36
——
55.16
8.
441.28

Lastly, Add 0 to 3.20 (the third Perpendicular;) then take 12.20 (the foregoing Length on the base Line) from 17, the whole Line, and there will remain 4.88, which being multiplied by 3.20, the Product will be 15.36; place this under the former Products, and collect their Sum, then have you the double Area of the Off-set in square Chains, which being multiplied by 8, gives the Content in Perches, *viz.* 441.$\frac{1}{4}$, as Top of the Dimensions: But as you proceed in casting up the Dimensions, draw a Dash with the Pen across each of those Lines that are between the Base and Perpendiculars, when or before you add the adjacent Perpendiculars, which will prevent your casting the same up twice over. Hence the Area of the Field is obtained *viz.*

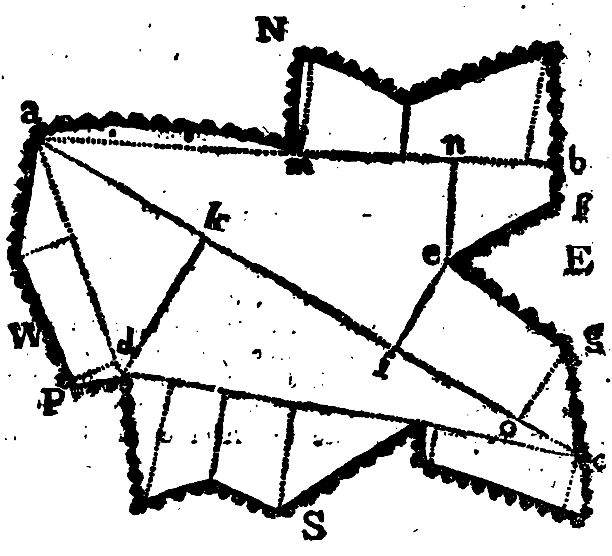
N. Off-set

N. Off-set	441¼				
E. do.	464		A.	R.	P.
S. do.	831½		37	0	27
W. do.	209½				
Trapezium	4000½				

Here suffer me to acquaint the young Surveyor, that as all the following Examples of this Kind relating to Off-sets, *&c.* are measured and cast up as above directed, I therefore think it needless to insert the different Operations that follow, since it will give my ingenious Reader an Opportunity (*if he chuses*) of becoming very perfect and ready in casting up the same; so that if the Result of his Work should happen to disagree with the Result at the Top of the Dimensions, he may then take it for granted that a Mistake is committed in his Proceedings, and therefore should re-examine his Figures.

Example II.

Let the following Figure represent an irregular Inclosure, I demand the Content or Area thereof.



To determine which way the aforesaid Field could be most expeditiously surveyed, would be to little Purpose; for seeing that any irregular Field will admit of great Variety (with regard to taking the Dimensions thereof;) it therefore matters not how the same be surveyed, provided Care be taken not to omit or measure any Part twice: However, I would recommend to the Learner, if the Field or Land be horizontal, to take the largest Trapezium or Rect-angle, &c possible, and let the Off-sets be as small as the Boundaries will conveniently admit of; but in curvilineal Superficies, or mountainous Ground, the Surveyor cannot be his own Carver. Field Practice in such Cases, will more effectually edify, than if whole Sheets were herein delivered concerning the practical Occurrences of Surveying.

Perhaps it may be observed, that the foregoing Figure or Field might as readily be surveyed by taking up three or four Trapeziums therein, and afterwards, *(if any Off-sets be omitted)* to measure them as heretofore directed. I'll not deny it; but as I propose in this and all the following Examples, to recommend a Method which in most Cases wll claim the Preference *(with regard to Expedition and Correctness)* to any thing relating hereto ever published; hence I presume to hope *(as I don't trace the Footsteps of others)* that this will meet with the Approbation of the Geometrician, and give general Satisfaction, the whole being founded upon Geometry.

Directions to take the Dimensions of the foregoing Field.

First, Suppose you entered the Inclosure at the Corner a, *(though it matters not where you enter, or where you begin)* looking along the North Side thereof, the Irregularity of the Fence tells you it must be straightened, which you effect by chaining the base Line a b, and taking up the North Off-set on the Left-hand, as directed in the foregoing Example; and when you are at right Angles to the Corner e on your Right-hand, measure the Perpendicular n e, enter the same as a Right-hand Off-set, and leave a Mark at e; then return and finish the base Line, at the End of which *(the Hedge being at right Angles thereto)* chain that Part on the Left first, which when entered, you may chain, and enter the Right-hand Perpendicular. Thus you have measured the North Off-set.

Secondly,

Secondly, Walk round the Hedge or East Side of the Field till you come to the Point c, there leave a Mark, and casting your Eye towards d on the West Side thereof, you perceive it in a Line with a Corner in the South Side; then chain to the Corner a, where you first began, and take up the Perpendiculars on the Right and Left-hand, thus: When you come to o, that is 4 Chains on the Base c a, measure the Perpendicular o g; and when you come to I, to wit, 11 Chains, 10 Links, measure the Perpendicular i e = 5.40, then proceed till you are at right Angles with the Mark left at d; measure the Perpendicular k d likewise, which enter as a Left-hand Off-set, return and finish the base Line c a, which also enter. *See the Dimensions following.*

Thirdly, Chain the base Line a d, and take up the West Off-set as you were directed in the West Off-set in the last Example.

Fourthly and lastly, Standing at the Corner d, look towards the Mark formerly set up in the Hedge at c, to which Place chain for a base Line to the South Off-set, and take up the same, which when done, your Dimensions are compleated.

Here note, When you were measuring the North Off-set, an Off-set on an Off-set occurred on 4.94, the third Perpendicular, which see how entered, and also another on the last Perpendicular you took in the South Off-set, which see likewise.

Mr.

Mr. *Greenfield's* Land,

Marl-Field Dimensions, 21st *June*, 1770.

North Off-set, Left-hand.

1036 $\frac{1}{4}$

0	0
3.80	1.10
8.10	1.10
13.	.00
13.	4.94
18.40	3.0
26.18	5.82

Left-hand Off-set, S. W.

2074 $\frac{3}{4}$

0	0
22.40	8.20
31 63	.00

West Off-set, Right-hand.

534 $\frac{1}{2}$

00	0
5.32	33.0
13.18	2.84
13.50	0

An Off-set on ditto W.

53 $\frac{1}{4}$

0	0.
4.94	1.39

Right-hand Off-set, N. E.

1581 $\frac{1}{2}$

0	0
4.0	4.35
11 10	5.40
31.63	00

South Off-set, L. H.

1330.

0	0
2.60	7.10
5.20	5 10
8.88	5 05
1.520	.00
16.20	2 0
23.96	3.0

An Off. on last Perpendicular.

24.

0	0
3.0	1.

A —— B

Herein the young Practitioner may meet with Matter sufficient to exercise his Pen, by casting up the foregoing Dimensions.

Here note, When the Dimensions of a Field are finished, draw a double Line under the same; *(see the double Line* A B *at the End of the foregoing Dimensions)* which will prevent both Confusion and Mistakes, when the Dimensions of several Fields succeed each other.

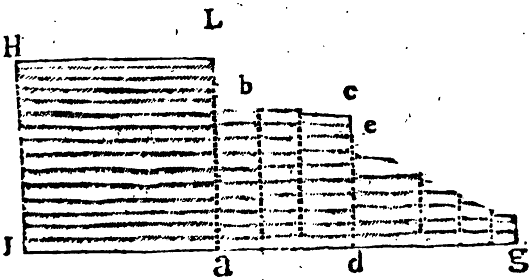
Note also, When you are to map your Dimensions, observe not to enter any thing in the Right-hand Column except Remarks, and an Off-set upon an Off-set when it occurs; see the North Off-set in the last Example, wherein on Off-set upon an Off-set is met with, and properly entered at, and upon the Perpendicular where it lies, with a dash or small Line drawn between the Perpendicular and the Place where the same is entered.

Here followeth an Example which will enable the young Practitioner to form a more clear Notion of two unequal Perpendiculars being entered at the same Length upon a base Line. See the North Off-set in the last Example at 13 Chains in the base Line, there is no Perpendicular; and also at the same Length there are 4 Chains 94 Links of a Perpendicular.

Example. III.

Let the following Figure represent a Parcel of Land in a Town Field, I demand the Area or Content thereof.

The



The Dimensions.

	2821¾	C. L.
0		10.05
10.35		10.00
10.35		7.24
17.10		6.85
17.10		3 90
26.10		1.55

The Dimensions of the above Figure are taken thus: You are supposed to begin at I, chain I H = 10. Chains, 05 Links: And as I g is at right Angles to I H, chain or measure it for a base Line: When you come to a, you'll have two Perpendiculars to enter, to wit, a L and a b, but be careful to enter a L before a b, as it respects the Land already measured, *i. e.* H I, L a. These Figures being entered, return to a, and chain till you come to d, where you likewise have two unequal Perpendiculars, namely d c and d e, which being entered as above directed, that is, the Perpendicular d c before d e; then proceed in chaining the base Line till you come to the End g; measure the Perpendicular also, and the Dimensions are compleated.

DEMONSTRATION.

First, The Perpendicular I H + a L × I a = Area H I a L, by *Example 2d*, *Chap.* V.

Secondly, a b + d c × I d — I a = Area b a c d, by ditto.

Thirdly, d e + g f × I g — I d = Area d e f g, by ditto. which being collected, amount to 17 Acres, 2 Roods, 13 Perches $\frac{3}{4}$. The Pleasure of the Operation is left for the Learner's Amusement.

Thus, courteous Reader, have I prepared you, (*I hope*) to enter and measure Inclosures bounded by right Lines or Hedges, though ever so irregular: And in the next succeeding Chapter you'll meet with something more difficult.

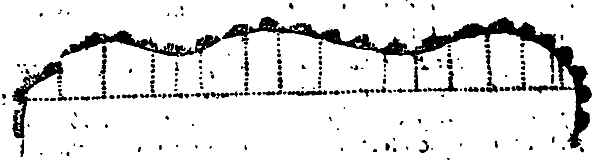
CHAP.

CHAP. VII.

Teacheth to measure and find the true Content of a circular or curved-line Off set: Also to find the Content of the most irregular Field, &c.

Example. I.

I Demand the Content of the following Figure, which may represent an Off-set taken up in the Side of a Field.



In this and all other Off-sets, you must take as many Perpendiculars upon the base Line to the subtending Hedge or Fence, so that if a right Line was drawn from the End of any one Perpendicular to the next (on either Side) it would neither exclude any Part of the Field or Land you are about to measure, nor include any of the adjacent, as directed in Page 88.

Dimensions

Dimenſions.

1114.

0	.60
2.	1.80
2.	2.10
4.40	3.00
6.50	2.30
7.70	2.10
9.00	2.40
11.46	3.20
13 10	3.25
15.20	3.00
20.26	2.0
22 0	2.60
24.0	2.80
26.0	2.80
26.80	2 50
28.60	1.20

This, and all Examples of the Kind, are caſt up according to the Directions laid down in the firſt Example of this Chapter, being founded upon Chapter the 5th, Part the firſt, *viz. The Sum of every two adjacent Perpendiculars multiplied by the intermediate Diſtance upon the baſe Line (found by ſubtracting every foregoing Number from the next ſucceeding) gives the double Area thereof*; (ſee Page 118) then, by collecting or ſumming up all thoſe ſeveral Areas together, their Sum or Amount is the double Area of the Off-ſet in ſquare Chains, which multiply by 8, the Product is the Anſwer in Poles or Perches, and muſt be entered at the Top of the Off-ſet.

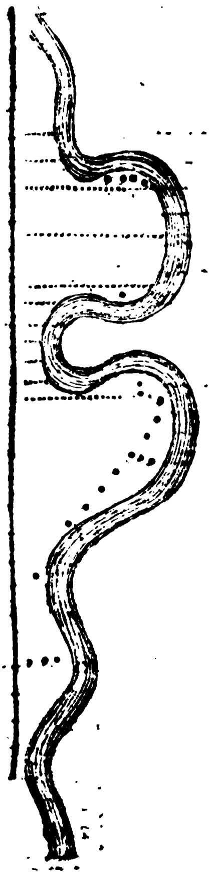
Whoever thus proceeds carefully, may, with the greateſt Certainty, rely upon the Reſult; but, for a farther Proof of the Work, it will be proper to prove the Multiplications; and if the Additions and Subtractions were firſt examined, the Proceedings might with greater Certainty be depended upon.

As my chief Aim is to edify to a Degree of Perfection, the ingenious Youth, I therefore ſhall, in the next Place, give an Example of an Off-ſet adjoining an old Brook; and that the young Learner may more perfectly comprehend the Figure and Dimen-

Dimenſions of this irregular Space, I muſt beg Leave to uſe a larger Scale (in this Example) than that mentioned in Page 103, that the ſame may be thereby rendered more conſpicuous, whereof a clearer Notion will be formed of iti curvelineal Space.

Example.

Let the following Figure repreſent on Off-ſet adjoining an old Brook, laid down by a Scale of 8 Statute Poles to an Inch, I demand the Area thereof.



Dimenſions

Dimensions.

N. Off. L. H.

59 ¾

0	0
,67	,40
1,23	,32
1,42	,45
1,70	1,31
2,30	1,50
2,72	1,32
2,95	,31
3,10	,20
3,20	,22
3,50	,21
3,68	,25
3,90	,60
3,90	1,50
5,55	,21
6,05	,23
6,60	,50
6,90	,45
7,50	00

An Off. on ditto, L. H.

1 ¾

0	0
,60	0
,75	,17
,91	,22
1,10	,21
1,31	0

An Off. on do. R. H.

1 ¾

0	0
,60	0
,80	,10
1,00	,22
1,20	,22
1,30	,14
1,50	0

L. H. an Off. on do.

2 ¼

0	0
,62	0
1,00	,23
1,20	,24
1,33	,21
1,50	,10

L. H. Off. between 1,50 & ,21

6 ½

0	0
,30	,30
,50	,35
,70	,38
,95	,35
1,60	00
2,10	00

Perhaps

Perhaps an Explanation *of the foregoing Dimensions* would be looked upon by the Reader as Tautology, since I have, in all the foregoing Examples, explicitly *performed the same respectively*; which now induces me not to be guilty of an unpardonable Trespass upon my Reader's Patience.

I am too well convinced, that whoever the Youth is that takes Delight herein, will have no Occasion for a Finger-post to each Example, seeing they are all performed alike.

The Off-sets collected.

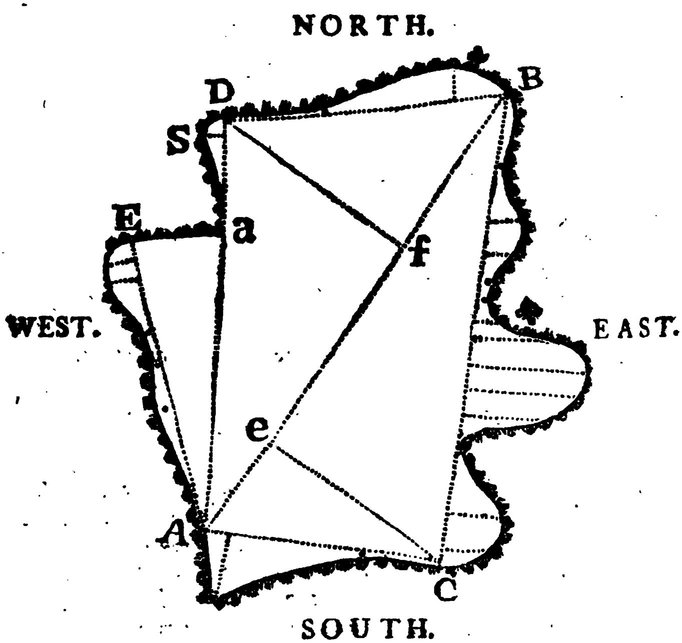
North Off-set, Left-hand ——— ———	$59\frac{3}{4}$
An Off-set on ditto, Left-hand ——— ———	$1\frac{3}{4}$
Ditto on ditto, Right-hand ——— ———	$1\frac{3}{4}$
Left hand Off-set on ditto ——— ———	$2\frac{1}{4}$
L. H. Off. between 1,50 & ,21 ——— ———	$6\frac{1}{2}$
	72

72 Perches, the Area of the Off-set—*Now every Whole being equal to all its Parts taken together*; hence the Area of the whole Off-set is obtained, by adding the mean Off-set and Off sets upon Off-sets together, as above.

I hope the foregoing Example of a Brook Side, will sufficiently direct the Learner, as therein is a Specimen of Entry which will qualify him to measure the most irregular Boundaries; and, by the Dimensions with the Pen, discover the true Area of the same: So that if a Meadow, or any other Inclosure, was bounded on all or any of its Sides by an old Brook, the Surveyor needs do no more than first to straighten the Sides thereof according to the Directions in the two last Examples; by which Means the same is reduced to a Trapezium, or an irregular Polygon, and may be measured as directed in Chapter the 5th, Part the 1st.

Example. III.

Let the following Figure represent a Field, I demand the Content thereof.



The

Dimensions.

1st. W. Off. L. H. on ditto.

189

0	0
6,60	1,00
9,0	,40
11,30	,50
13,40	1,70
14,50	1.60
15,0	1,30

2d W. Off. L. H.

635

0	0
15,10	5,0
15,10	00
17,40	00
20,50	,10
21,10	,30

N. Off. L. H.

192

0	0
5,0	,40
12,0	2,00
14,60	0

E. Off. L. H.

771.

0	0
1,50	,90
3.0	.40
4,60	,50
6,70	1,56
8,30	1,30
9 70	,60
10,20	,60
12,0	3,00
12,	5,50
14,	6,00
15,40	5,80
17,	,30
17,60	,20
18,90	,50
22,0	3,00
23,90	2,00
24,30	1,40

Trapezium.

4795

0		0
5,60	R H	11,0
17,0	L H	11,20
27,		00

Off-sets, &c. collected.

189			
635			
192			
771			
4795	A.	R.	P.
6582 =	41	0	22

The Field Work of the foregoing Figure explained.

N. B. This Explanation is occasioned by the two West Off-sets that appear in the Field-Book, which perhaps may not be so immediately understood.

First then, you are supposed to enter the Field at A; chain from A to E, and take up the West Off-set to the Left-hand, leaving a Mark at E.

Secondly, Return to A, and chain to D, upon which Line take up the second West Off-set. *See the Entry thereof.*

Thirdly, Take up the North Off-set as you chain from D to B.

Fourthly, take up the East Off-set as you measure the base Line from B to C.

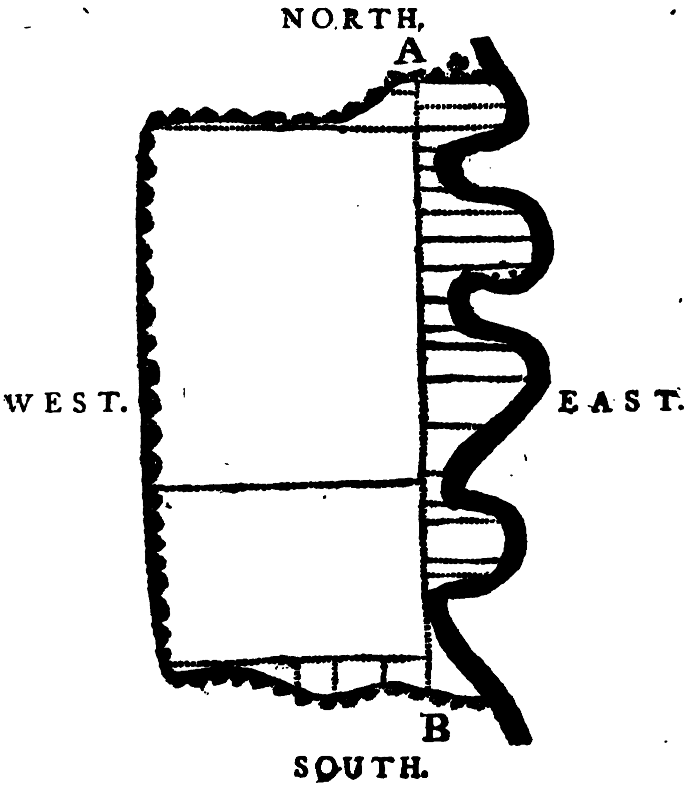
Fifthly, measure and take up the South Off-set, when chaining from C to A.

And lastly, measure the Trapezium A D B C, as you were taught in Page 115. and 116. *See the Contents of each Off-set entered at the Top of the several Dimensions.*

Example

Example IV.

Let the following Figure repreſent a Meadow bounded on one Side by an old Brook, I demand the Content thereof.



Dimensions,

1

Left-hand Off. Brookside, E.

1489¾ C. L.

0	0
2,0	5,00
2,50	4,0
4,0	1,20
5,0	1,20
5,50	1,40
7,0	5,10
8,00	5,40
9,50	5,35
11,40	1,20
13,0	1,38
14,0	5,0
16,0	5,0
18,20	4,20
20,20	1,10
22,0	1,10
23,0	4 0
25,0	4,0
26,0	3,0
26,30	0,6
32,0	3,0

2

Right-hand Off-set, W.

6174¼

0	1,00
3,0	4,20
3,0	13,70
20,30	14,20
30,0	14,0

3

An Off. on ditto, R. H.

31½

0	0
2,20	0
3,60	0,85
5,0	0,90
5,35	0

4

S. Off. L. H.

211¾

0	2,00
2,20	1,20
4,90	2,10
6,40	1,36
9,20	,20
14,0	0

1	Off-set -	1489¾
2	ditto -	6174¼
3	ditto -	31½
4	ditto -	211¾

A. R. P.

7907¼ = 49 1 27¼

the true Content of the Meadow.

Directions

Directions in the foregoing Field or Meadow.

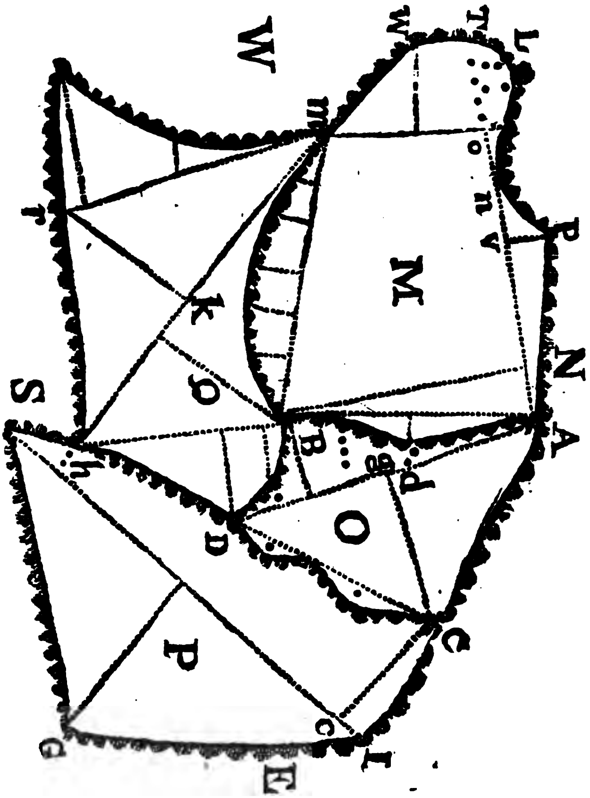
When you come into it, make for the North Side thereof, (*though any Side would answer the same End*;) then fix on a Place in the Hedge, suppose at A, and casting your Eye towards the opposite Side, fix on a Mark in the Hedge at B, to which Place chain, and as you advance take up the Left-hand or Brook Off-set, as you were directed in the second Example; and at the same Time take up the Right-hand Off-set; but when you have measured 30 Chains on your base Line, your Staff will inform you that a Perpendicular thereat doth arise into the subtending Corner, upon which you'll have a South Off-set; the first Perpendicular thereto lies between the Staff and the Mark in the Hedge at B; (*see the 4th or South Off-set, Left-hand*) then are your Dimensions ended, which you may cast up in the Field, if you think proper: And if the Dimensions are to be planned, you'll meet with Directions to effect the same in Chapter the Ninth.

N. B. If any of my ingenious Readers should think the preceding emblematical Types too few, or insufficient to qualify them for real Practice; let them draw, with a Pencil, or Pen and Ink, upon Paper, such curvelineal bounded Fields as their Fancies shall dictate; which, according to the foregoing Rules, may be measured by a Scale of equal Parts, and a Pair of Dividers, equally the same as if taken with a Chain in the Fields: Thus let them proceed in drawing the Form of one crooked Field after another upon Paper, till they become perfect and ready in measuring the same; and then, (*but not before*) they may venture into the Fields: But in case the Idea should prove somewhat barren, and the Youth be at a Loss to draw himself difficult Examples, let him walk into the Fields with Paper, Pen and Ink, and draw the Form, at Pleasure, of such and such Fields as he shall think proper; and when he comes home, may measure his random Plan by the Help of any Scale of equal Parts, which may be repeated till he is exceedingly ready therein; whereby he may qualify himself for real Practice. I would recommend this last Expedient as a preparative Introduction to the Chain in the Field; for the Learner may be assured to meet with every Day, and in every Inclosure, unexpected Variety, since there are scarcely two Inclosures to be met with alike in Form. And when he is ready in measuring one Field, let him fix upon another or two adjoin-

adjoining thereto, which he may meaſure and plan, if he chuſes, according to the Directions given in the ſucceeding Chapters; and, for his farther Improvement herein, ſhall introduce an Example of a ſmall Eſtate before I cloſe this Chapter, whereby he may form a clearer Idea of Field Practice.

Example V.

Let it be required to meaſure the following ſmall Eſtate, conſiſting of four Incloſures, ſo that the Dimenſions thereof may be caſt up by the Pen, and afterwards planned if deſired: I demand the Content of the whole, and of each Field ſeverally.



Obser-

Observation.

In measuring this Estate, you must be very accurate in your Dimensions, otherwise you cannot possibly give a just Return or Plan of the same: But here note, if you measure an inner Off-set in one Field, there will be no Occasion to have an Off-set up to the same Hedge in the adjacent or adjoining Field; (*see the South Off set in the Field* M;) and when you come to measure the Field Q, there will be no Occasion to measure or straighten the North Side thereof; but observe to take the Area of the South Off-set in the Field M, from the Area of the Dimensions of the Field Q, and the Remainder is the true Area thereof. Forget not to leave Marks in the Corners, &c. of every Field you come to when measuring, to which you must measure; for Instance, when you come to the Corner m, in the Field M, leave a Mark in the Hedge, and also one at B, underneath which the Chain must come when you are measuring thereto in the adjacent Fields And when you measure the East Off set therein, it will be needless to take Notice of the Hedge which lies up thereto when you are measuring the Field Q, to wit, the North Hedge, having the circular Form thereof in the Field M, the Area of which must be taken from the Trapezium m r h B, and the Remainder being added to the East and West Off-sets in the Field Q, the Sum will be the true Area thereof. And also the East Off-set in the Field O, must be taken from the Area of the Dimensions of the Field P; and there will remain the Area thereof, and so of any other, which should appear in the Dimensions, as follow.

Dimenſions of an Eſtate in the Townſhip of—— in the Pariſh of ———, and County of———, belonging to *J*———*T*, Eſq; *John Ancker*'s Tenant at Will, 9 *June*, 1770.

Field M.

N. Off. L. H.

307,

0	0
1,0	1,20
1,20	2,00
2,30	2,00
6,40	,10
8,0	,10
10,30	2,00
19,50	0

E. Off. L. H.

127,

0	0
6,0	1,50
10,60	00
13,40	00

Field Q.

R. H. Off. W.

486.½

0	0
4,60	,40
7,80	2,00
13,0	6,60
14,	00

R. H. Off. S.

2736.

0	3,00
4,75	8,00
17,	13,0
19,50	0

S. Off. L. H. in Field M.

—— Field Q.

313,½

0	0
3,	2,0
5,60	2,70
7,90	2,45
10,34	1,30

The

Field Q. continued.

Trapezium.

2492¼

0		0
11,30	R H	7,70
13,50	L H	7,80
20,10		00

Field O.

L. H. W. Off.

394¼

0	0
2,70	1,30
4,	4,00
6,80	3,00
9,10	1,20
16,0	,20

Field P.

L. H. Off. N. W.

1447.

0	0
4, to S. Corner Fd. Q	2,00
22,80	6,50
24,0	4,40

E. Off. R. H.

362¼

0	0
1,70	,60
7,20	4.20
9,10	3.00
10,50	,00

Right-hand Off-set, E.

1094¼

0	0
8,	8,0
16,	1,10

E. Off. L. H. in Fd. O—Fd. P.

107.¼

0	0
4.0	1,20
7 0	,00
9 0	1,10
11,60	00

R.H. Off. S.E.

1996¾

0	0
12,	10,00
24,	,80

The Field Notes explained.

First, you are supposed to enter into the Field M, at the Mark T, from whence (*after you have set up a Mark*) chain to the Corner A, and take up the Right and Left-hand Off-sets. *See the last or foregoing Example.* Then chain from the Corner A, to the Corner B, and take up the East Off-set also; in like Manner chain from B to m, taking up the South Off set as you were directed in the first Example of this Chapter: But here observe, that this Off-set projects into the North Side of the Field Q, and therefore you need not straighten the Hedge on both Sides; but take Care to mention at the Top of the Dimensions *Minus Field* Q; thus abbreviated, ——Fd. Q.

Secondly, Having finished the Field M, at the Corner m, enter into the Field Q thereat; and after you have observed the Form thereof, first take up the West Off set therein, which lies upon the Line m r; then return to the Corner m, and from thence chain to the opposite Corner, to wit, h, for a diagonal Line to the Trapezium m r h B, which, when you measure, raise Perpendiculars therefrom to r on the Right-hand, and B on the Left-hand. *See Problem* IV, *Chapter* IV; *and also Example* I, *Chapter* VI, wherein you have Directions to measure any Trapezium whatsoever; which being entered, then take up the East Off set that lies upon the Line h B, by chaining from the Mark in the Hedge at h, to the Mark you left in the Corner at B, then have you compleated the Dimensions of the Field Q.

Thirdly, Enter into the Field O, and start from the Mark you set up at D, to that left in the Corner A, taking up the Right and Left-hand Off-sets, as already taught. *But here observe, when you measure the Perpendicular on the Left-hand to* B, *you will have no Occasion to measure any other Perpendicular on that Hand till you come to* A.

But then you would have included therein the East Off-set in the Field M, *which should be subtracted therefrom; nevertheless, it will not be amiss for the Learner to have as great a Variety as each Example will admit of*; and (therefore) as he advances on the base Line D A, take up as many Perpendiculars as the Left-hand Hedge requires:

take

See that the Right-Hand Perpendiculars be not neglected, which done, walk to the Corner C, and measure the East Off-set also that lies between the base Line C D and the Hedge on the Left-hand, then is this Field measured likewise.

Lastly, step into the Field P, walk to S, the South Corner thereof; and from thence chain to I, the opposite Corner, upon which Line take an Off-set to the Right and Left-hand, (*see the Dimensions of the same*) which when entered you have finished the whole.

Observations.

1. In the foregoing Example I have designedly omitted in the Field Notes, Remarks, as Ponds, Pits, Timber, Buildings, &c. which perhaps might have occurred, being apprehensive the same would rather confuse than edify in this Place: Moreover, I have directed to measure each Inclosure separately, *though contrary to that correct and expeditious Method of chaining a Main-line across an Estate, and measuring the Inclosures severally that you pass through, as they are met with on the Right and Left-hand, whereby a Plan, with less Trouble, may be drawn from the Dimensions so taken; an Example of which I have delivered in Chapter X; but must intreat the young Practitioner not to peruse or examine the same until he is very expert in planning and casting up this and the foregoing Examples.*

2. And although in the last Example, the Right-hand Column contains Part of the Dimensions of the small Estate, yet, notwithstanding, if the young Practitioner be ready in the preceding Examples, he'll find it no ways difficult to plan the same, more especially after he has read the three succeeding Chapters.

The Amount of the Dimensions.

		Perches.
Field M,	North Off set, Left-hand —	307.
	South ditto, Right-Hand —	2736.
	East ditto, Left-hand —	127.
	South ditto, Left-hand —	313.½
		3484
Field Q,	Right-hand Off-set, W. —	486½
	Trapezium — —	2492¼
	East Off-set, Right-hand —	362¼
		3341
	—S. Off. Left-hand, in Field M.	313½
		3027½
Field O,	Left-hand Off-set, W. —	405¾
	Right-hand ditto, E. —	1094¼
		1500
Field P,	Left-hand Off-set, N. W. —	1447
	Right-hand ditto, S. E. —	1996¾
		3443¾
	— E. Off. L. H. in Field O.	116
		3327¾

The Amount of the whole Estate particularized, with the real Name of each Inclosure.

			A.	R.	P.
M, Dairy Field —	3484	=	21	3	4
Q, Pool's Meadow	3027½	=	18	3	27
O, Horse Pasture —	1500	=	9	1	20
P, Lady Acre —	3327¾	=	20	3	7¾
		Total	70	3	18¾

CHAP.

CHAP. VIII.

Division of Land.

LAND (when it becomes the Property of contending Parties, Co-heirs, joint Purchasers, or Co-partners, *&c.*) is occasionally divided into such Shares or Parts as the Co-parties are intitled thereto. And since this cannot possibly be done or effected without having Recourse to the Assistance of a Surveyor, or some Person equally qualified to perform the same, I shall, therefore, in this Chapter, lay down such Rules and Directions as will undoubtedly enable any Measurer to compleat the same when Occasion offers.

When any Land is to be divided, measure the same by the Directions before given, ere you divide it, except it is to be divided into two equal Parts; and in such Case it may be performed with less Trouble. Then proceed by the Rule of Fellowship taught in the first Chapter; but before you begin, you must be informed, by the Parties concerned, where their respective Shares should nearly be, namely, whether in the eastern, western, or southern Sides of the Land, *&c.* and if Water be scarce therein, it would be proper so to divide that each Part may have Communication with, and to that necessary Element; otherwise the Parties concerned and obstructed therefrom, will certainly find themselves aggrieved thereat, so as not to acquiesce to, and confirm the Division.

PROPOSITION I.

Shewing how to divide a triangular Piece of Land several Ways.

Example

Example I.

Let the Triangle A B C, represent a Piece of Land to be divided between two Men; first equally; secondly, unequally; and in both Cases the Line of Division to proceed from the Angle C. (*plate* 2, *fig.* 1.)

To divide this Field into two equal Parts, you need only chain the Side A B, and lay down the Half thereof, by measuring back again from B to D; then a Fence directly drawn or made between D and C, will divide the Field equally. For supposing a Line was drawn through the Point or Corner C, parallel to the Hedge A B, bisected in D, and D C being joined, reduces the Field to two Triangles standing upon equal Bases A B and D B; and Triangles standing upon equal Bases, and between the same Parallels, are equal by 38th *Prop.* 1 *Euclid*. Hence the Area of the Triangle A D C, is equal to the Triangle D B C Q E D.

Secondly, Let it be required to divide the same triangular Piece of Land into two unequal Parts, that is to say, one Man to have 5, 6, or 7 Acres more than the other; or to have two Thirds, or any other Part thereof, in all such Cases, this is the

RULE.

As the Content of the Field is to the Length of any one of its Sides, so is each one's Proportion or Share of the Content, to his exact Length upon the measured Side; which must be laid down or measured from the Corner B towards A, or from A towards B, according as the Parties have agreed concerning the Division.

Now, in the foregoing Example, let it be required to divide the triangular Field A B C, between *John* and *James*, and *John* to have 3 Acres more than *James*, I demand where the Line of Division must be drawn to the Hedge A B. By the foregoing Directions you measure and find the Content of the Field to be 28 Acres; and as *John* is to have three Acres more than *James*, take

take half the Difference between their Shares, that is to say, one Acre and a Half, and add it to half the Content, *viz.* 14 Acres, the Sum is 15 Acres, 2 Roods, *John*'s Share; and 1 Acre, 2 Roods, taken from 14, there remains 12 Acres, 2 Roods, *James*'s Part.

Then say,

A. C. A.

As 28 27 : : 15.5 to *John*'s Distance upon the Side A B.

```
            27.
           ----
           1085
           310
           ----    C.  L. Inches.
       28) 418.5 (14  94  4
           28 . .  or 14 Chains 94 Links,
           ----    1 2/4 of a Link, Answer.
           138
           112
           ---
            265
            252
            ---
             130
             112
             ---
              18
```

By the above Operation, you find that *John* must have 14 Chains 94 ½ Links, laid down or measured from the Corner A, towards the Corner B, *viz.* from A to G, and draw the Line E C, which will divide the Field as was required. If it were demanded to divide the same into any other unequal Parts, you must in like Manner proceed.

PROP. II.

Let it be required to measure and divide *fig.* 2, *plate* 2, which represents an Inclosure, into two equal Parts by a Line proceeding from a Pond at A.

The moſt ready Way to do this, is firſt to draw a Line from A that ſhall nearly divide the Field into two equal Parts, as AB, which you may call the ſuppoſed Line of Diviſion; then meaſure the Parts ſeparately, and if the Content of each be alike, you have equally divided the Field; but if unlike, take half the Difference from the greater Part, and join it to the leſſer, thus; divide half the Difference in ſquare Perches, by the Length of the ſuppoſed Line of Diviſion reduced to Poles, and the Quotient will be the Breadth to meaſure or lay down from the greater Part.

Here note, If you meaſure with a four-pole Chain, reduce your Chains and Links into a one Pole Chain, thus; multiply the Chains and Links thereof by 4, and the Product will be Poles, and decimal Parts thereof.

Example.

	C.	L.
I demand how many Poles in	7	19
		4
Anſwer,	28.76 Poles.	

	C.	L.
Alſo I demand how many Poles in	14	75
Anſwer, 59 Poles.		4
4)	59	00
Proof	14	75

And to reduce Poles to Chains, &c. divide by 4, as above, and the Quotient will be Chains and Links.

Example.

I demand how many Chains and Links in 13.84 Poles?

4) 13.14

Anſwer 3 Chains, 46 Links. 3.46

In

In the foregoing Example measure the Length of the supposed Line of Division A B, (but remember to begin at the Hedge on the other Side of the Pit, and not at the Point A) and you'll find it to be 15 Chains, 32 Links; then measure each Part separately, and cast up the same (as before taught) whilst in the Field, and you will find each Part to contain as follow:

	A.	R.	P.
The East Part	14	3	17
The West Part	12	1	34
The Difference	2	2	23
Half ditto —	1	1	$11\frac{1}{2}$
	4		
	5		
	40		

Supposed Line of Division —	C.	L.
	15	32
		4
	61	28

The suppos'd Line of Division is 61.28 Perches.

```
61.28) 21100 ( 3.44
       18384
       -----
       27160
       24512
       -----
        26480
        24512
        -----
        19680.
```

4)3.44
.86 Links of a four-pole Chain.

By the above Proceedings, you see the western Part is less than the Eastern by 2 Acres, 2 Roods, 23 Perches, the Half of which reduced (according to the foregoing Rule) is 211 square Poles, which being divided by 61.28, (the supposed Line of Division in Poles) gives 3.44 Poles, equal to 86 Links of a four-pole Chain, which must be laid down or measured from A towards d, and from B towards c, between which Point, a Fence made will divide the Field equally, as was required.

Example III.

Admit *fig.* 3, *plate* 2, to represent an Inclosure the Property of three Men, (*viz. Joseph, John* and *James,*) containing 21 Acres, 3 Roods, 12 Perches, to be divided equally, that is to say, each to have 7 Acres, 1 Rood, and 4 Perches; and the Lines of Division to terminate at, and communicate with a Pond of Water that is therein, so that each Person may have the Benefit thereof, and not trespass upon one another's Land.

		A.	R.	P.		P.
Joseph	—	7	1	4	=	1164
John	—	7	1	4	=	1164
James	—	7	1	4	=	1164
		21	3	12	=	3492

To effect this (after having fixt upon the Situation of each Part, by fixing Marks at A and E,) first straighten the Hedge A F E, by taking up the Off-set (as hath been taught in the first Example of the preceding Chapter) A L E F; and, in chaining the Base thereof, measure the Perpendicular L o: Having finished this Part, cast up the Dimensions thereof in the the Field, which amount to 1110 square Perches, being too little by 54, seeing each Man's Proportion is 1164 square Perches, as above.

Secondly, Measure the Trapezium A B o, and you'll find that it contains 1126 square Perches, being too little also by 38 Now, as you know the Field to contain just 3492 square Perehes. you need only take 38 from the Part unmeasured, *viz.* G C D E o, and adjoin it to the last measured Part, namely, the Trapezium A B G o; and also take 54 square Perches from the other Side of the unmeasured Share or Part, and lay it to the first measured Part, then is the Field divided as required. However, to prove the Work, it will not be amiss to measure the third and last Part, as you did the two former, (ere you take any thing therefrom) and finding it to be 1256 square Perches, that is, 92 too much; nevertheless, collect those differing Shares together, *viz.* 110 + 1126 + 1256 = 3492, a convincing Proof of your Proceedings. Supposing then the first Part belonged to *Joseph*, the second to *John*, and the last measured Part to *James*, who hath 92 square Perches more than his proportionable Right, which must be divided according as *Joseph* and *John* are deficient in their respective Parts, *viz*,

54 + 1110, *Joseph's* supposed Share = 1164 } their true
and 38 + 1126, *John's* ditto - - - = 1164 } Shares,

which, to lay down properly, you may proceed thus: First measure the Distance between the Mark in the Hedge at E, and the Mark left or set up at the Pond (when the Perpendicular L o was measured;) which being 12 Chains, 17 Links, = 48.68 Poles, a Divisor to 54. Perches, the Area of *Joseph's* Deficiency.

See the Operation.

48.68)54.00 (1 109 Poles reduced to the Links of a Statute Chain,
48.68

5320
4868

54200
43812

1388

thus:
4)1.109

.27¾ Links.

These 27¾ Links, lay off from n to a, at the Corner E, and at the Pond also, through which Places, to wit, a, a must pass a right-lined Hedge between *Joseph's* and *John's* Land.

Secondly,

Secondly, Measure the Distance between the Mark at G, and that set up at the Pond o = 10 Chains, 56 Links, which being reduced to Poles thus, 10.56 Chains;
in one Chain 4 Poles.

42.24 Poles in 10 Chains, 56 Links, a Divisor to 38 square Perches, the Land that *John* is short of in the supposed Share.

```
42.24)38.000(.899    reduced to Links of a Statute
      33 792          Chain, thus:
      ------                4.).899
       42080                ----
       38016                .22¼ Links.
       -----
        40640
        38016
        -----
         2624
```

Then, from the Line o G, lay off 22¼ Links towards d and e, through which Points or Places a right-lined Fence or Hedge must pass between *John* and *James*, and it is done.

Thus have you compleated the Division required: And if the same Field were to be divided into three, four, five, or six unequal Parts, and every Part or Share to have a Communication to, or with a Pond, Pitt, or Pool, whether in the Middle or one Side of the Field, the supposed Lines of Division must be so taken that every Division, Share, or Part, shall conjoin with the same if required.

Observation.

When Commoning, or any waste Land is to be inclosed, being the Property of several joint Lords, Freeholders, *&c.* the whole must first be measured, and then divided into such Proportions amongst them as their respective adjoining Estates pay Land-Tax, or as they are otherwise respectively intitled thereto; say-

ſaying, as the Amount of the Land Tax, &c. is to the Area of the Common or Ground to be incloſed, ſo is each Man's particular Tax, &c. to his reſpective Share of the Common which ſhould be ſo incloſed or laid out; ſo that each Diviſion or Share, may adjoin with its peculiar Eſtate.

PROP. II,

Teacheth to lay out an aſſigned Quantity of Land in a Field wherein, firſt, the Quantity is given: Secondly, the Length or Breadth muſt be found to obtain the other: Thus, if the Area of the given Quantity be divided by the Length of the Field, the Quotient will be the Breadth required; but if you are confined to a particular Breadth, the propoſed Quantity muſt be divided by the ſame, and the Quotient will be the Length thereof.

Example.

Suppoſe a Farmer lets an Acre of Meadowing to be laid out in one Side of a Field that is 24 Chains, 27 Links long, I demand the Breadth of the ſaid Acre therein.

See the Work.

```
      24.27
          4
      -----
Poles 97.08 ) 160.00          4)1.647
              97 08             -----
              -----              .41
              62920
              58248
              -----
              46720   Anſwer, 41 Links and
              39832    nearly a Half.
              -----
              68880
              67956
              -----
```

EXPLA-

EXPLANATION.

Though, from what has been already mentioned and taught on this Head, I should think it needless to expatiate upon this Example; but perhaps some of my Country Readers *(that have Occasion some Times to let Meadowing*, &c.) cannot so readily comprehend the same; and as I have hitherto with the utmost Chearfulness, endeavoured to render every Thing herein both plain and beneficial to the honest Farmer, I therefore look upon it a Duty indispensible to gratify, and (*if possible*) fulfil his Expectations by an explicit thorough Explanation not only in the foregoing Example, but also shall recommend the following Tables, whereby any Person may readily know the Breadth of an Acre, having the Length thereof, and the contrary.

First then, measure with a Chain the Field's Side, (which we'll suppose to be straight) and having found the Length thereof to be 24 Chains and 27 Links, reduce the same to Poles, *i. e.* multiply the Chains and Links by 4, the Number of Poles in a Chain, and the Product is 97.08.

Secondly, Divide the given Quantity of Land, *viz.* One Acre, or 160 square Perches, by the above 97.08, (the Poles in the Length of the Field) and the Quotient is 1.647, which being divided by 4 (to bring it into the Links of a four-pole Chain) the Quotient is 41 Links, and nearly one Half, which must be laid off, or measured from the Hedge or Field Side, in four or five different Places; and at each Place you must take $41\frac{1}{2}$ Links in your Hand, the Chain-leader holding the Chain End as near the Field Side as the Mower can cut, and then fix up a Stake that will appear from the next Mark or Stake: Thus do until it be sufficiently marked out.

And lastly for a Guide to the Mower, stand at the End of $41\frac{1}{2}$ Links, from the Field Side, and tread or beat down a narrow Road of Grass between each Mark, which you may effectually perform by keeping your Eye upon the next Mark as you advance, till you have got to the other End.

Two

Two TABLES designedly inserted for the Advantage of the honest Farmer.

TABLE I.

Sheweth the Number of Chains, Links and decimal Parts of a Link contained in the Length or Breadth of an Acre of Land, when either of the two are given or required.

Breadth.	Length.	
C.	C.	L.
1	10	00
2	5	00
3	3	33·333
4	2	2 50
5	2	00
6	1	66.6
7	1	42 285
8	1	25.
9	1	11.111
Length.	Breadth.	

TABLE II.

Sheweth the Length and Breadth in Perches, Yards, Feet and Inches, that compose an Acre of Land of a rect-angular, or long-square Form.

Length.	Breadth.			
P.	P	Y.	F.	I.
10	16	0	0	0
11	14	3	0	0
12	13	1	2	6
13	12	1	2	6
14	11	2	1	1
15	10	3	2	0
16	10	0	0	0
17	9	2	0	9
18	8	4	2	8
19	8	2	0	1
20	8	0	0	0
21	7	3	1	6
22	7	2	1	6
23	6	5	0	9
24	6	3	2	0

The Use and Application of the Tables.

It has been already observed, that 10 square Chains, (*i. e.* 10 Chains in Length and 1 in Breadth) make 1 Acre, or 5 in Length, and two in Breadth, as appears by the first Table. Hence it follows, if the Length or Breadth be given in Chains,

 Links,

Links, &c. the other may be readily found by Inspection, to wit, if the Length be given in Chains, look on the contrary Dimensions, and you'll see how many Chains, Links, &c. must be measured at right Angles, to make or lay down an Acre; for Instance, admit a Field Side, when measured, to be 6 Chains, then, by the Table, must be measured for Breadth 1 Chain, 66 Links 66, or something better than half a Link; which being multiplied by 6 Chains (the given Length) the Product will be 10 square Chains, or 1 Acre, the like in both Tables; and all other Examples of this Kind must be observed; so that any farther Illustration is needless.

Note, The first Table will answer statute, customary, and *Irish* Chains; but the second Table is calculated for Statute Measure only.

Note also, If the Side of the Field (up to which you are to lay out an Acre, &c.) be curved, or any how irregular, first straighten the Hedge, by taking up an Off-set thereto; which you must immediately after cast up, and whatever the Area thereof is short, or wants of the proposed Quantity, must be divided by the Length of the base Line reduced to Poles, and the Quotient will be the Breadth of the Quantity required.

Likewise, As Division, or laying out Land affords much Variety, I must therefore advise the young Learner *(when he is thoroughly capable to measure any Field)* to walk into an Inclosure, and practice therein, by laying out one Parcel of Ground after another, till he is perfect in the same.

Before I conclude this Chapter, I shall introduce a few more Examples that perhaps may be as serviceable to my Reader as any of the former, which may be performed without reducing the Length or Breadth of any Quantity of Land (taken in Chains) into Poles, &c.

And first, Having used the four-pole Chain *(and none else)* in this Treatise all along, I shall, in this Place, shew you how to turn any Number of Chains, into Acres, Roods and Perches, and the contrary.

Note,

Note 1ſt, That 10 Chains long, and 1 broad, *that is*, 10 *ſquare Chains*, make one ſquare Acre; therefore, if any Number of ſquare Chains be given to be turned into Acres, divide them by 10, and the Quotient will be the Number of Acres contained in ſo many Chains: But this Diviſion is abbreviated by cutting or pointing off the laſt Figure; for Inſtance, if 4740 ſquare Chains were given to be turned into Acres, by cutting off the laſt Figure, thus, 474|0, there remains 474 (to the Left hand) being ſo many Acres, which is equally the ſame as if you had divided 4740, by 10. But if Chains and Links were given to be reduced to Acres, Roods, and Perches, then cut or point off three Figures, *viz.* two for the Links, and one for the Chains; what remains to the Left-hand will be Acres; and to know the Value of the decimal Figures, cut or pointed off, proceed as in the following

Example.

In 1967 ſquare Chains, and 78 ſquare Links, how many Acres, Roods, and Perches?

Acres	—	196|778
		4
Roods	—	3|112
		40
Perches	—	4.480

Anſwer, 196 Acres, 3 Roods, 4 Perches, and nearly a Half.

On the contrary, if to any Number of Acres given, you add a Cypher, they will become ſquare Chains, the ſame as if you had multiplied the Acres by 10, (ſince 10 ſquare Chains are one Acre:) And if you would turn ſquare Chains into ſquare Links, add four Cyphers to the Right-hand thereof, thus, 1 ſquare Chain will be 10000 ſquare Links, ſo will 76 ſquare Chains, be 760000 ſquare Links, the ſame as if you had multipled 76 by 10000, the Number of ſquare Links contained in 1 ſquare Chain. So that in caſting up the Content of a Piece of Land whoſe

Dimensions were taken by a four-pole Chain *(in laying out, or dividing Land)* if you multiply Chains and Links, by Chains and Links, the Product will be square Links; for seeing that 1 Chain 24 Links may be thus expressed, 1.24 Chains; and by leaving out the decimal Point, it will be thus expressed, 124, that is, 124 Links; therefore Links multiplied by Links, produce square Links; so that you must cut or point off five Figures from the Product, to find the Acres; which is the same as if you divided the Product by 10000 (the Number of square Links contained in 1 square Acre;) then, by Reduction, find the Value of the Decimals so pointed off, and it is done.

Example.

Admit a rect-angular Field (commonly called a long Square) to be 7 Chains, 38 Links long, and 3.73 Chains broad, I demand the Content in Acres, Roods and Perches.

See the Work.

```
    7.38
    3.73
   -----
    2214
   5166
  2214
  -------
  2.75274
        4
  -------
  3.01096
       40.
  -------
  0.43840
```

Answer, 2 Acres, 3 Roods, and nearly half a Perch.

Thus the Learner may lay out, or divide Land equally the same as if he had reduced his Chains to Poles, according to the Directions in the first Part of this Chapter.

Note,

Note, From the two foregoing Examples may be deduced the following Propositions concerning the Transmutation of superficial Figures, to wit, to change Land from one Form to another; as also their Division, or Separation into any Number of proportional Parts required, which ought to be understood by every one that desireth to attain a competent Proficiency in the Art and Practice of Surveying; but as those Propositions tend more to amuse and divert the Learner, than to advance his Knowledge in the practical Part of Measurement, I shall not only omit a geometrical Demonstration thereof, but likewise be as brief as possible in every Article that doth not immediately relate to Field Practice; and therefore beg Leave to refer my curious Readers to the Works of those Authors who have more copiously treated thereon.

PROP. I.

A certain Quantity of Acres being given to know the Side of the square that shall be equal thereto.

RULE.

To perform this Proposition, annex 5 Cyphers to the Right-hand of the Acres proposed or given, which will turn them into square Links, the square Root whereof, will be the proposed Square to be protracted or laid down, according to the Directions given in Problem I, Chap. II, which see.

Example I.

Let it be required to find the Side of a Square that shall be equal in Area to 1 Acre of Land.

See the Work.

```
      )1.00000.(316  Anſwer, 3 Chains, 16 Links,
       9 ····             and nearly 1 Quarter of a
      ———                 Link.
  61) 100
       61
      ———
  626)3900
      3756
     —————
     14400
```

But if the Side of a Square be required that ſhall be equal in Area to any Quantity of Acres, Roods and Perches, add the Number of ſquare Links that are contained in the odd Roods and Perches, to the ſquare Links found in the given Quantity of Acres; and the ſquare Root of that Sum, will be the Side ſought.

PROP. II.

How to lay out any given Quantity of Acres, &c. in a Parallelogram, or Rect-angle, whereof one Side is longer than the other.

RULE.

Divide the ſquare Links that are contained in the Acres, &c. by the given Side, and the Quotient will be the Side ſought or required.

A Rect-angle is required, that ſhall contain juſt half an Acre, ſuppoſing the Breadth to be 6 Poles, I demand the Length thereof.

Note, As this Example does not conſiſt of Chains, I ſhall work it two ſeveral Ways, *viz.* firſt by Poles, and after by Chains, or ſquare Links.

See

See the Work both Ways.

First by Poles.

```
Breadth 6)80  square Poles in half an Acre,
          6
         ---     4)
          20     13.333  the Length.
          18     ------
         ---      3.333  Answer.
           20
           18
          ---
            20
            18
           ---
             20, &c.
```

Secondly, by Chains.

As 10000 square Links, are 1 Acre, 5000 square Links must be half an Acre: therefore 5000 divided by the Breadth (1 50, the Link in 1 $\frac{1}{2}$ Chain, or 6 Poles) quotes the Length, thus:

```
1.50)50000(333, &c. square Links, equal to
     450..                3 Chains, 33 Links,
     ----                 as before,
      500
      450
      ---
       500
       450
       ---
        50
```

How any Piece of Land in the Form of a Rect-angle, may be so laid out, that it shall be 4, 5, 6, 7, or 8 Times, &c. longer than it is broad.

RULE.

First let the given Quantity of Acres, &c. be turned into squares Links (as before) which Sum divided by the Number given

given for the Proportion between the Length and Breadth, as 4, 5, 6, 7, &c. then the ſquare Root of the Quotient, will be the ſhorteſt Side of ſuch a Rect-angle in Links, which being multiplied by that Number you made your Diviſor, the Product is the longeſt Side.

Example.

Let it be required to lay out 4 Acres in a Field, ſo that its Length may be 7 Times as long as broad.

See the Work.

```
      7)400000.
      ---------
         . . .     Links.
       ) 57142.85 (239 the ſhorteſt Side.
         4                7
        ---             ----
    43) 171          1673 the longeſt Side.
        129
        ----
   460) 4242
        ----
          18
```

As the laſt three Examples are more for Amuſement than any real Uſe in practical Surveying, I thought it needleſs to introduce Decimals in the Work, which ſhould be uſed in Practice, if an Example of the Kind ſhould ever offer.

CHAP.

CHAP. IX.

Shewing how to plan (Dimensions taken by the Chain only) *all Manner of regular and irregular Inclosures, whether bounded by curved or circular Hedges,* &c, *and also to map the same if required.*

YOU must take up your Dimensions, as hath been already taught in the foregoing Chapters; cast up the Content, as before directed, by the Pen; and though you have your Dimensions planned, you must not, (as Thousands have done heretofore) cast up from the Plan, it being impossible to tell the Links under ten, upon any Scale exactly; and of Consequence your Work would be subject to Error, which your Pen is no Ways liable to when your Dimensions are accurately taken, and the Productions of your Pen in working the same proved as you proceed; you then may, with the greatest Certainty, rely on your Return of the same.

Now, when your Dimensions are taken and cast up, the next Thing to be done is to lay down the same upon Paper, for which Purpose the Scale is very necessary. There are several different Sorts of Scales (with regard to Size,) *viz.* Scales of equal Parts, containing 1, 2, 3, 4; or 10, 20, 30, and 40 Chains to an Inch; and these are decimally reduced to any other Size, according as the Measurer hath Occasion to use them.

Of Scales, and Lines thereon.

There are many Lines upon a Scale besides the Line of equal Parts, namely, Lines of Proportion; as the Line of Number, Line of Sines, Tangents, Secants, &c. Alſo, for Projection, the Line of Chords (uſed in making and meaſuring of Angles,) Line of Tangents, and Semi-tangents, Rum-lines, &c. Theſe latter we ſhall have no Occaſion for in this firſt Part.

Excluſive of the above-mentioned Scales, there are others whoſe Lines are differently divided; namely, the Inch divided into 11, 12, 16, &c. equal Parts, I don't look upon ſuch Scales to be ſo particularly adapted to the Chain as the firſt mentioned Scale, notwithſtanding a Perſon may plan by, or from any Scale divided into equal (vulgar fractional) Parts, But thoſe which I would recommend, are the Inch, half Inch, &c. decimally divided, as the eaſieſt and moſt ready for a Learner.

Directions to uſe them.

Scales of equal Parts, are for meaſuring or laying down Lines, and are differently made and divided, if the 1, 2, &c. be accounted no more, the Sub-diviſions at the End and Top are 1 decimally divided into Tens, and Hundreds.

But if the 1 be reckoned 10, the 2, 20, &c. whether upon the Inch, half Inch, or quarter Inch, the Sub-diviſions are Chains, and tenth of a Chain, that is, 10 Links: And when you call the 1 or 2, &c. 100 or 200, &c. the Sub-diviſions at the Top repreſent ten Chains each; and thoſe at the End 1 Chain; for Inſtance; if it were required to take 370 Chains off the Scale, ſet 1 Foot of the Dividers in 3, (whether Inch, half, or quarter Inch, it is not material, ſo that it be the Scale you propoſe to plot by,) and the other Foot in the ſeventh ſmall Diviſion at Top, and that Ex ent will contain 370, which is the ſame Diſtance that repreſents either 3 Chains, 70 Links, or 37 Chains: But here every large Diviſion, where the Numbers 1, 2, 3, &c. are placed, are accounted 100, *viz* 1 is 100, 2 is 200, &c. and then every ſmall Diviſion at Top is 10, and each one at the End, repreſents 1 Chain only; and in this Caſe, if there be any odd Links, you muſt compute them between the Sub-diviſions, as ſuppoſe you muſt ſet off 81 Chains, 38 Links, ſet 1 Foot in 8, and extend the other to the firſt ſmall Diviſion at Top, as if you were to ſet off 81. and that repreſents 81.00, or 81 Chains; then ſhift both Legs of the Dividers almoſt 4 Diviſions at the End

End, that is, between 3 and 4; the 3 repreſents 30 Links, and the 4, 40 Links; ſo that you muſt compute, as near as you can, the 8 odd Links between the ſaid third and 4th Diviſion; and from 8 to that Place, is the Extent 81.38 required.

There are other Scales equally divided to meaſure and plot by, as the diagonal Scales, *Gunter*'s Scale, &c. which are partly the ſame with the common plain Scale, in regard to a Scale of equal Parts.

The common plain Scale is made 6, 9 or 12 Inches long, but *Gunter*'s Scale is two Feet: The plain Scale has the Diagonal, the Line of Chords, Rumbs, Sines, Tangents, and Semi-tangents, &c. on one Side (which are all Scales unequally divided.) *Gunter*'s Scale hath all the above-mentioned Lines or Scales on one Side, that the plain Scale has upon both; and on the other Side of it, there are Lines of Proportion, namely, Lines of Numbers, Sines, Tangents, &c.

First of the Line of Chords.

The Line of Chords (marked Cho.) is a Line of unequal Parts, numbered 10, 20, 30, &c. to 90, the Diviſions thereof grow leſs as the Numbers increaſe. There is commonly a Braſs Point at the Beginning, and alſo one at 60; the Chord of 60 being equal to the Radius, or Semi-diameter of a Circle, that Extent called the Chord of 60, is always taken to make or meaſure Angles with, and is applied to no other Purpoſe.— How this Line is made uſe of ſhall be ſhewed in a proper Place.

Of the Line of Numbers.

The Line of Numbers is alſo one of thoſe Lines upon *Gunter*'s Scale, commonly called *Gunter's Line*; and upon the Scale is diſtinguiſhed by the Name of *Line of Numbers*, marked Num. or Numb: It is numbered from the Left hand, with 1, 2, 3, &c. to 10 to the middle of the Scale; and from thence to the Right-hand, with 2, 3, 4, &c. to 10 again; the Diviſions are unequal, decreaſing from the Left to the Right, as the Numbers increase; both Parts from the Middle are alike divided, that is, the Space from 2 to 3 on the Left-hand Half, is equal to the Distance between 2 and 3 on the Right-hand Part or Half, and keeps the same Order exactly with regard to Space, that is, the Distance between 1 and 2 on the Left-hand, is equal to the Space between 1 and 2 on the Right-hand; but the Space between 1 and 2 on either Part, is not equal to the Distance between 2 and 3, or 4 and 5, upon the same, but larger: But the Space between 1 and 2, is equal to the Space between 2 and 4, or between 5 and 10, &c. beeause 1 bears the same Proportion to 2, as 2 does to 4, or 5 to 10, &c. and every two Numbers that bear the same nroportion between themselves, are equally distanced upon this Line. Hence the Proportion of any two Numbers being given, the Proportion of a fourth to a Third, may be obtained by a Pair of Dividers.

So that the greater the Number, the closer they are placed upon any Line on the Scale, because every Number included between any two Numbers, (though ever so large) are expressed between them on the Line, as well as all Numbers included between any two smaller, in the same Proportion; as for Instance, 24 bears the same Proportion to 6, as 8 does to 2; therefore all Numbers between 24 and 6, are contained in the same Space upon the Line, as the Numbers that are between 8 and 2.

The Figures on the Line of Numbers may be read as the Scale of equal Parts, namely, the 1 may represent on the Left-hand 1, 10, 100, &c. and the second Part is always 10 Times the Value of the first: Thus, if 2 be called 2 on the Left-hand, the 2 on the Right-hand is 20, 3 is 30, 4 is 40, and 10 at the End of the Line is 100, &c.

The Numbers between 1 and 10, and 10 and 100, are supplied by Sub-divisions; as the next large Sub-division towards the Right-hand of the 1 in the Middle is 11, the second 12 (where a small Brass Point is fixt for Timber Measure, &c.) and the fifth, which for Distinction is longer than the rest, is 15, and so on to 16, 17, &c. and then the 2 is 20, and so count on 21, 22, 23: Upon the larger Divisions, betwren 20 and 30, the 3 will be 30, the 4 40, &c.

And

And if your Numbers run higher, the Sub-divisions increase in a ten-fold Proportion accordingly.

This Line is only intended for Proportions; all Numbers equally distant upon the Line, bear the same Proportion to each other; upon which is grounded the Reason why Multiplication, Division, and the Rule of Three, &c. can be performed upon the Scale, or Line of Numbers, by a Pair of Dividers, as effectually as with or by the Pen: Mr. *Gunter* is supposed to be the Inventor of this useful Line, from whom it takes its Name.

Of the Line of Sines.

The Line of Sines upon the Scale is commonly marked *Sin.* or *S*; and is numbered from the Left to the Right-hand, with 1, 2, 3, 4, &c. up to 90 Degrees, where there is a Brass Center; these Divisions are likewise unequal, and are projected from a quarter of a Circle divided into 90 equal Parts: The Perpendiculars let fall from the equal Divisions of the Quadrant to one Side of it, and parallel to the other, are artificial Sines to that Radius. Directions to use this Line shall be given in a proper Place.

Of the Line of Targents.

The Line of Targents upon the Scale, is numbered from 1 on the Left-hand, to 45 on the Right-hand (because the Tangent 45 Degrees is Radius,) where there is a Brass Centre, and marked *Tan*; it is also numbered back again with 50, 60, 70, &c. and equally decreaseth as the Numbers 20, 30, 40, increaseth towards the Centre, that is, the 40 and 50 are represented by one Line; 60 and 30, and 70 and 20, being equally distant from the Center or Tangent 45 Degrees.

There are also many other Lines upon *Gunter's* Scale, as Secants, Rumbs, equal Parts, meridional Lines, &c. which I would describe here, but as we shall have no Occasion for such Lines in this Treatise, it is needless to say any thing of them.

Thus

Thus having explained the Scale, it follows next to apply it to Use, and being provided with a Pair of Dividers whose Legs are of equal Length, and the Points very fine, observe the Directions following.

Any Line or Distance measured by the Chain, how to lay down the same upon Paper.

Seeing that vulgar fractional Scales, *viz.* those that contain 11, 12, or 16, equal Divisions in an Inch, are not so convenient as the diagonal Scale, which is more particularly adapted to Chains and Links, and may be increased or decreased to almost any Proportion whatsoever, in laying down or protracting Lines upon Paper; and as the 1 upon the Inch, half Inch, or quarter Inch Scale, may represent 1, 10, 100, &c. so also your Chain Line may be increased or decreased, by halving, doubling, tripling, or quadrupling, &c. to be taken off any of the above Scales, in order to answer the intended Limits or Size of the Plan. One Instance or two will be sufficient to illustrate the same.

Example I.

Let us then suppose the Line D E to represent a Field Side, which being chained, is found to contain 32 Chains, 25 Links.

D————————————————E

Now to lay this down from the Inch, half Inch, or quarter Inch Scale, so that the same may be laid down upon Paper almost to any Size, may be performed as follows:

First, With the Dividers and Scale, draw a right Line at Pleasure; then fix one Foot of your Dividers at the Figure 3, in the Scale that best suits your intended Size; but if the Inch Scale be too small, you may double or triple, &c. your Chains and Links in each Line you lay down, and take the same off the Inch Scale; and if the quarter Inch Scale be too large, instead of multiplying, you must divide by 2, or 3, &c. and so of any other

other Scale. But to proceed; suppose the above is required to be laid down from the half Inch Scale, and let the 1 represent 10, the 2 20, &c. then fixing one Foot of the Dividers at the Point 3, for 30 Chains, extend the other Foot to two of the small Divisions at the Top (which represent the two odd Chains;) and for the 25 Links, shift down two Divisions and a Half, which are marked at the End with 2, 4, 6, 8, then you will have the whole Extent of 32 Chains, 25 Links, to wit, the Space from 3 of the large Divisions, on the half Inch Scale, unto 2 of the smaller; comprehending also, by shifting in a right Line, for 25 Links, two and a half of the parallel Lines, from the Left-hand to the Right, at the End, whereby you have the Extent sought.

Secondly, With the said Extent in your Dividers, place one Foot at the Point A, and with the other cross the said Line in the Point E; then, with a drawing or writing Pen, blacken the Space between A and E, and you have the Hedge D E, represented by the Line A E, equal to 32 Chains, 25 Links, as above.

A————————E

Thirdly, If you would have the same Line shorter, or longer, proceed as above directed, by using different Scales, or doubling the Chains, &c. as you see Occasion. Hence, each Line will be 32.25 Chains, and be in Proportion one to another, as the Scales from whence they were taken. And in this Manner may any Number of Chains and Links be taken from sundry Scales, as the Case requires. I might, in this Place, give some more Examples, but I think it needless, as there is no other Variety in taking any Number off the Scale, than what appears above. But be careful to remember, that whatever Scale you begin with in planning, or laying down Lines, you must make Use of the same until you have finished your Work; and not lay down one Line by one Scale, and another by another Scale. And if you would have a large Plan reduced to a small Compass, then use a smaller Scale: But on the contrary, if you mean to express every small Particular in your Plan, then you had better use a large Scale, as one Chain, or four Poles to an Inch; otherwise larger by taking two Poles, or half a Chain to an Inch, &c.

Whoever

Whoever desires to become a Planner of Land, may easily arrive at Perfection therein by practising according to the foregoing Directions.

A right Line being given, to find how many Chains and Links are contained therein, according to a Scale assigned.

AND,

Suppose the foregoing Line DE was given, and it were required to find how many Chains and Links were therein contained according to a Scale of 80 Poles to an Inch, that is, 20 Chains representing an Inch, taken off the half Inch Scale.

RULE.

Take in your Dividers the Length of the Line DE, and apply it to the half Inch Scale, you'll find that Extent to reach from 3, (or 30,) of the great Divisions to 2 Chains, 25 Links, of the lesser ones, as before taught; therefore the Line DE contains 32 Chains, 25 Links; which is the Reverse of the foregoing Example, seeing they interchangeably prove each other.

PROB. I,

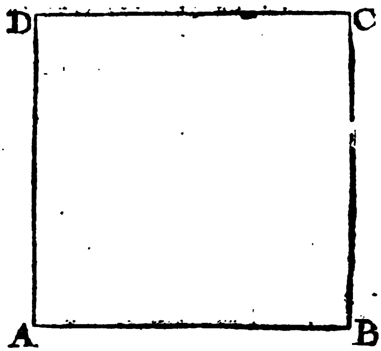
Teacheth to protract or plan upon Paper, a Field in Form of a geometrical Square. What a geometrical Square is, hath been explained in the Definitions.

Example.

It is required to plan the following Dimensions (*brought from Page* 105,) from a Scale of 40 Poles to an Inch.

Dimensions.		C. L.
0	——————————	16.82
16.82	——————————	16.82

PRO-



Protraction.

First, Take up in your Dividers, the first Perpendicular, *viz.* 16 Chains, 82 Links, from an Inch, or any other Scale, and lay it from A to B, according to the Directions given in the first Example of this Chapter.

Secondly, at the Point B, erect the Perpendicular B C, and proceed herein as you were taught in *Problem* VII. of practical Geometry (a Repetition thereof in this Place is needless) and the Square will be compleated. *See the Figure* A B C D.

PROB. II.

To plot a Field in Form of a Rect-angle, or long Square.

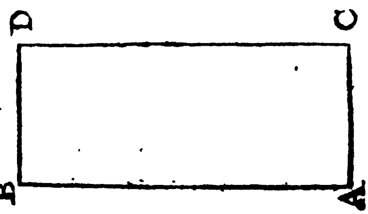
Example.

Let it be required to plan the annexed Dimensions from a Scale of 10 Chains, or 40 Poles to an Inch.

Brought from Page 107.

0 ———————————— 9.54
21.78 ———————————— 9.54

First, then, draw a Line parallel to your Breast with the Dividers, upon which lay down 21 Chains, 78 Links, taken from the Inch Scale; and then, upon the extreme Points thereof, at A and B, erect the Perpendiculars as you were taught practical Geometry, and lay thereon 9.54, taken from the same Scale, from A to C, and from B to D; draw a Line between D and C, and you will thereby discover the exact Form of the Field that contains your Dimensions wherein they were taken.



PROB. III.

To plan a Field having two of its Sides parallel, and a third perpendicular thereto.

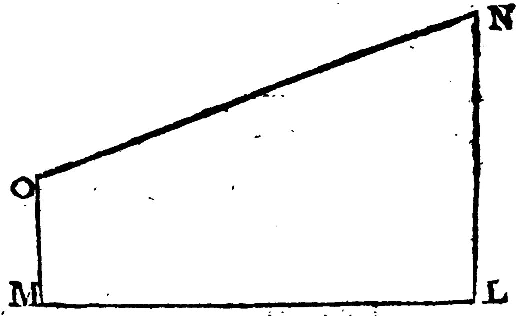
Example.

Let the annexed Dimensions be planned, taken from a Scale of 40 Poles, or 10 Chains to an Inch.

Brought from Page 117.

C. L.	C. L.
0	7.0
22.50	15.0

To



To perform this, first lay down the base Line L M, equal to 32 Chains, 50 Links, taken from the Inch Scale, and at the End thereof, at M, erect a Perpendicular, upon which lay down your first Number, *viz.* 7.0, from M to O.

Secondly, erect a Perpendicular at L, and lay thereon 15.0 Chains, from L to N.

Lastly, Draw a Line from O to N, and you will thereby procure the true Form of your Field.

PROB. IV.

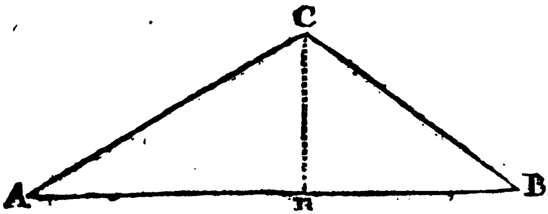
To protract a plane Triangle.

Example.

It is required to plan the annexed Dimensions from a Scale of 40 Poles to an Inch.

Taken from Page 109.

0	00
9.24	21.36
33.60	00



To plan the foregoing Dimensions.

First, Draw a base Line A B, at Pleasure; then, from your Scale of equal Parts, take 9 Chains, 24 Links, and lay it down from A to n; and thereat erect the Perpendicular n C, upon which lay 21 Chains, 36 Links (taken from the same Scale) from n to C.

Secondly, take 33 Chains, 60 Links, in your Dividers, and lay it down from A to B.

Lastly, Let there be drawn two Lines from A and B, to the Point C, by which you have compleated the Form of the Triangle sought, according to the above Dimensions.

Note, If your Dimensions had been different to the above, to wit, the Perpendicular at either End of the Base A B, you have Directions in practical Geometry to protract the same.

PROB. V.

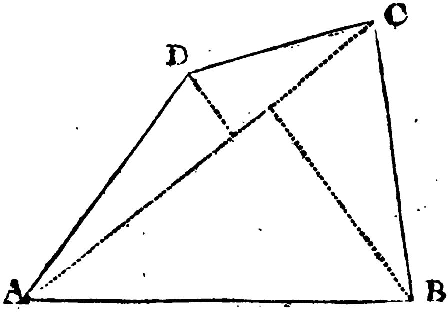
To protract a Trapezium from the Dimensions in Page 116.

Example.

o——————————o
14.——————————4.45 Left-hand Perpendicular.
15.35——————————12.10 Right-hand ditto.
23.12——————————o

The

The Difficulty of planning the foregoing Dimensions, vanishes when you consider them as two distinct Triangles, having one common Base, commonly called the *Diagonal.*



PROTRACTION.

First, At Pleasure draw the diagonal Line A C, and, by Problem IV, make the Triangle D A C; thus take from your Scale of equal Parts 14 Chains, and set it off from A towards C, and there erect a Perpendicular to the Left-hand, upon which lay down 4 Chains, 45 Links, the first Perpendicular found or met with in the field.

Secondly, From the same Scale take 15 Chains, 35 Links, in your Dividers, and lay it also from A towards C, at which Place erect a Perpendicular also, and lay thereon 12 Chains, 10 Links, your second Perpendicular. And,

Lastly, Join the Points A, B, C, and D, together, and it is done.

PROB.

PROB. VI.

Let it be required to plan the following Dimensions taken from Page 156.

Dimensions.

0	,60
2,0	1,80
2,0	2,10
4,40	3,00
6,50	2,30
7,70	2,10
9,0	2,40
11,46	3,20
13,10	3,25
15,20	3,0
20,26	2,0
22,0	2,60
24,0	2,80
26,0	2,80
26,80	2,50
28,60	1,20

CONSTRUCTION.

First, At Pleasure draw the Line A B, and, from any Scale of equal Parts, take 60 Links (as before directed) and lay it down from A, towards B.

Secondly, From the same Scale take 2 Chains, and also lay them down from A towards B, and thereat lay down 1.80 Links at Right-angles, above the Line A B, and at the same Place lay down 2 Chains, 10 Links, likewise.

Thirdly, Take 4.40 Chains from the same Scale, and lay them down from A, as before, and lay thereon 2.50 at right Angles to A B.

Fourthly, Take in your Dividers 6 Chains, 40 Links, and lay it down from A towards B, upon which set off 1.30 at Right-angles as before. Thus proceed in planning the aforesaid

ſaid Off-ſet, until you have laid down the whole Baſe A B = 28 60, at which Place there is a Perpendicular of 1 Chain, 20 Links.

Laſtly, With a black Lead Pencil (made very ſmall or fine) draw a curved Line through thoſe Points in the ſeveral Perpendiculars, which you may afterwards either blacken with a drawing Pen, by a ſingle Line, otherwiſe make a fine Hedge that ſhall repreſent the ſame, and it is done.

Note, The curved Hedges in each Field that you plan, muſt in like Manner be laid down, and the Boundaries thereof firſt drawn with a lead Pencil, which may be rubbed out with a little white Bread, after you have drawn the ſame with Ink, or made a Hedge, bnt ſee the Bread be not too new.

Note alſo, If you would have your Field placed in a true Situation with regard to the cardinal Points, obſerve the Directions for planning in Part the ſecond, and proceed accordingly.

P R O B. VII.

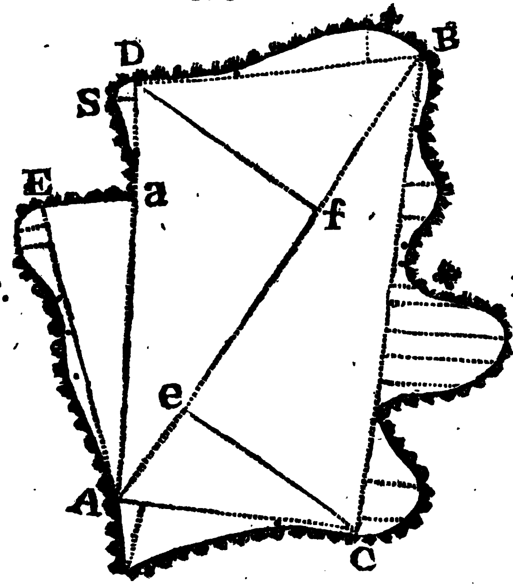
Let it be required to plan the irregular Field A C B D, *Example* III, Chap VII, from the Dimenſions as they are there, to which I refer my Reader.

Firſt, Draw the Line A B at Pleaſure, then, from a Scale of 40 Poles to an Inch, to wit, the Inch Scale, take 27 Chains in your Dividers (being equal to two Inches and ſeven Tenths of an Inch,) and lay it from A to B.

Secondly, From the ſame Scale take 5.60 Chains in your Dividers, and lay it from A to e, at the Point e erect a Perpendicular towards the Right-hand (it being the firſt you took in meaſuring the Trapezium) and lay thereon 11 Chains. Alſo take 17 Chains in your Dividers, and lay it from A to f, at which Point erect a Perpendicular to the Left-hand, upon which lay off your ſecond Perpendicular, to wit, 11.20 Chains, then join the ſeveral Points AC, CB, BD, and DA, by drawing the Lines AC, CB, BC, and DA, with your Dividers, upon which Lines plan reſpectively the particular Off-ſets, as you meaſure them in the ſaid Field. *See the following Figure.*

First,

NORTH.



SOUTH.

First, By the Directions given in the last Problem, plan your second West Off-set upon the Line A D, because the first Off-set you took in the Field depends thereon.

Secondly, From the Point E (the End of the first Perpendicular in the second West Off-set) draw the Line E A with your Dividers, and thereon lay down your first Off-set, as before directed.

Thirdly, At the Point D, begin to lay down your North Off-set.

Fourthly, Upon the Line B C, lay down your East Off-set.

Lastly, Upon the Line C A plain your South Off-set; and all your Out-lines being drawn with a fine-pointed Lead Pencil, shews you a true and exact Representation of the Field.

CHAP.

CHAP. X.

Sheweth how a Manor, Lordship, or any Quantity of Land (consisting of any Number of Inclosures contiguous to one another) may be accurately surveyed by the Chain only; so that the Dimensions thereof may be cast up by the Pen, and the Area of each Close be truly found; also, afterwards (if required) a correct Plan delineated from those Dimensions, whereby a Map decorated with peculiar and ornamental Embellishments, may be obtained. See Plate the 3d, which is a Map of a small Estate taken from a Plan of the same in Plate 2d.

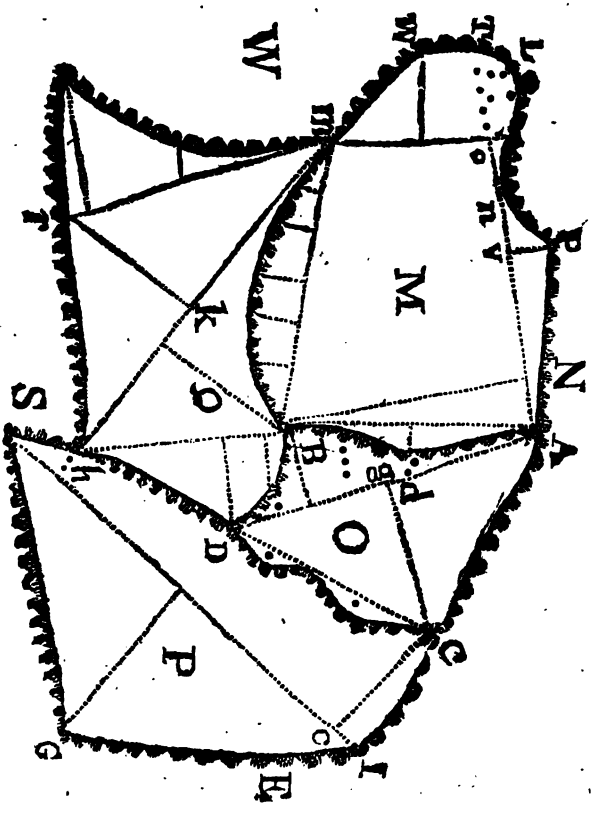
HAVING, in the preceding Chapters, treated orderly, as well as briefly, of all Manner of Fields, whose Sides are not only many, but also the Fence or Hedges both curved and circular; wherein I have shewn how the same may be accurately measured, cast up by the Pen, and planned; I shall now observe, and direct, how an Estate, consisting of any Number of Fields, may be accurately measured; and, from the Dimensions thereof, correctly planned.

Observe the following Directions.

First, you may either measure each Field separately, as already taught, and plan the same; or otherwise, begin at one Side of the Estate, it matters not which, and draw a Line quite across the same; then measure each Field you come into as directed in the second Example of this Chapter, by taking up your Dimensions upon the Right and Left-hand.

Secondly, Until you are thoroughly Master of planning, it is adviseable not to measure more than three or four Fields, 'till you plan your Dimensions, otherwise your Forenoon Dimensions may be planned in the Afternoon: However, when you are become pretty tractable in the Fields, every other or third Day will be sufficient to plan your Dimensions, or Field Notes.

Thirdly, Having made Choice of a Scale to plan by, you must proportion your Paper accordingly, to wit, if you design your intended Plan to be so large as not to be contained in one Sheet of common white Paper, it will then be necessary to paste a sufficient Number of Sheets together.



Example

Example I.

Admit it were required to plan the following Dimensions brought from Pages 168, and 169. *See the next preceding Figure.*

Field M.

N. Off. L. H.

307,

0	0
1,0	1,20
1,20	2,00
2,30	2,00
6,40	,10
8,0	,10
10,30	2,00
19,50	0

E. Off. L. H.

127,

0	0
6,0	1,50
10,60	00
13,40	00

Field Q.

R. H. Off. W.

486.½

0	0
4,60	,40
7,80	2,00
13,0	6,60
14,	00

R. H. Off. S.

2736.

0	3,00
4,75	8,00
17,	13,0
19,50	0

S. Off. L. H. in Field M.

—— Field Q.

313,½

0	0
3,	2,0
5,60	2,70
7,90	2,45
10,34	1,30

 The

Dimensions of Field Q continued.

Trapezium,

$2492\frac{1}{4}$

0		0
11,30	R H	7,70
13,50	L H	7,80
20,10		00

Field O.

L. H. W. Off.

$394\frac{1}{4}$

0	0
2,70	1,30
4,	4,00
6,80	3,00
9,10	1,20
16,0	,20

Field P.

L. H. Off. N. W.

1447.

0	0
4, to S. Corner Fd. Q	2,00
22,80	6,50
24,0	4,40

E. Off. R. H.

$362\frac{1}{4}$

0	0
1,70	,60
7,20	4,20
9,10	3,00
10,50	,00

Right-hand Off-set, E.

$1094\frac{1}{4}$

0	0
8,	8,0
16,	1,10

E. Off. L. H. in Fd. O—Fd. P.

$107\frac{1}{4}$

0	0
4,0	1,20
7,0	,00
9,0	1,10
11,60	00

R.H. Off. S.E.

$1996\frac{3}{4}$

0	0
12,	10,00
24,	,80

The

The Field wherein you first began, is called the Field M, which you must lay down (from any suitable Scale of equal Parts) upon Paper, as you took it up, *viz.*

1. Draw a Line with your Dividers of a sufficient Length, then assume a Point therein, as T; from a Scale of equal Parts take 19.50, and lay it from T to A, upon which lay down your Left-hand Off-set, as you were directed in the two foregoing Examples, Chapter IX.

2. Having planned this Off-set, begin with those Dimensions that are on the Right-hand Side of the Line T A, and thus proceed:

3. At T erect the Perpendicular C w, and lay thereon 5 Chains for your first Perpendicular to the Right-hand; lay down 4 Chains upon the common Base T A, from T to o, and thereat lay down, at Right-angles, your second Perpendicular, namely, 8 Chains; also 17 Chains from T; lay off your third Perpendicular 13 Chains, which will point out the South-East Corner of this Field; with your Pencil join T w and m together, which Line will represent the West Hedge.

4. Draw a Line from the Corner B, to the Corner A, as a base Line for your East Off-set, and lay thereon 6 Chains, at which Place lay off your Perpendicular 15 Chains, then with your Pencil join A d and B, for the East Side of the Field.

5. Draw a Line from B to m, and in like Manner lay thereon your South Off-set, as above directed, and,

Lastly, with your Pencil draw a Line through m B, and the extreme Points of the several Perpendiculars raised upon that Line, so shall you have the South Side of the Field represented. The Form of the Field being thus plotted, you may easily trace the Boundaries thereof with a drawing Pen and Ink.

The next you entered was Q, Pool's Meadow, which to plan, proceed thus:

1. With 20.10 Chains in your Dividers, and setting one Leg in m, describe an Arch, and from your Scale take 10.50 Chains also

erected on the Right and Left-hand, to the subtending Corners or Angles in each and every Inclosure you meet with when chaining or advancing through the same; but if you should happen to be obstructed by Pond, River, Building, &c. in that Case, proceed according to the Directions given in Page 92.

Secondly, At Pleasure you may fix in any Part of the Boundaries, and from thence chain the above-mentioned Line quite across the Estate (it matters not whether a meridian, parallel, or compound Line) which, when you are chaining, or measuring, carefully observe to take the Dimensions of each Inclosure that you pass through, according to the foregoing Directions.

Thirdly, Having finished this main or chief Line, and the Dimensions of each Field, cast up the same (as hereafter directed) the whole Proceedings being founded upon Problem V, Chap. IV, foregoing; and afterwards with Scale and Dividers plan the Field Notes, which done, repair to that Part of the Estate unmeasured (whether on the Right or Left-hand of your Main-line) and measure it also, either by another Main-line, or otherwise, as appears most convenient; cast up and plan those Dimensions with the former; and in like Manner proceed until the Dimensions of the Whole be compleated. But in measuring any Line (perpendicular to your Main-line) which excludes a Part of the Field wherein the same is taken, whether to the Right or Left-hand thereof, the same must be taken up as an Off-set upon an Off-set, (*see Article 5th, Page* 96) and entered as already directed in its proper Place: This being done, and you perceive any other Part or Parts of the Field which those Lines that are perpendicular to the Main-line cannot comprehend or include, in that Case measure the same distinctly, as Off-sets upon Off-sets, or otherwise, till there is no Part omitted or left out.

Fourthly, It matters not whether you cast up the Dimensions before or after they are planned, but see that you leave not the Premises ere the Plan is accurately finished, *I mean before you have noted and inserted every Thing remarkable therein*, otherwise the Map thereof (of Course) will be as imperfect as the Plan, for from the Plan the Map is obtained.

Fifthly,

Fifthly, Return the Ground Plot (only) of all Edifices, Buildings, &c. except you have Orders to ſhew the Elevation of ſome beautiful Edifice, ſuch as the Manor Houſe, Hall, &c. which ſhould not appear in the identical Place where the ſame ſtands, but in ſome vacant Corner or Place of the Map laid down from as large a Scale as that Vacancy will admit of; for if erected, or drawn upon the Foundation or Ground Plot, according to its real Size, that is to ſay, projected from the ſame Scale, the Beauty of the Edifice will be rendered thereby almoſt inconſpicuous; and if it be drawn or laid down (where its real Foundation is) from a larger Scale, the adjoining Gardens, Folds, Cloſes, &c. will conſequently be concealed or covered thereby, which induce me to recommend Vacancies to repreſent the Elevation of Buildings in.

Sixthly, Having heretofore given ample Directions and Cautions to young Practitioners concerning the true Method of meaſuring and planning, I ſhall now proceed to Example the 2d, wherein, inſtead of unneceſſary Repetitions, I ſhall refer to ſuch Pages as will ſufficiently direct the young Learner; but obſerve, in the ſucceeding Example, there are not only ſingle Fields to be meaſured, but Care muſt be taken how they adjoin to the adjacent Incloſures, ſo that the ſame may be accurately planned: However, the Surveyor hath this Advantage (when many conjoined Fields are to be ſurveyed;) for having meaſured any, or all the Sides of one Field, though extremely irregular, thoſe Hedges that intercept the adjacent Incloſures, will appear when that Field which he has meaſured is planned, ſo that it will be needleſs to meaſure or ſtraighten the ſame over again. *See Example* V, *Chap.* VII, wherein there are Directions to caſt up all ſuch Dimenſions.

Seventhly, If your Orders be to return a Map wherein the Contents muſt not appear, which often happens, and eſpecially when large Demeſnes, Manors, &c. are to be ſurveyed; in that Caſe get a Reference Book with as many Leaves therein, as the Size of the Eſtate ſhall require, and place a different Letter, or Number in each Field that is repreſented in the Map, which will refer to the Name and Quantity thereof in the Reference Book, the ſame Letters or Numbers being put therein; and if the Manor, &c. conſiſt of ſeveral Tenements, the ſhading in the Map ſhould diſcover the ſame at firſt Sight; and in Part the ſecond there are Directions for that Purpoſe.

Eighthly, When Buildings, Gardens, Folds, Ponds, Wood, or whatever elſe that are inacceſſible, do occur, or interpoſe between any two Perpendiculars, the true Area of the ſame may be thus obtained. From the Area of the Space that thoſe two Perpendiculars include, or comprehend, deduct the Area of the circumjacent Off-ſets that lie between the Main-line, thoſe Perpendiculars, and the Buildings, Gardens, Folds, &c. the Remainder will be the Area of the inacceſſible Ground, Water, &c. An Inſtance of this Kind you'll meet with in the following Example, *viz.* Between the Perpendiculars 15 Chains, 12 Links, in Dairy Field; and 20 Chains, 75 Links in Pleaſure Ground, the Buildings, Garden, Orchard, and Fold, are included therein; and alſo two ſmall Triangles, *i. e.* one in Dairy Field, between the Perpendicular and the Orchard Hedge; and the other in Pleaſure Ground, between the Wall, and the firſt Perpendicular therein.

Ninthly, When ever any two Perpendiculars are met with at the ſame Place, one of which is occaſioned by a Road or Lane; in caſting up the Dimenſions, that which reſpects the Lane, muſt not be noticed, as it is deſignedly taken to plan the ſame by; but in calculating the Area of the Road, it is then conſidered, if the ſame hath not been before particularly and diſtinctly meaſured.

Laſtly, In drawing or forming a Plan, let all thoſe Lines that denote Boundaries and Fence, be drawn with a black Lead Pencil; and ſee that all other Lines therein be drawn with one of the Points of your Dividers (guided by your Scale,) which laſt mentioned Lines, I term or call by the Names of *obſcure*, *occult*, or *dry* Lines: And if a Miſtake ſhoud happen to be committed in drawing the Plan, a little white Bread will take out the Fence or penciled Lines; but if you find the Boundaries correct, then draw or trace them off with Pen and Ink.

Example

Example II.

Let *fig.* 4 *plate* 2, represent the ground Plot of an Estate belonging to *John Tod*, Esq; and it be required to measure the same with the Chain only, so that the Dimensions thereof may be cast up by the Pen, and afterwards an accurate Plan delineated therefrom, whereby a Map properly embellished, and the true Content of each Field inserted therein, may be obtained. *See the Map Plate the 3d.*

Dimensions of an Estate in *Tarpoley*, in the County of *Chester* belonging to *John Tod*, Esq; 12th *July*, 1770.

Sandy Field, L. H. Off. W.

$201\frac{1}{4}$.

0 —————— 00

3,70 —————— 4,40

5,72 ——— ——— 0,

5,72 ┼ h Damsels —— 5,64

$457\frac{1}{4}$

9,40 to N E ∢ Ox-past. 7,11

10,84 ┼ h Ox-pasture — 0,

$953\frac{3}{4} - 167\frac{3}{4} = 786$

10,84 ——— ——— 7,04

26

11,00 ┼ h Dairy Field - 00

30

16,36 ┼ Pond in Fold — ,61

Remarks and Off-sets on ditto.

N. E. Off. L. H.

27.

0 —————— 00

3,46 —————— ,00

6,0 —————— ,71

6,13 —————— ,52

—N. E. Off. on ditto, L. H.

$73\frac{1}{2}$

0 —————— 00

4,91 —————— 1,63

5,64 —————— ,00

E. Off. L. H. in Damsels.

$55\frac{1}{4}$

0 —————— 00

1,03 —————— 1,71

2,24 —————— ,52

3,82 —————— ,34

5,93 —————— ,18

—N. E. Off. on ditto, Ox-past.

63.

0 —————— 0

7,04 —————— 1,12

Dimen-

323
20,10 ⊥ Wall Plea. Gd. ,40

20,10 ⊥ Road —— 1,00

23,80 —— —— 1,42

23,80 ⊥ Road to mark in South
< Ox-past. —— 2,16

24,0 ⊥ sunk Fence —

27,12 —— —— 2,68

30,04 Main-line ended - 2,92

30,04 to the Fur. Side Road 3,53

S. E. Off. in Ox-pasture.

$219\frac{1}{2}$

0	00
,80	,65
2,21	1,22
6,00	,55
7,54	,90
9,80	2,62
10,84	2,10
10,95	1,21
11,00	,42
11,60	,00
12,50	,50
13,00	,72
13,80	,80

— An Off. on ditto, R. H.

26

0	0
2,92	1,12

An Off. on last Perpendicular in Ox-pasture.

6.

0	0
80,	,96

Sandy

Sandy Field, R. H. Off. E.

$238\frac{1}{4}$

0 ——— 00

,44 ——— 1,71

1,00 to N. < Quiſtil Fd. 3,52

$82\frac{1}{2}$

5,72 + h Damſels — 2,02

10,84 + h Ox-paſture — 00

$543\frac{1}{2}$

11,00 + h Dairy Field — 6,40

15,12 ——— 7,50

15,12 ——— 8,62

$635\frac{3}{4} - 85\frac{1}{2} + 28\frac{1}{2} = 521\frac{3}{4}$

16,36 + h Po. Bu. Fold, &c. 00

$710\frac{1}{2}$

20,10 + Wall Pleaſure Gd. 00

20,75 to S.W. < Garden 5,50

24 + ſunk Fence. *Here draw the Form of the Gate, &c.*

25,23 S. < Pleaſure Gard. 4,61

29,30 ——— 4,22

30,04 Main line ended — 00

13 T, T, in N. E. Sides of Damſels, O.

3 A, Aſh, in ditto.

9 P, Poplar at the Water-ſide.

72 o, Oak Trees in Ox-paſt.

N. Off. on ditto, R. H.

$252\frac{1}{4}$

0 ——— 00

1,92 ——— 4,05

6,12 ——— 1,51

6,40 ——— 00

26 T. T. o, eq. d. in Dairy Field, with a Pond or Water in the Middle.

N. Off. R. H. Pleaſure Ground.

$28\frac{1}{2}$

0 ——— ,65

5,50 ——— 00

W. Off. in Pleaſure Ground, Left-hand.

5.

0 ——— ——— 0

1,40 ——— ——— 0

2,20 —— —— —— ,30

3,50 ——— ——— 0

4,69 ——— ——— 0

Here note, If the Learner be unready in Field Practice, ſuffer me to adviſe and prevail on him not to make any farther Progreſs in the Survey of this Eſtate, until he has caſt up and planned the above Dimenſions; and then, with greater Chearfulneſs and Certainty, he will perform the Reſidue.

Bridge

Bridge Meadow,

L. H. Off. W.

	$328\frac{1}{2}$	
0		0
1,10		2,72
1,30	+ Road or Lane	3,30
6,12		3,60
6,12	+ Road	4,00
	$99\frac{1}{2}$	
6,12	+ Fence Popl. Mea.	00
6,60		1,53
13,88		00
	$149\frac{1}{2}$	
13,88	+ Fen. Lawn Pluds	1,60
15,30		2,03
17,0		1,74
19,96	2d Main-line ended	00

S. W. End of Lawn Pluds.

L. H. Off. S. E.

	145.	
0		00
6,84		2,42
7.50		00

14 p, Poplar Trees in this Meadow, and twice that Number in Poplar Meadow.

An Off. on ditto.

	$29\frac{1}{2}$	
0		00
4,00		,92

29 p, Poplar in Lawn Pluds.

17 Willows, and 32 A, Ash Trees, equal Distance, in the North West Side of Lawn pluds; and the North End thereof is full of Shrubs and Mire.

Bridge Meadow, R. H. Off. W.

102½

0		00
2,72		1,50
4,34		1,17
5,54		1,72
	279½	
6,09	✝ H. in Pop. Mea.	00
6,09		2,08
7,65		,94
8,90		8,90
9,82		3,21
13,52		2,23
13,88		3,07
	62¼	
13,88	✝ Fence, Lawnpl.	,00
17,00		,80
18,47		1,19
19,50		,81
19,96		00

S. W. End of Lawnpluds, R H

92¾

0	00
1,00	1,11
1,80	,10
2,50	,08
3,13	,20
3,50	,91
4,00	2.09
4,70	1,50
5,52	1,23
7,50	,00

An Off. on Ditto.

12½

0	0
2,08	,76

An Off. on ditto, L. H.

60½

0	00
,72	2,44
3,07	00

Cracadony

Cracadony, L. H. Off. W.

730.

0	— —	00
2,20	— — —	5,40
8,55	— — —	4,00
10,40	— — — —	4,32
10,87	— — — —	4,81
10,87	┼ H. Ash Field —	0
	$402\frac{1}{2}$	
12,60	— — — —	5,32
14,58	— — — —	4,85
14,58	— — — —	3,70
16,30	— — — —	2,20
21,23	Main-line ended —	00

Quiflil Field.

L. H. Off. N. W.

21.

0	— — — — —	,10
80,	— — — —	,22
2,65	— — — —	,08
9,00	— — — —	,16
11,00	— — —	0

An Off. on ditto, R. H.

43.

0	— — — — —	00
4,81	— — — —	1,12

An Off. on 1,12 Perpen. L. H.

$10\frac{3}{4}$

0	— — — — —	0
1,12	— — — —	1,20

A good Deal of young Timber in the Boundaries of this Field.

Cracadoney

Cracadony, R. H. Off. E.

158¼

•		00
1,00		,20
2,20		,15
2,42		,21
3,40		,72
4,81	to < Plea. Ground	1,10
9,00	to N. W. < ditto	1,48
10,87	⊢ h Ash Field	1,10

313.

14,30	00
15,00	00
15,00	1,20
19,41	4,50
20,80	2,56
20,80	1,00
21,23	00

This Field in Tillage.

A small Plantation in the West Corner thereof. *Here draw the Figure or Form of the same with your Pen.*

26 T T O.

2 Rect-angular Ponds in Pleasure Ground, *i. e.* 1 on either Side of the middle Gate. Various Kinds of Trees to and fro dispersed, which greatly add to the Beauty thereof.

Quistil Field, R. H. Off. S. E.

549¾

0	00
,70	,70
2,03	1,65
3,10	3,65
7,62	5,30
11,00	00

This Field is of a sandy Quality, in Tillage, with a Pond of Water near the Middle. *Here draw with your Pen the Form thereof.*

To meaſure this Eſtate, let the Surveyor repair to any Part of the Boundaries; ſuppoſe at A in the North Side of Sandy Field, and there fix a Mark in the Hedge; and being furniſhed with Croſs-ſtaff, meaſuring Pins, Chain, and a Perſon (who ſhould know the Name of each Incloſure) to lead the ſame; then fixing on a Mark on the oppoſite Side of the Eſtate *(ſee the Directions in Page* 143,) as at B, to which Place chain for a Main-line, and raiſe Perpendiculars therefrom to the ſubtending Angles or Corners in every Field the Main-line paſſeth through; but always remember, when you meaſure any Perpendicular, to leave the Meaſuring-pins *that pertain to the Main-line* ſtanding with the laſt Pin your Foreman ſtuck down therein, otherwiſe a Miſtake in counting your Pins or Arrows may inadvertently be committed. Your Field-Book being prepared and ruled, (according to the Directions in Page 90,) in the firſt Column thereof, Page the firſt, enter thoſe Dimenſions that are on the Left-hand Side of the Main-line: And in the firſt Column of the next Page inſert the Right hand Dimenſions thereof; the two remaining Columns reſerve for Remarks, and Off-ſets upon Off-ſets, as heretofore directed in Page 91. And, for the young Learner's thorough Information herein, permit me to hand him Step by Step through all the Dimenſions taken on the Right and Left-hand Side of the firſt Main-line in this Eſtate, which will, I hope, enable him to advance with greater Chearfulneſs.

1. Having inſerted the Owner's and Tenant's Names, alſo the Townſhip, Pariſh, County, and the Name of the firſt Field, *(ſee Field Book, Page* 90,) with L H in the firſt Column firſt Page, and R H in the firſt Column ſecond Page: If the Sun appears, the Situation and Bearing of the Main-line may be diſcovered *(ſee Pages* 95 *and* 96.) Whilſt you are thus preparing the Field-Book, you may direct your Foreman (if you have no other Aſſiſtant) to go and ſet up occaſional Marks; this done, begin and ſtraighten the Eaſt Side of Sandy Field, by taking up the North Eaſt Off-ſet therein, which enter; but throughout your Field Proceedings, carefully obſerve all the foregoing Directions.

2. Return to A, and direct your Foreman ſtraight towards B, then, on the firſt Chain of the Main-line, that is to ſay,

44

44 Links from the Start, Right-hand Side, a Perpendicular = 1 Chain, 71 Links, must be raised, which enter: Also at the End of the Chain another on the same Side will rise to b, into the North Corner of Quiftil Field, measure and enter it likewise; then return to the Pin left standing in the Main-line; and when you have measured 3 Chains, 70 Links thereon, a Perpendicular will arise on the Left-hand to the Mark left in the Hedge at t, when you took up the North East Off-set therein, which measure, enter, and return to the Pins standing in the Main-line, wherein advance, and upon the 6th Chain, the Hedge that divides or separates this Field from Damsels, occurs, to wit, at 5 Chains, 72 Links: But here observe, your Foreman must put the Chain through the Hedge, and crossing the same, let him stretch the Chain as though there was no Hedge or Fence between the Fields, whilst you remain at the standing Pin in Sandy Field; lay down your Chain; come and see where it crosseth the Hedge, *viz.* at 5 Chains, 72 Links, which being entered thus; in Left-hand Column at 5.72 cross Hedge, Damsels, it is—0; and in Right-hand Column at 5.72 cross Hedge Damsels, it is 2.02, the Length of the Hedge on the right Side, and which is found (by the cross Staff) to be at Right-angles to the Main-line, abbreviated thus:

5 72 ⊹ h Dam.————————00; and in Right-hand Column
5.72 ⊹ h Dam.————————2.02.

3. Being in Damsels, measure a Perpendicular from the Hedge on the Left-hand Side, which is equal to 5 Chains, 64 Links; and upon this Perpendicular you have a Left-hand Off-set upon an Off-set, which being measured and entered, straighten the East Side of this Field by taking up the Off-set that lies upon the Base f, g, (*see the Entry thereof in the Field Book, viz.* E. Off. L. H. Dam.) Leave a Mark in the Hedge at g, and then return to the 6 Pins left standing together in the Main-line, wherein proceed till you come to 9 Chains, 40 Links, whereat a Perpendicular = 7 Chains, 11 Links, will arise to the Mark left in the North Corner of the next Field at g, measure and enter this also, then return to, and pursue the Main-line; and at 10 Chains, 84 Links, another Hedge is met with in the South Corner of this Field, and then, with regard to the Dimensions thereof, the Entry in both the Right and Left-hand Columns must be thus:

10.84————————00

And now, admit it were required to know the true Content of this Field, the Dimensions are as follow:

L. H. Off. E.

$457\frac{1}{4}$

5,72	5,64
9,40	7,11
10,84	00

R. H. Off. W.

$82\frac{1}{2}$

5,72	2,02
10,84	00

N. Off. on ditto, L. H.

$73\frac{1}{2}$

0	00
4,91	1,63
5,64	00

E. Off. L. H. in Damsels.

$55\frac{1}{4}$

0	00
1,03	1,71
2,24	,52
3,82	,34
5 93	,18

Perches

$$\text{Collected}\left\{\begin{array}{r} 457\frac{1}{4} \\ 73\frac{1}{2} \\ 82\frac{1}{2} \\ 55\frac{1}{4} \end{array}\right.$$

Area $668\frac{1}{2}$ = 4 Acres, $28\frac{1}{2}$ Perches.

By which it appears that the true Content of the Field is 4 Acres, $28\frac{1}{2}$ Perches; and so of any other Inclosure herein. It would be great Prudence in the young Learner to select the particular Dimensions of every Field that the Main-line passeth through, and cast up the same severally; by which Means their respective Areas are obtained; and when he finds that he is expert and ready therein, the Difficulty which at first Sight presents itself (in casting such Dimensions up by the Pen) will soon vanish; but

but not to commit a prolix Digreſſion, let us proceed in the Survey.

4. Being in the North Weſt Corner of Ox-paſture, chain a Line from thence on the Left-hand at Right-angles to your Main-line, *i. e.* to D, and take up thereon an Off-ſet upon an Off-ſet, Left-hand; which done, look from the Mark at D, towards the Mark at C, in or near the South Corner of the ſame Field; to which Mark chain, for a baſe Line, to the South Eaſt Off-ſet therein, and as you proceed forget not to fix a Mark at E, that will appear from the Bridge. This Off-ſet being meaſured and entered, leave a Mark at C, and take up a ſmall Off-ſet on the laſt Perpendicular towards the Corner; then return to the Main-line at h, where you left one Arrow ſtanding in the Fence, (*for, as it hath been already obſerved, at the End of* 10 *Chains, you counted and returned the Arrows to your Foreman,*) whereat you enter the Dairy Field, and there erect a Perpendicular to the Weſt Side thereof = 6 Chains, 40 Links, upon which Line you have an Off-ſet upon an Off-ſet thus entered; N. Off-ſet on ditto, R. H. (*ſee the Dimenſions thereof*;) this done, return to the former mentioned Pin or Arrow, and make Entry in both Columns thus: L. H. 11.0 ⟊ h Dairy Fd. —— 0 R. H. 11.0 ⟊ h, Dairy Fd. — 6.40, proceed forward, and at 15 Chains, 12 Links, on the Main-line on the Right-hand thereof, raiſe a Perpendicular to the North Weſt Corner of the Orchard; but ere you come thereto, you meet with the Weſt Corner of Dairy Field, by which there are two different Perpendiculars at the ſame Place (on your Main line,) to be entered thus:

15.12 ———————————— 7.50
15.12 ———————————— 8.62

This done, return to the ſtanding Arrows, and proceed, and at 16 Chains, 36 Links, the Main-line croſſeth the Hedge into the Fold, &c. thus entered: L. H. 16.36 ⟊ h, Pond, Fold, &c. 61 Links, and R. H. 16.36 ⟊ h, Pond, Fold, &c. — 00: Omit not here to draw with your Pen, in the reſerved Columns, the Form of the Pond, Fold, &c. which will enable you to repreſent the ſame in the Plan accurately, though you may chuſe taking Notice of ſuch Things until your Plan is ready wherein the ſame may be delineated and ſpecified with leſs Trouble, and

more

more Accuracy; the Situation of which being limited, and your Chain at Liberty to execute and perform the particular Dimensions thereof; Directions for taking up the same would be looked upon as Tautology by all those who are perfect in the foregoing Chapters, and therefore whoever is not ready therein, will gain very little by the Perusal of this Example. *But to proceed.*

5. Having advanced on the Main-line 20 Chains, count and return the measuring Pins; and on the next, *viz.* at 20 Chains, 10 Links, a Wall in a right Line with the House Front, is met with, thus entered; L. H. 20.10 -+- Wall, Pleasure Ground .40; and to the further Side of the Road, 1 Chain, which shews the Road to be 60 Links broad; see the same entered in the Field Book, thus, R. H. 20.10———————0, with Regard to the Fold, Garden, &c. To find the Area of which, consult the 8th Article, Page 216.

6. Your Foreman having stuck down a Pin in Pleasure Ground, and standing thereat, let the Chain be stretched on the Ground to that Part of the Wall where it crossed; then at 20 Chains, 75 Links, you'll find a Perpendicular will arise to the South West Corner of the Garden, which being measured and entered, return to the standing Pin (*but remember you have begun a third Change*;) continue the Main-line, and on 23 Chains, 80 Links, a Perpendicular will arise to the Mark left at C, in the South Corner of Ox-pasture; see the Field Notes thereof thus entered, L. H. 23.80 ——— 1.42 and 23.80 -+- Road to mark in Ox-pasture 2.16; return and proceed at 24 Chains, cross sunk Fence, represented by o q; and at 27 Chains, 12 Links, on the Main-line, raise and measure a Perpendicular on the Left-hand Side thereof, which being entered, come back to the standing Pins, and chain forward, and on 29 Chains, 30 Links, raise and measure a Perpendicular on the Right hand to the West Corner of Pleasure Ground; this done, continue the Main-line, and at 30 Chains, 4 Links, the same is ended, where there is a Perpendicular on the Left-hand = 2 Chains, 92 Links, upon which lies an Off-set upon an Off-set, *viz.*

o — — — — —— o

2.92 — — —— —.96

This last measured and entered, walk to the West Side of Pleasure Ground, and between the two last Right hand Perpendiculars take

take up a small distinct Off-set thus entered: W. Off-set in Pleasure Ground, &c. *See the Field Notes thereof.*

Now admit it were required to find the true Area of the Ox-pasture Field by the foregoing Dimensions thus selected:

L. H.			L. H. in Dairy Field.		
	$953\frac{3}{4}$			$167\frac{3}{4}$	
10,84	————	7,04	11,00	————	00
23,80	————	2,16	16,30	————	,61
			20,10	————	1,00
			23,80	————	2,16

The first Perpendicular in Ox-pasture = 7,04 added to 2,16, the Perpendiculars raised at 23.80, to the South Mark therein, which being multiplied by the intermediate Distance = 12.96, the Product in square Perches will be $953\frac{3}{4}$, the Area of the Rect angular Figure h D C w; and if from this Sum the Area of the irregular Ligure h C w = $167\frac{3}{4}$ be taken, the Remainder will be 786 square Perches, which being added to the several Areas of the North, South and East Off-sets, to wit, $786 + 63 + 6 + 219\frac{1}{2} = 1074\frac{1}{2}$ square Perches, which are equal to 6 Acres, 2 Roods $34\frac{1}{2}$ Perches, the true Area thereof. The Area of any other of the Fields may likewise be obtained by the Pen; see the several Contents entered in the Dimensions under the Name to which they belong; thus having obtained the true Area of those Inclosures through which the Main-line passed, it follows next to plan the same, which to effect, Directions shall be given at the End of this Example.

7. Then repair to the unmeasured Part of the Estate, suppose to the Bridge, and from thence chain to the Mark left at E (on the River Side) for another Main-line, and as you advance therein, omit not the Perpendiculars &c. which shall or may occur, and proceed in like Manner as in the former Dimensions, wherein there are so much Variety (with regard to Field Notes) as will sufficiently enable and qualify any Youth, though of the slenderest

slenderest Capacity, to proceed therein for Miles upon the like Occasion; *see the Dimensions of this Main-line in the Field Book*; but observe, in crossing the Fence into Lawn-pluds, to leave a Mark thereat, and when you have finished the Line, return thereto, measure and enter the Dimensions of the South West Part of the same. (*See the Directions given in the third Article, Page* 214.)

8. Make for the East Side of the Estate, and chain another Main-line from the South Corner of Cracadony, to the North West Corner of Quistil Field, *viz.* from r, to M, whereon take up so many Perpendiculars, &c. on the Right and Left-hand Side, as will include the Area of all the Fields which that Main-line passeth through, as you may see in the Field Book, wherein the Dimensions of the same are carefully entered, and correctly cast up, according to the foregoing Directions.

Lastly, Step into Quistil Field, which you measure by chaining a Line from M in the South Corner thereof, to b, the North Corner, at which Place a Mark was left when Sandy Field was surveyed; and upon this Line, take up the Perpendiculars that shall occur on the Right and Left-hand Sides, which being finished, concludes the Survey.

Abbreviated Characters in the Field Book explained.

+ H, or h,	denotes—	Cross Hedge,
Plea Gd.		Pleasure Ground.
Fd. ——		Field.
Bu.	denotes—	Buildings.
<		Corner of a Field.
M.		Mark, &c. &c.

Note, The above Cross should be made when in the Fields, by two Strokes of the Pen like the Character *Plus*.

Here

Here follows the Area of the foregoing Dimensions of this Estate, respectively collected from the Field Book, as they appear therein.

Sandy Field.

L H Off E —— ——	201¼
R H Off W ——	238¼
N E Off L H ——	27
	466½

Damsels.

L H Off. E ——	457¼
R H Off. W ——	82½
N Off. on ditto, L H——	73½
E Off. on ditto L H ——	55½
	668½

Dairy Field.

L H Off. E ——	26
R H Off. W ——	543
R H Off. on ditto ——	252¼
	821¼

Ox-pasture ——	1074½

See Page 229.

Pleasure Ground.

L H Off. E ——	323
R H ditto, W ——	710
R H Off on ditto ——	25½
W Off on ditto ——	5
	1063½

Bridge Meadow.

L H Off W ——	328¼
R H ditto E ——	102½
An Off on ditto R H	29¼
	460

Poplar Meadow.

L H Off W ——	99½
R H ditto E ——	279½
R H Off on ditto ——	12½
L H ditto, N ——	60½
	452

House, Garden, Fold, &c.

Area between 15,12, and 20,75		635$\frac{3}{4}$
Area of an included Triangle in Dairy Field	85$\frac{1}{2}$	114
Area of ditto in Pleasure Ground	28$\frac{1}{2}$	
Remains		521$\frac{3}{4}$
An East Off		30
		551$\frac{3}{4}$

Lawn-pluds.

L H Off W	149$\frac{1}{2}$
R H Off E	62$\frac{1}{4}$
S W End	
L H Off E	145
R H ditto W	92$\frac{3}{4}$
	449$\frac{1}{2}$

Cracadony.

L H Off W	730
R H ditto E	158$\frac{1}{4}$
An Off on Ditto	43
Ditto on ditto	10$\frac{3}{4}$
	942

Ash Field.

L H Off W	402$\frac{1}{2}$
R H Off E	313
	715$\frac{1}{2}$

Quistel Field.

L H Off W	21
R H ditto E	549$\frac{3}{4}$
	570$\frac{3}{4}$

Lane	134

The

The Whole collected.

	Perches.		A.	R.	P.
Sandy Field —	466½	=	2	3	26½
Damsels —	668½	=	4	0	28½
Ox-pasture —	1074½	=	6	2	34½
Dairy Field —	821½	=	5	0	21½
Gardens, Folds, &c.	551¾	=	3	1	31¾
Pleasure Ground -	1063½	=	6	2	23½
Bridge Meadow -	460	=	2	3	20
Poplar Meadow -	451	=	2	3	11
Lawn Pluds —	429½	=	2	2	29½
Cracadony — —	942	=	5	3	22
Ash Field — —	715½	=	4	1	35½
Quistil Field —	570¾	=	3	2	10¾
Lane ———	134		0	3	14
	8348¾	=	52	0	28¾

These Dimensions being cast up, your next Care will be to plan the whole from any Scale of equal Parts that you shall think proper, which, when performed, if the Size thereof be either too large or too small for the intended Map, you'll meet with ample Directions in Part the Second to augment or diminish the same to any Size: The small Compass of this Treatise induced me to make Choice of the quarter Scale, *i. e.* 16 Statute Poles to an Inch to plan this Estate from; but notwithstanding, would advise the Learner to plan the same from sundry Scales, such as the Inch, half Inch, half-quarter Inch, &c. which will greatly edify him in the Art and Practice of Planning; but let him strictly observe whether his Plan bear a thorough Similitude to *fig.* 4, *plate* 2; for if not, a Mistake is committed, which may be readily discovered by Comparison; and that he may the more effectually correct the same, here follows certain edifying emblematical Instructions for his more immediate Improvement with respect to a Plan of this Estate.

Directions to plan this Estate.

Being accommodated with a Sheet of Paper, Scale and Dividers, draw an obscure or dry Line quite across the Middle thereof,

 per-

perpendicular to your Breast, that shall represent the first Main-line in the Field.

2. Fix upon a Point therein as at A, and from your Scale take 30 Chains, 4 Links (though the 4 Links cannot be adjudged at on this Scale,) and lay it from A to B, which Points limit the Main-line; upon the Left-hand Side thereof lay down those Dimensions that were taken up on that Side in the Fields; the Right-hand Side is appropriated to all those Dimensions entered in the Right-hand Column of the Field-Book, which being placed before you, proceed thus:

3. At the Beginning at A, it is no Perpendicular, neither in the Right or Left hand Columns; but at the End of 44 Links, it is 1 Chain, 71 Links of a Perpendicular to the Right-hand, therefore take 44 Links from your Scale, and lay it on the Main-line from A towards B, at which Point erect a Perpendicular to the Right-hand, by *Prob.* 3. *Chap.* 2; otherwise apply the End of the Scale upon, and parallel to the Main-line, setting or fixing one Corner of the Scale to the Point made with your Dividers in the Main-line, 44 Links from A, the Beginning, and from thence draw a Perpendicular or obscure Line, whereon lay down 1 Chain, 71 Links, the first Perpendicular; then from A to this Point, draw a penciled Line. Also lay down one Chain from A in like Manner, at which Point erect another Perpendicular as you did the former, upon which lay off your second Perpendicular = 3.52, to b, and with your Pencil join this to the End of the last Perpendicular; then take in your Dividers 3 Chains, 70 Links, and lay it on the Main-line, as before, at which Point draw an obscure perpendicular Line on the Left-hand Side; upon which lay down 4 Chains, 40 Links to t; with Scale and Dividers draw a Line between t and A, and lay down thereon the N. E. Off-set, beginning at A; this being done, take from the Scale 5 Chains, 72 Links, lay it down as before from A towards B, to which Place draw a Line with the Pencil from t, which will represent Part of the Hedge between this Field and Damsels; and as the same Hedge on the Right-hand is at Right-angles to the Main-line, raise a Perpendicular thereat, upon which lay down 2 Chains, 2 Links to e, and then, with a Pencil, draw a right Line between d and e, and also one between e and b, the former will represent the Remainder of the Hedge

between

between this Field and the Damsels; and the latter, the Hedge between this and the Quistil Field.

4. At the Point d, draw a Perpendicular, then take 5 Chains, 64 Links, up in your Dividers from off the Scale; lay the same down from d to f, and join f c with your Pencil; also take 9 Chains, 40 Links, and set it off from A upwards, at which Place draw a Line Perpendicular on the Left-hand Side, upon which lay down 7 Chains, 11 Links to g; draw a Line from f to g, and thereon lay down the East Off-set in Damsels, as heretofore taught; which done, take 10 Chains, 84 Links, in your Dividers, and lay it from A to h, to which Point draw two penciled Lines, the one of them from g, to represent the Hedge between Damsels and Ox-pasture, and the other from e, for the Hedge, one Part of which separates the Damsels and Dairy Field, and the other Part thereof divides the Damsels from Quistil Field.

5. At h erect h D on the Left-hand Perpendicular to the Main-line, and lay thereon 7 Chains, 4 Links; also take 11 Chains from the same Scale, and on the Main-line, from A, as before, lay it down, and thereat erect a Perpendicular to the Right-hand Side, and lay thereon 6 Chains, 40 Links: Upon this Perpendicular is an Off-set upon an Off-set, to the Right-hand, which plan, and draw a penciled Line from the End of the Perpendicular therein, and it will represent the Hedge between the Quistil and Dairy Fields.

6. Take from your Scale 15 Chains, 12 Links, and laying it from A towards B, at this Point draw a Perpendicular on the Right-hand Side; and on this Line first lay off 7 Chains, 50 Links, and then 8 Chains, 62 Links; with your Pencil draw a Line between these two Points, and also draw therewith a right Line from the End of the last penciled Line, to wit, from the South West Corner of Quistil Field, to the first Perpendicular which will represent the Hedge between the Ash and Dairy Fields; Then take 16 Chains, 36 Links off your Scale, which being laid from A towards B, shews where the Hedge must be drawn between Dairy Field and the Orchard, Fold, &c. so that 61 Links being laid off at Right-angles on the Left-hand Side, from this

this Point draw a penciled Line to h and k, which will denote the Fence between Ox-pasture, Fold, Orchard, and Dairy Field.

7. Lay down 20 Chains, 10 Links, as before, from A towards B, to wit, at m, through which a Wall passeth in a Line with the House Front thereat; on the Left-hand draw a Line perpendicular, and lay thereon 40 Links, and also 1 Chain (the Space between these Points, is the Breadth of the Road leading from the Bridge to the Fold and Buildings) from which draw two penciled Lines to either Side of the Pond in the Fold, to signify the Road or Lane; which being done, take 20 Chains, 75 Links, and lay it from A (as before;) at this Point erect a Right-hand Perpendicular, upon which lay off 5 Chains, 50 Links, to n; (but here let me once more caution the young Practitioner not to make Use of any other Scale in the Plan than that which he began with, for should one Line be taken from this Scale, and another off any other, it would, in that Case, be impossible for his Plan to close;) through this Point n, and that made where the Wall was met with, draw a penciled Line to represent the same.

8. From your Scale take 24 Chains, and lay it from A (in like Manner as before) to p, where the sunk Fence was met with; but before you come to this Point, raise a Perpendicular on the Left-hand 20 Links short of p, and lay thereon 1 Chain 40 Links, to shew the Point that the Hedge must pass, that is on the near Side of the Lane; and also upon the same Line lay down 2 Chains, 16 Links, which discovers the Mark C in Ox-pasture, according to the Field notes, from which draw an occult Line to the Point D in Ox pasture, and plan thereon, the South East Off-set therein beginning at D.

9. Lay off from A towards B, 25 Chains, 23 Links, and on the Right-hand Side thereat, raise or draw a Perpendicular, upon which lay off to q, 4 Chains, 61 Links, then, with a Pencil, draw a Line from q, through p and o, for the sunk Fence; omit not to represent the arched Fence on each Side of the Gate, which, according to the Figure thereof in your Field-Book, is a Semi-circle: Also take 27 Chains, 12 Links, in your Dividers, and

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Fig. 1.

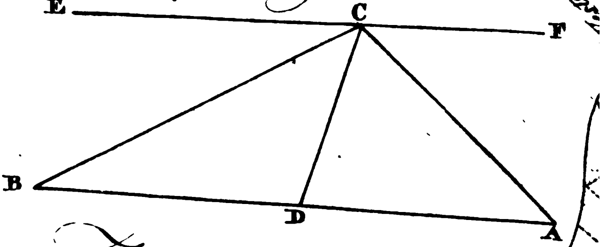


Fig. 3

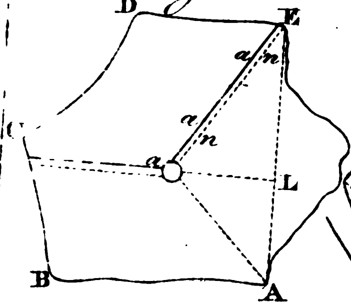
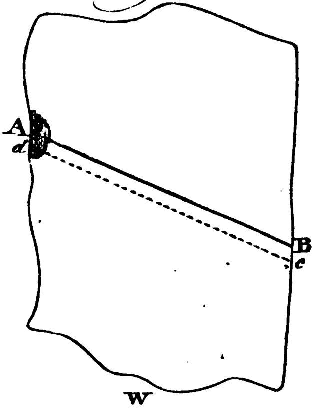
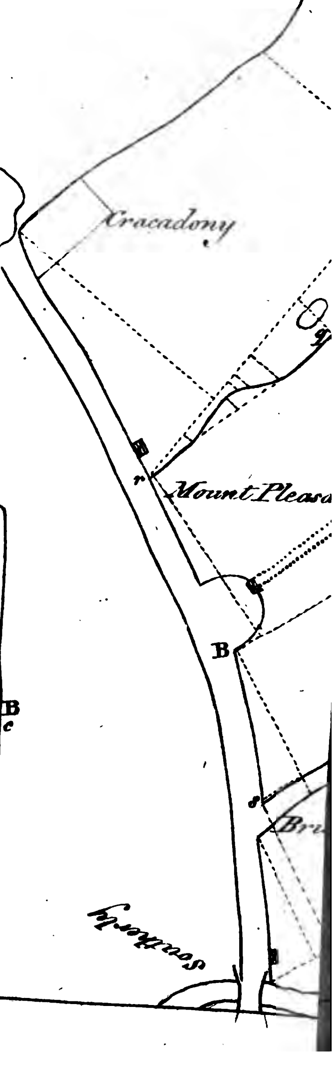


Fig. 2.





and set it off from A towards B, and on the Left-hand Side draw a Perpendicular, upon which set off 2 Chains, 68 Links; then, with your Pencil, continue those Lines that represent the Lane, the nearer Line passing through this Point, and the Point o, until it meets the former penciled Line; and parallel thereto, draw another Line through C, which will denote the opposite Side of the Lane; then take in your Dividers 29 Chains, 30 Links, and lay A down as before, on your Main-Line, whereat draw a Line perpendicular thereto, on which lay 4 Chains, 22 Links to r, the South West Corner of Pleasure Ground: Here lescribe the Arch on each Side the Gate, as it appears in the reerved Columns of your Field Book, and at the Point B, erect a 'erpendicular on the Left-hand Side, and lay thereon 2 Chains, 2 Links; upon this Line there is an Off-set upon an Off-set, hich plan; and also let those Lines be continued to S and x at represent the Lane; lay down a small West Off-set that apars in your Book between r and q; then draw a penciled Line ewise from r to S, and then delineate the internal Simicle at the Gate, which concludes a Plan of those Dimensions t respect the first Main-line.

Then will the next Step be to plan those Dimensions taken up the second Main-line, but ere you can proceed therein, this in-line must first be drawn, which being done removes all the ficulty therein, and is thus effected: Your Field Notes inn you, that a Perpendicular = 3 Chains, 30 Links, was ed in the Meadow on the Left-hand at 1 Chain, 30 ks, to the South Corner of Pleasure Ground, at the Point therefore, take 3 Chains, 30 Links in your Dividers, and one Foot in the Point S, describe an Arch with the other Foot. if 1 Chain, 30 Links, be taken from 19 Chains, 96 ks, there will remain 18 Chains, 66 Links, (the Distance ween the Place where this Perpendicular was raised, and the nt E in Ox-pasture.) Hence 18 Chains, 66 Links, being n from the Scale with which, (setting 1 Foot in the Point E) ribe an Arch that shall intersect the former, through which nt of Intersection, and the Point E, draw a Line with the nt of the Dividers, for the second Main-line; and then from r Scale take the whole Length of this Main-line = 19 ins, 96 Links, in the Dividers, which lay down thereon from

from E, and it will point you out the North Corner of Meadow, whereat you made a Beginning in this Main-lin here remember that you'll have no Occasion to take No you are planning) of those Perpendiculars which were ta on the Left-hand Side of this Main-line, except the first yo in Poplar Meadow, by which the Fence on the Nor thereof, and also that between Poplar Meadow and Lawn- are drawn; for all the other Fences or Hedges between a former Main-line, are already planned. It is likewise n to give any Directions (in this Place) to plan the Righ Perpendiculars that are terminated by the River; for who ready in planning the foregoing Examples, cannot possibly b Loss to raise Perpendiculars from a Base Line at each resp Place the same were taken at: However, in joining the Pe diculars with a Pencil, forget not to draw a Line parallel th between 40 and 50 Links distant therefrom, to represen River, which by the Chain, measured so much; when turn over to the Dimensions of Cracadony, wherein you that the Main-line taken therein, begins at r, in the S Corner thereof, and passeth by k, the West Corner of the chard already planned, which limits the Direction of this Ma line.

Here note, All the Difficulty of planning from Main-li depends upon drawing them exactly true in their proper Pl This done, the Work will then be found to be exceeding easy

Having drawn the Line, there will be no Occasion to t Notice of the Perpendiculars on the Right-hand Side (except three last) the Hedge being already planned which is on that S between this and the Quistil Field; therefore, by erecting, the Right-hand, (according to the Field Notes) Perpendicu respectively, upon which the several Numbers, as they appea the Field Book, being laid thereon; then, with the Pencil, j the Ends of the same, as heretofore directed. This last penci Line shews the Hedge between Ash Field and Quistil. As the Perpendiculars on the Left-hand Side, plan them as you those on the Right-hand Side of the last Main-line; this be done, and the Boundaries described by your Pencil, the whol planned save only the North West Side or Fence of Quistil Fi wherein the Proof and Truth of all your Proceedings (both the Fields and Chamber) will appear, which you diſcover thus; draw an occult Line from M to b, which being taken between your Dividers, and applied to the Scale, if the Extent correſponds with the ſame Line in your Field Book, (to wit, 11 Chains,) you have made *a good Cloſe*, which will always be the Caſe when Care attends each Step; otherwiſe it would be unreaſonable to expect it. However, this Line anſwering with the Chain-line in the Field-Book, confirms the Accuracy, upon which lay down the Left-hand Off-ſet thereon, and with the Pencil draw the North Eaſt Side of this Field.

Laſtly, With Pen and Ink draw or trace off all the penciled Lines in the Plan, then is the ſame ready to be transferred to a Map on Vellum, or whatever elſe is intended for that Purpoſe, which to perform, obſerve the following

Directions.

To transfer or trace off, upon Vellum, Parchment, or Paper, the Plan of an Eſtate, and afterwards to embelliſh the ſame.

1. The Size of your Vellum, Parchment, or Paper, being adapted to the Plan, wherein if Greaſe, or any thing elſe ſhould hinder your Pen to ſlide freely, a little Pounce rubbed thereon occaſionally will greatly help the ſame, and alſo prevent the Ink from ſpreading; ſome double refined Loaf Sugar diſſolved in your Ink will give it an additional Gloſs.

2. Lay your Plan carefully upon the Vellum, Parchment, or whatever elſe you intend to draw your Map upon, and three or four ſmall Nails being ſtuck into the Table through the Plan and Corners of the Vellum, &c. to prevent the ſame from ſhifting or moving (though ſmall Weights, or Books will, with Care, anſwer the ſame Purpoſe:) Then, with the Point of your Dividers, trace off all the Lines in the Plan, preſſing the ſame gently, ſo that the Impreſſion may appear on the Vellum, &c. Thus having gone or traced over all the Lines exactly, take up the Plan, and you'll ſee underneath, all thoſe Lines upon the Vellum, &c. that are in the Plan; and then, with a fine Pen, and good *Indian* Ink, make thereon Hedges, &c. ſuch as appear in the following Map.

3 When the Hedges, &c. belonging to each and every Field are finiſhed, it will be a great Addition to the Beauty of the Map, to adorn the Hedges on one Side with proper Shading, or Colours, to repreſent the Ditches; and the Paſture or Meadowing being touched up with a tranſparent Green Colour, in Imitation of Graſs, (but not dawbed on;) arable or ploughed Land with a brown earthen Colour, &c. laid on in ſuch a Manner (*ſee the following Map*) as will render the ſame all thorough a Similitude of Ridges and Furrows. There are many Gentlemen that chuſe to have a Map of their Eſtates ornamented with Colours, but, in my humble Opinion, good Indian Ink is much preferable thereto: However, it greatly behoves every Surveyor to pleaſe, if poſſible, his Employer, and therefore I ſhould think it adviſeable for thoſe who are ſo employed to have a ſmall Specimen of their Performance upon Vellum, curiouſly ornamented, to ſhew their Employers, wherein ſhould appear ſome Cloſes finiſhed with *Indian* Ink, and ſome with Colours.

4. Having compleated the Fields, &c. in the Map, make Choice of a Compartment, or Vacancy therein, at the Top, if poſſible, to draw the Coat of Arms belonging to the Gentleman that owns the Eſtate, with Shield, Creſt, and Supporters; the Shield ſhould be drawn ſo that it may contain the Title, Townſhip, and County, or any thing elſe that is proper to denote the Situation thereof. The Art of drawing ſuch Ornaments, will ſoon be obtained by aſſiduous Application, and ſome Inſtructions therein from a Limner, which the ſmall Size of this Treatiſe prevented me to give in this Place.

5. In another Compartment, or Vacancy, draw the Dividers, drawing Pen, the Scale you laid down the Map by, &c.

Laſtly, Draw the Mariner's Compaſs, with the Flower de Luce therein, pointing to the North exactly, *ſee Page* 96. However, for the young Learner's farther Improvement herein, here follows a Map of the Eſtate mentioned in the foregoing Example, properly embelliſhed, wherein is repreſented Paſture, Meadowing, ploughed Land, and whatever elſe that is neceſſary, which will undoubtedly edify more than if ſeveral Pages were wrote upon the Occaſion. Now, if the Whole be well performed, the Map will be a neat Ornament to hang up in the Owner's Study, or wherever elſe he ſhall chuſe, ſo that at Pleaſure he may ſee his whole Eſtate in his Chamber, and likewiſe the particular Quantity of each and every Incloſure therein, without any Manner of Trouble, but rather a Pleaſure.

Thus having briefly, and particularly taught and directed how an Eſtate (conſiſting of any Number of Incloſures) may be ſurveyed by the Chain *(unaſſiſted by Inſtruments,)* and alſo how the ſame may be accurately planned and mapped, I come, in the next Place, to ſhew how a Pond, Pool, Mere, Wood, or any inacceſſible Ground may be meaſured two different Ways, *i. e.* the one by rect-angular Lines; and the other by ſtationary ones, and in both Caſes this is the

RULE.

From the Area that the rect-angular or ſtationary Lines includes, deduct the Area of the ſeveral Inſets that are between thoſe Lines and the Pond, Pool, &c. the Remainder will be the true Area ſought.

Note, When rect-angular Lines are uſed, the Pen diſcovers the real included Area; but in uſing ſtationary Lines, the Scale and Dividers muſt be engaged for that Purpoſe, and conſequently the Reſult will be ſomewhat doubtful.

Example.

Admit *fig.* 5, *plate* 2, to repreſent a Mere, or Pool of Water, and it be required to know the true Content thereof, to perform which obſerve the following

DIRECTIONS.

1. Set up your Croſs-ſtaff at, or in the Corner A, and there fix upon two Places, or Marks (to wit, at B and D,) at right Angles to each other.

2. Meaſure the Line A D, and take up a Left-hand Inſet thereon, which being entered, return to your Staff, but forget not to leave a Mark at D.

3. Chain the Line AB, upon which take up an Inſet on the Right-hand thereof.

4. Fixt your Staff in B, which will direct you to chain another Line at Right-angles to this laſt meaſured Line, to wit, B C, and take up an Inſet upon this alſo.

Laſtly, Chain from C, to the Mark left at D, and take up the Inſet thereon, and it is done, whereby you have obtained the following

Dimenſions.

Dimensions.

N. W. Infet, L. H.
Taken upon the Line A D.
$41\frac{1}{2}$.

0	0
1,40	0
2,30	1,10
3,60	,50
4,00	,10
5,0	,10
5,50	,28
6,20	0
7,10	0
8,40	,80
8,60	0

N. E. Infet, R. H.
Taken upon the Line B C.
80.

0	0
1,10	0
2,50	1,0
3,80	1,20
7,20	,00
10,0	,50
10,60	00

S. E. Infet, R. H.
Taken upon the Line B C.
37.

0	0
,30	70
3,40	0
4,20	1,00
4,80	,30
5,70	0

S. W. Infet, R. H.
Taken upon the Line C D.
146.

0	0
,20	,90
2,50	0
4,70	2,10
6,70	1,10
8,30	1,20
9,40	0
11,0	0

Fig. A B C D.

$1212\frac{1}{2}$

0	8,60
10,60	5,70

The Area of the Figure A B C D.

The feveral Infets upon	A D —— 41					
	A B —— 80	$1212\frac{1}{2}$				
	B C —— 37	$304\frac{1}{2}$				
	C D —— 146	——		A.	R.	P.
The true Area ——	——	908	=	5	2	28

Here

Here follows an Example wherein a Pond, &c. is meaſured by ſtationary Lines, and exterior Angles, taken partly in like Manner as directed in Page 124, wherein I propoſed to give an Example of a Field meaſured by ſuch Lines, but being adviſed, by a Friend, not to introduce an Example therein (relating to Land) that would admit of many Anſwers, I therefore prudently omitted the ſame, as the Dimenſions ſo taken could not poſſibly be caſt up without having Recourſe to Scale and Compaſs: And I can aſſure my Reader, it is with the utmoſt Reluctance that I am now prevailed on to give an Example *(though of Water)* whereof the ambiguous Reſult will unavoidably admit of unlimited, uncertain Variety; nevertheleſs, as Pools are ſeldom or ever paid for by the Acre, and as *ſmall Waters* are generally allowed to be horizontal, conſequently there will be no Occaſion to make any Allowance for Altitude or Depreſſion; ſo that, with diligent Care, the Errors ariſing from ſuch Dimenſions will be but trifling, as the Off-ſets taken around the ſame are caſt up by the Pen; but, notwithſtanding, permit me to caution the young Practitioner, when he takes an Angle by the Chain, to be very exact, for othewiſe he'll find it extremely difficult *(I might have ſaid impoſſible)* to obtain, from the Dimenſions ſo taken, a perfect Cloſe; however, my Brevity herein will, I hope, plead my Excuſe for introducing this

Example.

Admit *fig.* 6, *plate* 2, to repreſent a ſmall Pool, or Pond of Water, and it be required to ſurvey the ſame by ſtationary Lines, and Angles taken by the Chain.

Note, The Inſets that occur, are taken up in like Manner as you were directed in Page 155, to take up Off-ſets.

Firſt chain a Line from E to A = 4 Chains, 60 Links, which Station being entered, ſet up a meaſuring Pin at A, and fixing upon a Mark at B, continue the Line E A 2 Chains farther, whereat leave a Pin; return to A, and meaſure towards B 2 Chains; then meaſure the exact Diſtance (with the Chain) between the laſt Pin ſtuck down,

down, and the former = 2 Chains, $82\frac{1}{4}$ Links, which is a Chord-Line to the Angle A, made by the first and second Station, as already observed; see that you forget not to take up the Insets upon each Line.

2. Chain the Line or Side A B = 5 Chains, 70 Links, and take, as before, the Angle made by this and the next succeeding Station, = $1.81\frac{3}{4}$ = to the Chord 3, 4.

3. In like Manner Chain B C, for a third Station = 2 Chains, 20 Links, and measure the Chord Line 5, 6 = $1.77\frac{1}{2}$.

4. Measure C D = 6 Chains, 30 Links, and at the End thereof take up the external Angle, as before, whose Chord is 2 Chains, 8 Links.

Lastly, Measure the Side D E, and at the Corner E, take up the last Chord Line, *i. e.* 9, 10 = 1 Chain, $69\frac{1}{2}$ Links.

The

The Dimensions.

1st Stat.

St.	Sds.	Di.	An. C. L.	Chords.
1	EA	4,60	A	2,82¼
2	AB	5,70	B	1,81¾
3	BC	2,20	C	1,77½
4	CD	6,30	D	2,80
5	DE	5,72	E	169½

2d Stat. Inset.

35¾

0	0
3,80	,90
4,0	,40
5,70	0

3d Stat. Inset.

8¼

0	0
,80	,50
2,20	00

5 Stat. on Inset.

14.

0	0
,40	0
2,50	,30
3,80	,30
5,0	0
7,72	0

1st Stat. Inset.

48.

0	0
1,70	1,36
2,30	1,32
3,90	,00
4,60	.00

4 Stat. Inset.

5.

0	0
1,0	0
1,60	,50
2,30	,44
3,10	,04
3,30	,05
4,60	,40
6,30	00

Trapezium A B D E.

525.

0	2,40
9,00	4,90

Triangle B C D.

87¼

0	0
7,80	1,40

The

		Perches.
The Area of the	Trapezium ABDE	525
	Triangle BCD	$87\frac{1}{4}$
	Area of ABCDE	$612\frac{1}{4}$

Deduct the several Insets upon the	1st Stat.	48	
	2d ditto	$35\frac{3}{4}$	
	3d ditto	$8\frac{3}{4}$	
	4th ditto	5	
	5th ditto	14	
			$111\frac{1}{2}$
			$500\frac{3}{4}$

By the above it appears that the Content of the Pool or Pond by Scale and Dividers is $500\frac{3}{4}$ Perches, which are equal to 3 Acres, $20\frac{3}{4}$ Perches, of Statute Measure.

Now if it were required to reduce the above, or any other Quantity of Statute Acres, into customary, or Plantation Measure, or the contrary, there are Directions for so doing in Pages 33 and 34.

Directions to plan the above Dimensions.

1 Draw an occult Line, and lay thereon your first Station = 4 Chains, 60 Links, (taken from any Scale of equal Parts,) as from E to A; let this Line be continued something farther, then take 2 Chains from the Inch Scale, and setting one Foot in A, describe the Arch 1, 2; then take your first Chord-line = $2.82\frac{1}{2}$, from the Inch Scale also, and lay it upon this Arch, from 1 to 2, through the Point A, and this Point 2, draw an obscure Line for the second Station.

Note, *The larger the Scale is from which you describe your Angles, the more correct will your Plan be.*

2. Upon this last Line, from A to B, lay down your second Station = 5.70, from the Scale you first made Choice of for your

your ſtationary Lines; and take 2 Chains, as before, from the Scale, and ſetting one Foot in B, deſcribe the Arch 3, 4, upon which lay down from 3 to 4, your ſecond Chord-line = $181\frac{3}{4}$, taken from the Inch Scale: and through the Point 4 draw another Line for your third Station.

3. Having laid down from B to C, your third Station Line, = 2 Chains, 20 Links, ſet one Foot of your Dividers in the Point C, and with 2 Chains therein (as before) deſcribe the Arch 4, 5, and lay thereon (in like Manner as you did the former) your third Chord-line = $1.77\frac{1}{2}$; and through the Point C and 5, draw a Line for your 4th Station.

4. Lay down 6 Chains, 30 Links, from C to D, and in the Point C deſcribe the Arch 5, 6; upon which, from C, lay off the 4th Chord-line = 2 Chains, 80 Links, from 5 to 6; and if a Line be drawn from D to E that will paſs through the Point made in the laſt Arch at 6; you may then conclude that your Angles were correctly taken, and as correctly planned; moreover, the Diſtance between D and E ſhould alſo be = 5 Chains, 72 Links, otherwiſe there is a Miſtake committed, which ſeldom happens when the Angles compleat a Cloſe.

Here note, It may happen when you meaſure Ponds, Pools, &c. by ſtationary Lines, that an exterior Angle or Angles may be met with, in which Caſe, if you leave the Pool on the Right-hand in your ſurrounding, thoſe exterior Angles muſt be entered in a Left-hand Column, otherwiſe go howſoever you will round the ſame, wherein you take exterior and interior Angles; the one may be entered in the Left-hand Column of your Field-Book (formerly mentioned,) and the other in the Right-hand Column of the ſame Page.

The Inſets that are taken upon each Line being entered accordingly, may be planned in like Manner as directed in the two foregoing Examples.

Note, If the Eſtate be hilly, or uneven, and the Main-line, or any other meaſured thereon croſſeth the ſame, it will occaſion a disclose in the Plan, which to prevent, or remedy, in Part the ond you are directed, by the Help of an Instrument, to take Depression, or Altitude, of an Hill, and Trigonometry will find the base Line thereof, which must be used in planning. here methinks I see the honest Country Youth astonished at very Sound of both Instruments, and Trigonometry, saying, *ut! cannot Land (both accessible and inaccessible) be accurately veyed by the Chain only, without being troubled with a Number of cessary Instruments?* I answer in the Affirmative, MOST CERINLY. Instruments (before a more correct and expeditious thod was found out) were esteemed very useful in this Art, now-a-days they serve old Practitioners (who know no better) amuse Country People (that are ignorant thereof) in order to ke them pay the Surveyor more freely; nor should I have induced Instruments in this Treatise, had I not considered the ny Artificers who are thereby supported; together with a mber of *old Practitioners* whose Livelihood hath an absolute pendence thereon: However, as I have in Part the second, only pointed out some of the many Errors the Instrument is avoidably liable to, but also given ample Directions therein to oncile and correct those Errors as near the Truth as the Case ll admit of, [illegible] the Pen several Ways nd which will [illegible], will doubtedly [illegible].

Directions to the young Surveyor [illegible] and [illegible] hilly Ground.

When a Hill interposes in the Survey, in chaining over the ne, you may find both the Area and also the Chord-line, *i. e.* the Hill's Foundation, thus:

If the Hill be not very steep, let your Foreman, at the End every ascending Chain, stick down his Arrow, keeping the hain-End close to the Ground, [illegible] holding up the Chain full stretch, Breast high, or higher, until it be parallel to the orizon, to wit, at Right-angles to a supposed Line between our Chain-hand and the Arrow formerly stuck own, the Chain-End being held exactly over the same in is Manner proceed until you surmount the Hill, by which

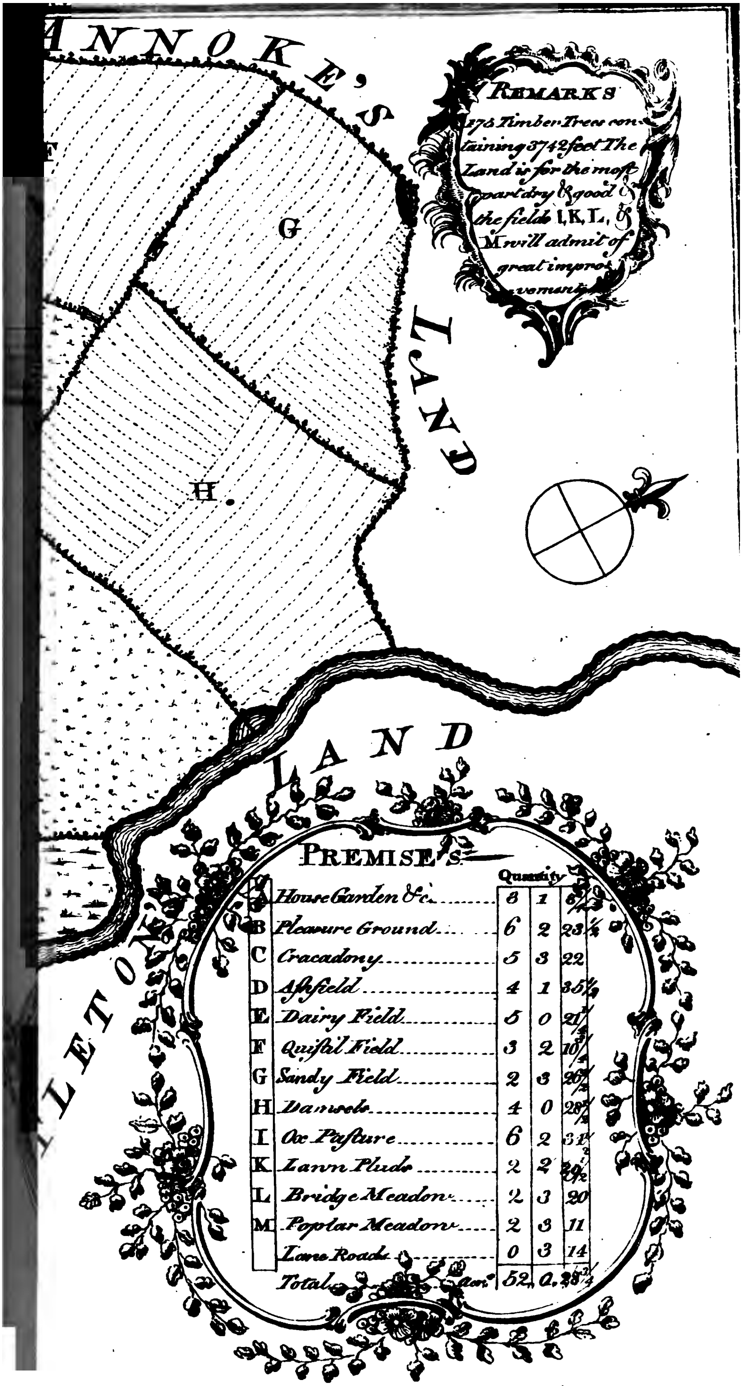
Means you'll have the Foundation-line of the Hill as far a
thus advance thereon; and as you ascend, you may also m
the slant Line thereof, which will enable you to find the
ficial Area and Altitude of the same if required. In desce
a Hill, you must perform the Part your Foreman did whe
cending, whilst he raises his Chain hand, &c. as you did be

But if the Hill be very Steep, your best Way then will
measure up and down the same by half, or quarter Ch
which, with Care, will more effectually answer your End,
all the Instruments ever constructed for the like Occasion.

Thus have I finished the first Part as proposed, and therefore
soever intend or hope to learn any thing contained therein,
not only read the same, but also apply Pen, &c. to Paper; fo
by casting up and planning the several Examples, together
some others of their own proposing, intermixed with Dilig
and Care, will most certainly accomplish their Desires of
coming compleat Surveyors.

The END of the FIRST PART.

PAR



PREMISES

		Quantity		
A	House Garden &c.	8	1	6¼
B	Pleasure Ground	6	2	23½
C	Cracadony	5	3	22
D	Ashfield	4	1	35½
E	Dairy Field	5	0	21¾
F	Quistal Field	3	2	10¼
G	Sandy Field	2	3	26½
H	Damsels	4	0	28½
I	Ox Pasture	6	2	31½
K	Lawn Plude	2	2	29½
L	Bridge Meadow	2	3	20
M	Poplar Meadow	2	3	11
	Lane Roads	0	3	14
	Total Acr.s	52	0	28¾

PART II.

The PROEM, or ARGUMEMT.

Having in Part the first, shewn and taught the Use and Performance of the CHAIN (unassisted by any Instrument whatsoever) *in all the various Occurrences that can possibly be met with in practical Surveying, and also how the Dimensions so taken, may be planned with the utmost Accuracy: In this Part I propose not only to introduce, describe, and explain, the Use and Application of such mathematical Instruments as are generally made Use of in measuring and mapping of Land, but also shew how to reconcile the Errors of Estimation, as near the Truth as any Instrument will permit, so that the Dimensions may be cast up by the Pen several Ways; with some Remarks on the numberless Errors that occur in the Practice and Use of the Theodolite, Circumferentor, &c. Trigonometry being essential to this Method of surveying, I therefore make it the Subject of the first Chapter.*

CHAP.

CHAP. I.

Containing the Doctrine of plane Triangles.

TRigonometry is that Part or Branch of the Mathematics which treats particularly about Triangles: It consists of Lines and Angles only, wherein having three Things given, *viz.* three Sides, two Sides and an Angle, and two Angles and a Side, a fourth may be obtained or found; so that in a comparative Sense, it is not much unlike the Golden Rule, for the Middle Number must be of the same Name with the Thing sought or required.

In the geometrical Part of this Treatise, Chapter the 2d, there are some Definitions relating to Trigonometry, but as they are not sufficient for a Learner, whereby he may have a clear and thorough Knowledge thereof, it is therefore necessary to introduce the following

Definitions.

1. A Triangle is comprehended under three Lines, and consisteth of six Parts, *viz.* three Lines or Sides, and three Angles.

2. A plane Triangle is projected on a plane Superficies, and consequently its Sides are Right-lines. *See Def.* 6, *Page* 71.

3. When two Sides crossing each other make the Angles on all Sides equal, then those Angles are Right-angles, and the Lines are perpendicular.

4. A Degree is the 360th Part of the Periphery, or Circumference of a Circle, equal to 69 *English* Miles, and something better than an Half.

5. The Complement of any Number of Degrees, is what they want of 90.

6. A

6. A Triangle, is either Right-angled, having one Angle right; or oblique, having none right.

7. In a right-angled Triangle, the Side opposite to the Right-angle, is called the *Hypothenuse*; and the two Sides containing the Right-angle are called *Legs*, or *Base* and *Perpendicular*.

8. In all plane Triangles, the Sum of the three Angles is equal to 180 Degrees.

9. In a right-angled plane Triangle, two Things must be given, and one of them a Side to find a third.

10. But in all oblique Triangles, three Things, and one of them a Side, must be given to find a Fourth.

11. Three Letters denote an Angle, as A B C signify the Angle B, and two Letters a-side, *i. e.* AB, denote the Side A B.

12. Given Things, whether Lines or Angles, are marked with a Dash, | 1 |; and required Things, with a Cypher, thus, (0).

13. Every Circle is allowed to contain 360 Degrees; every Degree 60 Minutes; and every Minute 60 Seconds.

14. d, after any Number signifies Degrees; and m, Minutes, thus, 35 d, is 35 Degrees; and 38 m, is 38 Minutes.

15.

S —	Stands for	Sine,
S c -		Sine Complement,
T —		Tangent,
T c		Tangent Complement,
Sec —		Secant,
Sec c		Secant Complement,
Z —		Sum,
X —		Difference.

Note,

Note, There are ſeven Caſes in right-angled plane Triangles, and ſix in oblique Ones; but before I inform or direct the Learner to make Proportions to ſolve the ſame, he ſhould be well acquainted with *fig.* 1, *plate* 4, which will enable him to ſolve all the Caſes in plane Trigonometry very readily, as that *Figure* is a Scheme on which the Doctrine of plane Triangles entirely depends; and that he may perfectly underſtand the ſame, ſo as to know the Names of all the Lines therein, let him obſerve the following

Explanations.

1. K B, or D F, the Diameter. *See* 24 *Def. Page* 73.
2. A B, or A I, &c. the Semi-Diameter, or Radius.
3. B I, an Arch of the Periphery, or Circumference.
4. B C, the Tangent of that Arch.
5. A C, the Secant thereof.
6. E I, the Sine thereof, commonly called the *Right Sine*.
7. A E, the Sine Complement of the ſame Arch, *i. e.* B I.
8. G I, the Chord thereof.
9. D L, the Tangent Complement of the Arch B I.
10. A L, the Secant Complement thereof.
11. E B, the verſed Sine thereof.
12. D n, the verſed Sine Complement thereof.

Laſtly, m I, the Chord Complement of the ſame Arch, *i. e.* B I.

Hence the following Axioms are obtained, or derived.

AXIOM I.

In all plane Triangles, if the Hypothenuſe be made Radius, each Leg will repreſent the Sine of its oppoſite Angle (as A I, in the Triangle A B I, *fig.* 1, *plate* 4.) But if either of the Legs

Legs be made Radius, the other Leg will represent the Tangent of its opposite Angle, and the Hypothenuse the Secant of the same Angle.

1. To find a Side any Side may be made Radius, saying, As the Word upon the given Side, is to the given Side, so is the Word upon the Side required, to the Side required.

2. To find an Angle, one of the given Sides must be made Radius; saying, As the Side made Radius, is to Radius, so is the other given Side to the Word upon it, whether a Sine, Tangent, or Secant.

PROB. I,

Case 1. *The Angles, and Hypothenuse given to find either of the Legs.*

Example in the Triangle A B C, *fig.* 2.

The	Hypothenuse	A C	25 Chains	given	A B	requir'd
	Angle —	A	30 d 30 m		B C	

To construct this Figure.

1. Draw a base Line at Pleasure, as A D; then take from the Scale of Chords 60 Degrees, and placing one Foot in A, describe the Arch m n, and mark with the Point of your Dividers where it crosseth the Line A D, as at d; and from thence to c, lay off 37 d, 30 m, taken from the same Scale.

2. Lay a Ruler from A to c, and draw an occult Line, upon which lay down 25 Chains taken from any Scale of equal Parts, *viz.* to C; and by Problem IV, Page 73, let fall the Perpendicular C B, which compleats the Triangles A B C.

To find B C by *Gunter*'s Scale.

As R, : A C : : S, B A C : B C.
S, 90 : 25 Chains : : S, 37 d, 30 m : 15.30 Chains,

that is to say, the Extent from 90 to 37 d 30 m, on the Line of Sines, will reach from 25 to 15.30 on the Line of Numbers:

Obſerve to proceed in like Manner in all the following Proportions, except where the Secant is mentioned, which is worked only by Logarithms, the which we ſhall have no Occaſion to uſe herein, as I propoſe to lay no Manner of Streſs or Dependence upon the Nicety of ſuch Proceedings, ſince ſurveying by Inſtruments may be performed without any Tables, except thoſe adapted thereto, which are at or towards the latter Part of this Book; nor ſhould I have introduced Trigonometry at any Rate, but to ground the Learner in the Principles upon which are founded the Method of caſting up *(by the Pen)* the Dimenſions of an Eſtate wherein Inſtruments were uſed, and therefore I hope to be excuſed for making Uſe of the Scale inſtead of Logarithms, in the following Proportions; for from what hath been already ſaid (with Regard to the Scale) it is manifeſt that the Reſult thereof will be uncertain or doubtful; yet, notwithſtanding, the Scale may very well anſwer our Purpoſe in this Place.

Note, *The Extent upon any Line from a greater Number to a leſſer, will reach upon the ſame, or any other Line, from a greater to a leſſer; and, on the contrary, from a leſſer to a greater.*

Two other Proportions to find B C.

$$\text{As} \left\{ \begin{array}{l} \text{Sec, B A C} \\ \text{Sec. B C A} \end{array} \right\} : \text{A C} : : \begin{array}{l} \text{T, B A C} \\ \text{R, T 45} \end{array} \Big\} : \text{B C}$$

PROB. II. Caſes 2d and 3d.

The Angles and one Leg given, to find the Hypothenuſe and the other Leg.

Example.

In the right-angled Triangle A B C, *fig.* 3d.

$$\text{The} \left\{ \begin{array}{l} \text{Angle A C B} = 52\text{ d } 30\text{ m.} \\ \text{Leg A B} = 19.80\text{ Cha.} \end{array} \right\} \text{given} \left\{ \begin{array}{l} \text{Hyp. AC} \\ \text{Leg BC} \end{array} \right\} \text{required}$$

Con-

CONSTRUCTION.

1. Draw the Line A B, and lay thereon 19.80 Chains; then at the Point B, erect a Perpendicular.

2. At the Point A, with the Chord of 60, describe the Arch n m; then take the Complement of the given Angle = 37d 30m. from off the Line of Chords, and lay it from m to c.

3, Lay a Ruler from A to o, and draw an occult Line which will cross the Perpendicular in the Point C, and it is done.

First, To find the Hypothenuse A C, make it Radius, and the Proportion is (*by Axiom* I, *Note* 1) thus:

As S, C : A B : : R, : A C.
S, 52d 30m : 19.80 : : S 90 : 25 Chains.

Secondly, To find B C, A B being made Radius.

As R : A B : : T A : B C
T 45 : 19.8 : 37d 30m : 8.40

Note, When you work by Tangents, you must use Radius Tangent, 45d.

Thirdly, To find B C, B C being made Radius.

As T C : A B : R : B C
T, 52d 30m : 19.80 : T 45 : 8.40

Note also, There might here be made three other Proportions to find A C and B C, but then the Secants must be used therein, which cannot be wrought upon the Scale (as hath been already observed.)

PROB. III. Cases 4 and 5.

The Hypothenuse and one Leg given, to find the Angles and the other Leg.

Example.

In the Triangle A B C, *fig.* 4.

$$\text{The}\left\{\begin{array}{l}\text{Hyp} : AC = 25\text{ Chains}\\ \text{Leg} : AB = 19.80\text{ do.}\end{array}\right\}\text{given}\left\{\begin{array}{l}ACB\text{, or }BAC\text{,}\\ \text{and Leg }BC\text{,}\end{array}\right\}\text{req.}$$

CONSTRUCTION.

1. Make A B = 19.80 Chains, and at the Point B erect a Perpendicular.

2. Take in your Dividers 25 Chains, and setting one Foot in the Point A, describe an Arch that shall intersect the Perpendicular in the Point C.

Lastly, Join A and C together, and it is done.

First, To find the Angle A C B, A C being made Radius, the Proportion by *Axiom* I, *Note* 2*d*, is thus:

$$\begin{array}{l}\text{As } AC : R, :: AB : S, ACB\\ \quad 25 : 190 :: 19.80 : 52\text{d}, 30\text{m}.\end{array}$$

Secondly, To find B C, A B being made Radius.

$$\text{As}\left\{\begin{array}{l}R, : AB :: T, BAC\\ T, C : AB :: R, —\end{array}\right\} \begin{array}{l}: BC\\ \;\; 8{,}40\text{ Chains.}\end{array}$$

PROB. VI. Cases the 6th and 7th.

The Legs given to find the Angles.

Example.

In the right-angled Triangle A B C, *fig.* 5.

$$\text{The Legs}\left\{\begin{array}{l}AB\ 19.80\\ BC\ \ 8.40\end{array}\right\}\begin{array}{l}\text{Chains}\\ \text{given}\end{array}\left\{\begin{array}{l}\text{Angle }BAC\text{, or }ACB\text{,}\\ \text{and Hypothenuse }AC\end{array}\right\}\text{req.}$$

CON-

CONSTRUCTION.

First, Draw a Line parallel to your Breast, and lay thereon 19.80 from A to B, at B erect a Perpendicular, upon which lay down 8.40 from A to C; join A C, and it is done.

First, To find either of the Angles, the Proportion is *by Axiom* I, *Note* 2.

As A B : R, : : B C : T, B A C
19.80 : T, 45 : : 8.40 : T, 35d 30m.

Secondly, To find the Hypothenuse A C, the Angles, as above, being found.

As S, B A C : B C : : R, : A C
S, 37d 30m : 8.40 : : 90 : 25 Chains.

Note, The 5th and 7th Cases may be performed by the 47th Proposition of 1 Book of *Euclid*, to wit, the Square of the Hypothenuse is equal to the Base and Perpendiculars, wherein are three Varieties.

1. The Square Root of the Sum of the Squares of the Base A B, and Perpendicular B C, is equal to the Hypothenuse A C.

2. The Square Root of the Difference of the Squares of the Hypothenuse A C, and Base A B, is equal to the Perpendicular B C; and the square Root of the Difference of the Squares of the Hypothenuse A C, and Perpendicular B C, is equal to the Base A B.

The three Axioms *that pertain to oblique plane Triangles, with the* 6 Cases *thereof.*

AXIOM II.

In all plane Triangles, the Sides are in such Proportion one to another, as are the Sines of their opposite Angles, that is,

1. As

1. As the Sine of any one Angle is to its opposite Side, so is the Sine of any other Angle to its opposite Side.

2. As any Side is to the Sine of its opposite Angle, so is any other Side to the Sine of its opposite Angle.

Note, To find a Side, begin with an Angle; and to find an Angle, begin with a Side.

From this Axiom are derived the Proportions for the first, second, and third Cases following.

PROB. V. *fig.* 6.

Case the 1st. *Of oblique Angles, two Angles and one Side given, to find either of the other Sides.*

Example.

In the Oblique Triangle B D C.

$$\text{The}\left\{\begin{array}{lcl} \text{Angles D} & = & 127\text{d} \\ \qquad\ \ \text{B} & = & 23\text{d} \\ & & \text{C. L.} \\ \text{Side}\ \ \text{B C} & = & 10\ 50 \end{array}\right\}\begin{array}{l}\text{given}\\ \text{Sides}\end{array}\left\{\begin{array}{c}\text{C D}\\ \text{and}\\ \text{B D}\end{array}\right\}\text{required}$$

CONSTRUCTION.

Note, To make an oblique Triangle, three Things must be given, and one of them a Side.

1. Make B C equal to 10 Chains, 50 Links; and at B make an Angle (by Problem the first) equal to 23d, thus: Take in your Dividers the Chord of 60d. and with one Foot in the Point B, describe the Arch a b, on that Arch lay 23d from c to d, through the Points B and d, draw the Line B d.

2. From 180 Degrees, the Sum of all the three Angles, by Definition 9, take 150d, the Sum of the two given Angles, the Remainder is 30, the Quantity of the Angle B C D.

3. At

3. At C make an Angle of 32d in like Manner, that is, with the Chord of 60, describe the Arch e f, and lay thereon 30d from g to h.

Lastly, Through h, draw the Line C h, that shall intersect the Line B d in D, and it is done.

PROPORTION.

The Proportion, according to Axiom the second, for finding the Side D C, is,

As S, of the Angle B D C, is to B C, so is the Sine of the Angle D B C, to ——————— D C, the Side required.

As S c D	:	B C	: :	S B	:	D C.
53	:	10.50	: :	23d	—	5.10

To find the Side B D, the Proportion is by the same Axiom.

As S, D	:	B C	: :	S, C	: :	B D
Sc 53d	:	10,50	: :	30	:	6,50

P R O B. VI. Cases the 2d and 3d. *fig.* 7.

Two Sides and an Angle opposite to one of them given, to find the other opposite Angle, and the third Side.

Note, The given Angle obtuse, the Angle sought is acute: But when the given Angle is acute, and opposite to the lesser given Side, then it is doubtful whether the Angle sought be obtuse or acute, and ought to be determined before the Operation.

Example in the oblique Triangle B C D.

The Sides { B C 10,50 / B B 6,50 / Angle G 30d } given { Angle D obtuse, and Side C D } required.

CON-

CONSTRUCIONS.

1. Make B C 10,50 Chains, and at the Point C make an Angle = 30d, then take in your Dividers the other given Side, *viz.* B D = 6,50 Chains; and setting one Foot in the Point B, describe an Arch that shall intersect the Line C D, in the Point D; then join B D and it is done.

For the Angle D, the Perpendicular is

As B D	:	S C	: :	B C	:	Sc D		180
6,50	:	30d	: :	10,50	:	53d		53
							The Ang. D =	127

Note, The Proportion produceth 53d for the required Angle; but being obtuse, you must take its Supplement to 180d, *viz.* 127d, as above.

AXIOM III.

In all plane Triangles, as the Sum of the Legs is to the Difference of the Legs, so is the Tangent of half the Sum of the opposite Angles, to the Tangent of half the Difference; half that Difference added to half the Sum, gives the greater Angle; and taken from half the Sum, gives the lesser Angle.

PROB. VII. Cases the 4th and 5th. *fig.* 8.

Two Sides and the included Angle given, to find the Angle and the other Side.

Example.

The Legs { B C = 105, B D = 63, Ang. B = 23d } given { the Angle C & D & the Side D C required.

CONSTRUCTION.

1. Draw the Line B C parallel to your Breast, and at the Point B make an Angle of 23d.

2. Take

2. Take from your Scale of equal-Parts 105 Chains, and lay it down from B to C, and in like Manner lay 65 Chains from B to D; join D and C, and it is done.

Proportion whereby to find the Angles. See the foregoing Axiom.

As Z Legs : X Legs : : T ½ Z 2 opp. ∠s : T ½ X
170 : 40 : : T 78,30 : 49,10
49,10

Lesser Angle 29,20 = C

Greater Angle 127,40 = D

	105				180
	65				23
Z Legs	170	Chains		Z opp. ∠s	157
X Legs	40	Chains		½ the Sum	78.30

To find D C, this is the Proportion.

As S C : D B : : S B : D C
S 29,20 : 65 : : 23d : 53 Chains.

AXIOM IV.

As the Base is to the Sum of the Legs, so is the Difference of the Legs to the Difference of the Segments of the Base; half that Difference added to half the Case gives the greater Segment, and taken from half the Base gives the lesser Segment.

PROB. VIII. *fig.* 9.

The three Sides of a Triangle given to find the Angles.

Example.

The Sides $\left\{\begin{array}{l} BC = 10{,}50 \\ BD = 6{,}50 \\ DC = 5{,}30 \end{array}\right\}$ given $\left\{\begin{array}{r} \text{their Angles } B \\ C \\ D \end{array}\right\}$ required.

Construction.

1. Draw an occult Line parallel to your Breast, and lay thereon 10 Chains, 50 Links, from B to C; take also 6 Chains, 50 Links, in your Dividers, and setting one Foot thereof in the Point B, describe an Arch.

2. Take 5 Chains, 30 Links, in the Dividers, and setting one Foot in the Point C, with the other describe an Arch that shall intersect the former in the Point D; joint B D and C D together, and it is done.

Proportion to find the Segments by Scale and Dividers.

As Base : Z Legs : : X Legs : : X Segments.
10,50 : 11,80 : : 1,20 : 1,34

			Legs	{ 6,50 5,30
	,67			
$\frac{1}{2}$ Base	5,25		Sum	11,80
Greater Segment	5,92		Difference	1,20
Lesser ditto	4,58			

To find the Angle B.

As B D : R : A B : S, A D B
6,50 : 90 : 5,92 : 65

Hence the Angle B is 25d, and by the 3d Axiom find the Angles C and D,

As Z Legs : X Legs : : T $\frac{1}{2}$ Z opp. <s : T $\frac{1}{2}$ X
17 : 4 : 77,30 : 46,45

	10,50		180
	6,5		25
Sum of Legs	17,0	Z op. <	155
Diff. of Legs	4,	$\frac{1}{2}$ Z	77,30
			46,45
The greater Angle			124,15
The lesser Angle			30,45

This

This Problem concludes plane Trigonometry, which Branch being well underſtood, will greatly enable the young Learner to work a Number of curious Queſtions relating to this and ſeveral other Branches of the Mathematics; ſome of which would undoubtedly prove entertaining here if the Size of this Treatiſe would admit thereof: But, perhaps, ſome that look upon the firſt Part of this Treatiſe to be ſufficiently comprehenſive in the Art of ſurveying, may be at a Loſs to know wherein Trigonometry is, or can be uſeful in this Place; to thoſe I anſwer, When Inſtruments are uſed, Altitudes, Depreſſions, Bearings, and Diſtances may be obtained thereby: Alſo thoſe Tables towards the End of this Book were calculated by Trigonometry, wherein the Bearing (or Angle at the Perpendicular) and Hypothenuſe being given, to find the Baſe and Perpendicular; *for in all right-angled plane Triangles, the Hypothenuſe repreſents the ſtationary Line; the Baſe (with Reſpect to Surveying) is the Departure; the Perpendicular is the Difference of Latitude; the Angle at the Perpendicular repreſents the Bearing or Angle made by the ſtationary Line and Meridian; and the Angle at the Baſe is the Bearing Complement.*

Note, Whatever herein relates to Surveying, is more fully explained in Chapter the third, to which I refer my Reader.

CHAP. II.

Containing the Description and Use of several Instruments that are made Use of in the Art of Surveying.

SECTION I.

THE practical Part of Surveying for Ages past, hath been generally performed by such Instruments as are particularly adapted to the Art, which may be comprehended under the two following Heads, *viz.* LINES and ANGLES.

First of Lines, or measuring of Distances.

There are several Sorts of Chains, *&c.* mentioned for that Purpose in Pages 82 and 83.

Secondly of Angles.

There are various Instruments whereby the Quantity of Angles are taken, namely, the Theodolite, Circumferentor, Semicircle, *&c. &c.*

And thirdly.

There are also many Instruments used in planning a Survey from the Field Notes, calculating and working Proportions, *&c.* as the Protractor Scale, sliding Rule, Dividers, *&c.*

SECT. II.

And first of the THEODOLITE.

There are such Varieties of Theodolites constructed now-a-days, that it would be an endless Task to give a particular Description of each; I therefore think it sufficient to give such a general

general Account of them as may enable any Person, desirous to learn the Use thereof, to know how to distinguish such from other Instruments.

The Theodolite hath been accounted useful in some Surveys, and are most commonly made of Brass, supported by three Legs, and consists of a Circle about 8 or 10 Inches Diameter; this Circle is divided into 360 Degrees, and these Degrees in some are subdivided into smaller Parts, as the Size of the Instrument will admit of; sometimes by equal Divisions, and sometimes by Diagonals drawn from the outermost to the innermost concentrick Circle of the Limb.

There is, in the Middle of the Brass Circle, a Box and a Needle touched with the Loadstone, the Center or Cap of the Needle being in the Center of the Circle; as is also the Center of the Index upon which it turns to take up any Angle as Occasion requires.

On the under Side of it there is a Ball and Socket screwed on, by which it is fixed on a three-legged Staff, so that, when in Use, it may be turned about, or fixt in an horizontal Position without removing the Legs of the Staff.

This Instrument is esteemed useful to take Angles, Elevations, and Depressions; and to take the Quantity of an Angle thereby in the Fields proceed thus:

Place the Instrument in the angular Point given, then turn the Index till it is parallel to one Side, and make fast the Ball by turning a Screw fixt therein.

Secondly, Turn the moving Index until you have it directly in a Line with the other Side, and take an Account of the Degrees cut in the Limb by the graduated Edge of the moving Index, which is the Quantity of the Angle requir'd.

But here note, The larger the Limb thereof is, the more near the Truth you may come in esteeming the Quantity cut by the graduated Edge of the Index. In the next succeeding Chapter I have

I have expatiated upon the Use and Practice of this Instrument, which see.

Of the CIRCUMFERENTOR.

The Circumferentor consists of two chief Parts, namely, the Box and Index; the Index is commonly about 14 Inches long, with a Sight at each End; the Box or Circle is often made in Proportion to the Index, *viz.* the Diameter of the Box, or Circle, is about half the Length of the Index.

There is, on the under Side of the Instrument, either a Ball and Socket, or a Socket screwed on, that it may thereby be placed upon a three-legged Staff. In the same Manner as the Theodolite is fixed when it is to be made Use of.

Some of the Indexes have Scales of equal Parts thereon, of six, eight, ten, or more, to an Inch, and serve for Scales to protract with, for which Purpose the Instrument is applicable.

In the Bottom of the Box there is the Mariners Compass represented by 32 Points, with the Flower de Luce for the North; the Side of the Box is divided into four Nineties, representing the four cardinal Points; and the upper Part of the Box is divided into 360 Degrees, if the Box be large enough to admit of it, so that you may either count by the Points of the Compass within the Box, or by the Degrees from the Meridian.

The Flower de Luce in the Box, is placed exactly over a Line that goes through the Middle of the Index, passing through the Center of the Compass; and that End where the Flower de Luce is placed, must always be turned towards you in Time of Observation, except when you take back Sights.

In the Center of the Box (which is exactly in the Middle of the Index) there is fixed a sharp-pointed Steel Center-pin, upon which there is suspended a Needle touched with the Loadstone, and covered with a Glass, to defend it both from the Violence of the

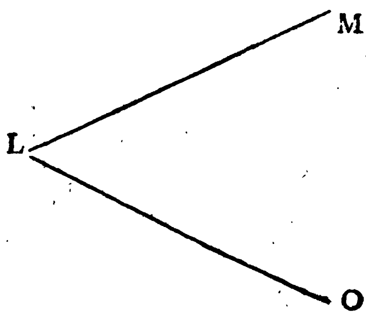
the Air, and Inclemency of the Weather: Thus secured, the Needle points North and South, the Variation excepted, which ought to be found and allowed for in placing the Flower de Luce in the Map according to the true Position or Situation of the Estate.

Find the Variation as hereafter taught, and allow for it accordingly.

At each End of the Index are screwed two Vanes, or Sights, through which you are to look at the Object proposed for Observation.

This Instrument (as well as the Theodolite already mentioned, and all other horizontal Instruments) is placed upon a three-legged Staff, and moves by the Help of a Ball and Socket.

The Use of this Instrument, is to find the Quantity of any Angle in the Field, so that the same may be protracted or planned, and is thus performed:



Let L O and L M be two Hedges in a Field, and it be required to know what Angle the Hedge L O makes with L M, set up the Instrument at L, ond fixing the Flower de Luce towards you, look along the Hedge L O, and observe what Degree the Needle points at, which suppose 50, then turn the Instrument about till you can behold, through the Sights, the Hedge L M; and

and obſerve alſo what Degree the Needle points at, ſuppoſe 106, from which take 50 (the former Bearing) there Remains 56, the Angle required.

Note, If in taking the Degree of any Angle, the Needle ſhould point on each Side of 360, you muſt add what the firſt Obſervation wanted, or was paſt 360, to what the ſecond wanted, or was paſt 360, and the Sum is the Angle required. This is ſo eaſy that I think an Example needleſs.

Of the PROTRACTOR.

The common Protractor generally conſiſts of two Parts, a Scale and a Semi-circle, though there are Numbers made having no Scale; the Semi-circle is to lay down Angles, and the Scale is no more than a Scale of equal Parts to plot by.

They are moſtly made of Braſs or Ivory of different Sizes, as well as different Shapes; the Braſs ones in Caſes, commonly repreſent a Semi-circle; ſome indeed there are both of Braſs and Ivory, made in an oblong Form, but all ſerve for the ſame Purpoſes.

In the Middle of the Diameter there is a Point which is the Center to the Protractor, about which are drawn three concentric Semi-circles within each other, at ſuch a Diſtance that the two Spaces between them will contain Figures, each Quadrant of the Semi-circle being divided into 90 equal Parts called Degrees, ſo that the Semi-circle contains 180 Degrees.

The outermoſt Circle is marked from the Left to the Right with 10, 20, 30, &c. to 180; and the innermoſt is numbered from the Right to the Left back again, with 10, 20, 30, &c. to 180 Degrees; ſome of the innermoſt Circles are marked different, *viz.* from the Left to the Right with 190, 200, 210, 220, &c. to 360: The Diameter of the Protractor (wherein the Center is) repreſents the Meridian, and calling that End North where the outermoſt Circle begins to be numbered, the other will be South.

USE.

USE.

Chuſe any convenient Point on your Paper, to which bring the Center-point of your Protractor, then look for the Degree of your firſt Station in the Semi-circle, and thereat make a Point in the Paper with a Protracting Pin, or fine-pointed Needle, through which, and the firſt choſen Point, draw a Line upwards, if your Degree be leſs than 180, but downwards if more; upon which Line lay off the Diſtance chained (the firſt Station) from a Scale of equal Parts, and at the End thereof place your Protractor as before (if you protract by Parallels) parallel to a Meridian Line drawn through your firſt choſen Center, and examine, in the Semi-circle, for the Degrees of your ſecond Station, which mark in the Paper, as before directed; through this Point and the laſt Center-point draw a Line upward if your Degrees be leſs than 180, but downwards if more; upon which Line lay down your ſecond Station in Chains and Links taken from the Scale; and in this Manner proceed until all your Stations are protracted. Whoever are deſirous to have further Explanations herein, let them turn over to Chapter IV, wherein they will meet with an emblematical Illuſtration.

Of the SECTOR.

‘ The Sector is an Inſtrument that hath been formerly of al‘ moſt univerſal Uſe, being applicable to Arithmetic, and all the ‘ Branches of the Mathematics; nor is it yet quite diveſted of its ‘ Property and great Uſe; but ſince, *Gunter*'s Scale hath been ‘ invented whereby the Proportions in Trigonometry, Naviga‘ tion, Aſtronomy, &c. &c. are performed as accurately, and ‘ with much leſs Trouble, the general Eſteem that this Inſtrument ‘ deſervedly met with daily declines.

‘ This Inſtrument is conſtructed of Silver, Braſs, Ivory, or ‘ Box Wood, in Length 6, 8, 9, or 12 Inches, with a Joint ‘ like a Carpenter's Rule, ſo that the ſaid Legs, together with cer‘ tain right Lines drawn from the Center of the Joint, contain ‘ Angles of different Quantities: The Lines that are commonly ‘ drawn upon the Face of this Inſtrument, to be uſed Sector‘ wiſe, are the Line of Lines, or equal Parts, numbered with ‘ 1, 2, 3, to 10, and marked with L L; the 1 may ſometimes 'stand for 10, the two for 20, or 200, &c. according as the 'Matter in hand requireth. Next these lies a Line of Chords 'issuing from the Center, and marked with C C at the End, and 'numbered 10, 20, 30, &c. to 60d, which Chord of 60 is 'equal to the Radius of a Circle, or whole Sine of 90, by '*Prop*. 15, *Book* IV, of *Euclid*.

'On the other Face of the Sector is a Line of natural Sines, 'numbered with 10, 20, 30, &c. to 90, and marked at the End 'with S S: By the Sides of the Sines lie two Lines of natural 'Tangents issuing from the Center also, and numbered with '10, 20, 30, &c. to 45d; because the Tangent 45, Sine of '90, and Chord of 60, are all equal to the Radius of a Circle. 'These Tangents are marked at the End with T T: between 'the Sines and Tangents on each Leg is a Line of lesser Tan-'gents, issuing from two little Brass Centers, and there begin-'ning to be numbered with 45, 50, 60, 75, and marked 'with t t.

'This Line supplies the Line of greater Tangents when your 'Angle exceeds 45d; and on the same Face with the Chords, 'and equal Parts, or Line of Lines, lies the Line natural Se-'cants, issuing from two little Brass Centers lying betwixt 'the Chords and Line of Lines, and numbered with 20, 30, '40, 50, 60, 70, 75, marked with S S. These Chords, Sines, 'Tangents and Secants, are all projected from the same Circle 'to the Radius of the Sector they are placed upon. There are 'other Lines arbitrarily placed upon the Sector, but tending 'nothing to my present Purpose, I shall not, therefore, trouble 'the Reader with their Description or Use at this Time.'

USE.

'I shall only touch upon geometrical Proportion, or the Rule 'of Three, which is a great Part of Arithmetic; and in per-'forming this observe this Method, which should also be ob-'served in the Proportions of Trigonometry, or any Operation 'performed by Sines or Tangents, as well as the Line of Lines.

RULE.

R U L E.

'Take the second Term in your Compasses, and placing one 'Foot of your Compasses in the first Term, on one Limb of 'the Sector, open the Sector so that the other Foot of the Com-'passes will fall in the said first Term on the other Limb of the 'Sector; then keeping the Sector at the same Opening, place 'one Foot of the Compasses in the third Term; on one Limb 'extend the other to the said third (or collateral) Term on the 'other Limb; that Extent measured on the Line in which the 'Answer is to be (whether Number, Sine, or Tangent) shall 'give the Answer to the Question.

Example.

'If 4 Acres of Land, or any thing else, be lett at 2 l. 10 s. 'per Annum, what will 6 Acres amount to at the same Rate?

'This Question, according to the Rule of Three, is thus 'stated:

	Acres	S.		Acres.
If	4 :	50	: :	6

'The Term required, or the Answer, being always of the 'same Name or Denomination with the middle Number, in this 'Station it is Shillings, therefore take the second Term 50 in 'your Compasses, *viz.* extend the Compasses upon the Line of 'Lines from the Center to 50, and with that Extent, and one 'Foot in 4, the first Term, open the Sector till the other Foot 'fall in 4 on the Line of Lines on the other Limb; then keeping 'the Sector at that Opening, extend the Compasses from the 'third Term 6, on one Limb to the same on the other; that Ex-'tent measured on the Line of Lines from the Center of the 'Sector, will reach to 75, *viz.* 75 s. or 3 l. 15 s. the Answer to 'the Question.

'And as the Rule of Proportion is worked by the Extent 'before-mentioned, so Multiplication is performed by making '1, the first Term in the Proportion, and saying, as 1 to the 'Multiplier, so the Multiplicand to the Product; but the 'Proportion being already explained in the Use of the Line of

'Numbers, and the Manner of extending upon the Sector be' ing just now described, I shall not need to enlarge further 'upon it.'

Note, There are several other Instruments used in Surveying, to wit, the *Perambulator*, *plane Table*, &c. which might here be described, but I presume those already mentioned sufficient. As for the *plane Table*, I am not insensible that it is very much used by Numbers in this Kingdom: I'll grant that a Surveyor may thereby take Dimensions upon an horizontal Plane, but to find the Contents of those Dimensions he must have Recourse to Scale and Dividers, and then *the old Assistant Estimation* will officiously recommend itself. But if the Field or Estate (wherein the plane Table is made Use of) be hilly or uneven, the Error arising from such Dimensions, will be in Proportion to the Unevenness of the Earth's Superficies; for Instance, admit a Field very uneven or hilly on one Side, and the opposite Side flat or level, which Field being measured by a plane Table from one or two stationary Places, the Dimensions of the hilly Side being planned upon Paper, will most certainly distort the same of its true Form. *See Chapter the 3d, Part the second.* But this is not all, there are other bad Consequences that the *plane Table* is Heir to; for in wet or hazy Weather it cannot be used, consequently the Measurer must stand still: Rain in half a Minute destroys the Work of the Day; and though it be defended from the Rain, yet, notwithstanding, wet or dry Weather will dilate or contract the Paper. And though it doth escape all those Disasters, it is confessedly granted by most of the Practitioners themselves, that the Chain alone is more expeditious, and equally as correct; nevertheless there are many plane Table Practitioners so enamoured, or rather infatuated therewith, that a Blackmoor may as soon be washed white as to dissuade some Practitioners from their darling Opinion in its Favour, who, instead of supporting this Instrument, *(by geometrical Proofs)* from Censure, too many of them assign this Aphorism: '*I have practised and used the Table upwards of forty, fifty, or 60 Years, and am sure, nay very sure, it is right, otherwise should not have measured so long therewith.*' I can assure my Reader, that in the Circuit of Application for Subscribers, I met with several Plane-Table Surveyors who gave no other Testimony for its Correctness than their long Practice thereof. Moreover it

It were to be wished that all those Surveyors who are equally wedded to, and prepossessed in Favour of Instruments, *i. e.* the Theodolite, Circumferentor, Semi-circle, &c. were less partial and more charitable in their Reflections against the plane Table and its Adherents. I say let them not contemn a Method since theirs is scarce advanced one Step nearer the Truth, as will appear anon. To censure those of the same Profession administers no additional Credit to the Character of any Man; let not, therefore, any Person conscious of his Error be guilty of throwing the first Stone, but always favourably speak, and chearfully assist (if required) a Brother Concomitant; whoever thus deport themselves, will, in the End, *(if not before)* reap the Advantage thereof.

Of the Variation *of the* Needle, *and how to rectify your Meridian.*

1. The Variation of the Needle, or Compass, is an Arch of the Horizon, intercepted between the Solstice and magnetic Meridian, either easterly or westerly, and cannot exceed 90 Degrees.

2. The Variation is easterly when the magnetic Pole is to the East of the North Pole, but if it lie to the West, then the Variation is westerly.

3. Magnetic Poles are two (imaginary) moving opposite Points, which revolve about the Poles of the World nearly 9 Degrees distant therefrom, and compleat their Revolution in about 600 Years, which occasions the Variation of the Needle.

4. Magnetic Meridian, is a great Circle passing through the magnetic Poles, to which Meridian the Needle hath Respect, if not otherwise obstructed.

5. The Variation of the Needle may be found by an Amplitude or Azimuth, to find which you must have the Latitude of the Place, the Declination of the Sun, and magnetic Amplitude thereof.

6. The

6. The magnetic Amplitude, is an Arch of the Horizon, intercepted between the East and West Points of the Compass, and the apparent rising or setting of the Sun from the above-mentioned Points, which is found by observing the Sun either at rising or setting, with an Amplitude Compass.

7. Amplitude is also an Arch of the Horizon, intercepted between the Sun and the East and West Points of the Horizon, and may be found by this Analogy:

As Sine Com. Lat. is to Radius, so is Sine of the Sun's Declination, to Sine of the Amplitude.

8. If the Magnetic, and the true Amplitude are both alike, (which seldom happens) then there is no Variation; but if they differ, their Difference rightly counted, is the Variation.

Note 1st, The Amplitudes, both North, or both South, their Difference is the Variation; but one North and the other South, their Sum is the Variation.

2. Both Amplitudes easterly or westerly, if the true Amplitude be to the Right-hand of the Magnetic, the Variation is East; but when it is to the Left-hand, then the Variation is West. An Example or two will make it easy.

Example I.

Suppose the true Amplitude at Sun rising be East, 28 northerly, and magnetic Amplitude be East, 9 Degrees northerly, their Difference is 19, the Variation. Now, as the magnetic Amplitude is more remote from the North than the true, therefore the Variation is westerly. If this had been at Sun setting, the Variation would have been easterly.

Example II.

At Sun-setting let the true Amplitude be West, 21 northerly, and the magnetic 14 West southerly, their Sum is 35, the Variation easterly.

It

It is affirmed that the Needle has a particular diurnal Variation of a few Minutes, namely, from about eight in the Morning, till about four in the Afternoon; during which Time the Needle is gradually and regularly affected by a westerly Motion, and then becomes stationary for some Hours: The Variation westward gradually decreases, and the Needle re-assumes its former State of Correctness. This Variation increases and decreases, as the Sun approaches to or declines from us, *viz.* it is supposed to have in

January	7	Minutes,	*July*	13	Minutes.
February	9		*August*	12	
March	11		*September*	11	
April	12		*October*	10	
May	13		*November*	8	
June	13		*December*	7	

Hence the Variation of the Needle (in the Surround of a Survey) may more justly be imputed to this, than to the magnetic Variation, for I can assure my Reader that the Variation of the Compass (as it is commonly called) has not the least Effect upon any Angle taken by a Needle in the Field; for Reason will convince us, that as the Point of Attraction is so very remote from the Instrument, the Error of Course is insignificant; and though 500 Chains were measured easterly, or westerly, from any Meridian in the temperate Zone, it would not affect the Needle one tenth of a Degree, or 6 Minutes, with respect to the Angle.

Thus have I given my Reader a brief easy Method of finding the Variation, which will enable him not only to place his Map in a true North and South Position (when the Needle is used,) but likewise (if he has any Notion of Dialling) direct him how to fix his Meridian, or twelve o'Clock Line.

CHAP.

CHAP. III.

Teacheth the invaluable Method of casting up by the Pen, the Dimensions of an Estate taken as correctly by an Instrument as the Nicety of Estimation will admit of.

THE Instrument in Surveying (as already observed) is only to take the Quantity of an Angle, which to perform in in the Surround of an Estate to an Exactness, is beyond not only the Reach of Instruments, but likewise out of the Power of the most judicious Practitioner, for the following Reasons:

1. Every Circle is allowed to contain 360 Degrees (equal to twenty-five Thousand, two Hundred *English* Miles, or thereabouts,) as appears in the Box of a Circumferentor, or the Limb of a Theodolite: Now the undivided Space between each of those Divisions on the Limb, or Card, is (69 *English* Miles, and something better than a half) about the 20th Part of an Inch: This Space is so small, that it will not admit of a less Subdivision than a Quarter, though there is not one Instrument in an Hundred that hath the Space between the Degrees divided; then judge, kind Reader, if it be possible when the Needle, or graduated Edge of the Index points thereto (in taking the Quantity of an Angle) to guess thereat nearer than one Quarter of a Degree, to wit, *about* 17 *English Miles:* This is what I term in the Field *Estimation*, by which a Quarter under or over the true Angle may readily be entered: However, let us suppose an Estate to be horizontal, (which is seldom or never met with) and admit it was surveyed by 10 or 12 stationary Lines and Angles taken by an Instrument; but, as above observed, the most circumspect Practitioner cannot avoid entering 12 or 15 Minutes *(or Miles)* more or

or leſs, than the real Quantity in moſt of the Angles, if not in all; and therefore, (if one Error doth not cancel or reconcile another which often happens with Inſtruments) the Miſtake may be great, the *Cloſe* imperfect, and conſequently the Plan incorrect. Moreover, let us ſuppoſe the Inſtrument perfect *(though contrary to Reaſon,)* and that the Surveyor can thereby take the real Quantity of every Angle in the Fields *(which is equally as impoſſible as to divide or ſplit a Hair of the Head into 30 equal Parts)*; nevertheleſs there is another unſurmountable Difficulty attending the Uſe of the Inſtruments more irreconcileable than the above, which I preſume is not intirely owing to, or occaſioned by *the Imperfection of the Needle, careleſs Chaining, or Eſtimation (though it is manifeſt that Errors are thereby committed,)* but chiefly to the Irregularity of the Earth's uneven Surface; for in meaſuring with an Inſtrument, the Terraqueous Globe is conſidered as a Plane comprehended under a right-lined horizontal Superficies *(though apparently curvilineal;)* the Meridians, or North and South Lines, are conſidered thereon as right Lines parallel to each other; and the Eaſt and Weſt Lines, or Parallels of Latitude, to croſs the ſame at right Angles, *ſee fig.* 12, *plate* 4, wherein the Lines N S, repreſent Meridians, and E W Parallels of Latitude; and the Lines A C, and C F, two ſtationary Lines taken in the Surround of an Eſtate.

1. Let it be granted that the Bearing of the Angle B A C be taken as exact as poſſible for the firſt Station, which being entered, the Surveyor proceeds in meaſuring the curved Line A C, = 11 Chains, which repreſents the Unevenneſs of the Earth's Surface.

2. Being at the End of the firſt Station Line, to wit, at C, where the Inſtrument being likewiſe ſet up, in like Manner take the Bearing of E F, the ſecond Station; this being entered and chained, thus let the Surveyor proceed with every Station until he ends where he began, taking up the Off-ſets or Inſets on each Station, as directed in Part the firſt.

3. In protracting thoſe Dimenſions, the Surveyor will then *(if not before)* diſcover the Miſtake in both Lines and Angles, by an unavoidable Diſcloſe occaſioned *(if not elſewhere)* in Station 1ſt. This Figure exhibits at firſt Sight a Diſtortion of the whole

Survey: For a farther Illustration thereof, the curved Line AC (as before observed) represents the uneven Surface of the Earth, whereon a stationary Line (taken in the Surround of an Estate) measured 11 Chains, though the true horizontal Distance is but 10, which, when planned, or protracted upon a plane Superficies, to wit, Paper, the Error will be too apparent to be concealed.

Demonstration.

1. Take 11 Chains from any Scale of equal Parts, and lay it down from A to D, *fig.* 12, which should have extended no farther than to C, the Place whereat the second Station in the Fields began.

2. At the Point D, instead of C, lay down the Bearing of your second Station (equal A C F,) *viz.* A D G, but the Point F is the Place whereat the third Station in the Field was taken: Hence it is manifest, that your second Angle A C F, is become (upon Paper) A C G, being increased by the Angle F C G; also the true stationary Line A C, is become A D, being increased by the Distance C D = 1 Chain, the true Difference of Latitude of the Stat. A C, is A B, but becomes A H, being increased B H = 80 Links; and the Departure B C, is become D E, being also increased a D = 60 Links, consequently the Angles, Distance chained, Difference of Latitude and Departure, will, throughout the Survey, all vary from the Truth, and therefore a *Disclose* is unavoidable. Q. E. D.

Hence it is evident, that when Instruments are made Use of in Surveying the Result will be doubtful, and *the Close imperfect*; whether the Mistake be occasioned by *the Irregularity of the Earth's Superficies, Estimation, or the Incorrectness of the Instrument*, is not material, since the Error is unavoidable; therefore how absurd, how ridiculous it is for any Man to affirm (in the Surround of an Estate) that he can, with an Instrument, obtain a *Close* within three Links; perhaps when he said so, he meant that one Error should compensate for, and close another; for do but ask any Instrument Practitioner what Allowance he makes, or how he accounts for Hills, Dales, &c. in protracting his Dimensions? He will immediately answer, That he subtracts some

Links

Links from those Stations taken thereon. Does not this Step plainly prove that his Proceedings are attended with random Guess-work? The honest Farmer, from the Gleanings of Experience in Cultivation only, can do no more than guess at the Quantity of an Inclosure.

Note, If the Sum of the Angles taken in the Surround of an Estate, be divided by the Number of Stations therein less by 2, and nothing remaining, proves the Angles exactly taken; but where is the Surveyor that can boast of such a Close, even upon an horizontal Plane? nevertheless, though such a Testimony in Practice did occur when the Dimensions are planned, the Surveyor *(according to the old Method)* must cast up or find the Contents thereof from the Plan by the Help of Scale and Compass; and then judge, kind Reader, at the Consequence of such boasted Exactness in the Field Notes, when the friendly Assistant *Estimation* must lend a helping Hand; therefore, from what hath been observed *with Regard to Instruments*, it is clearly manifest that Errors both in the Fields and Chamber, are most certain; however, as those pertaining to the Instrument *in the Fields* cannot be totally removed, let us endeavour to remove those of *the Chamber*.

Mr. *Henry Wilson*, in his Treatise intitled *Surveying Improved*, introduces a Method to find the Area of an Estate by the Pen, whose Dimensions were taken by an Instrument, by which Means the Errors of the Scale and Protractor are avoided; but his Method, *in my Opinion*, is rather too abstruse. Also, Mr. *Thomas Burgh* hath, upon the same Principles, discovered an universal Method of obtaining, by the Pen, the Area of an irregular Polygon, whose Sides and Angles were obtained by Chain and Instrument: His Method does great Honour to its Author; however, as there is Room for some additional Improvements therein, whereby the same may be more readily understood when applied to real Practice; I therefore shall beg Leave to recommend the same in this Place, with some necessary Alterations as will, I hope, render it more plain and easy, being performed entirely by the Pen, and consequently the *Chamber Errors* occasioned by the Scale and Protractor, are removed and exploded.

To effect this material Point, let us consider the Superficies of the terraqueous Globe, which (with regard to Surveying) may be reduced to two Heads, namely, regular and irregular Planes; and first of

Regular PLANES.

By the Definition of a regular Plane, may be understood a Plane Surface being poised or placed lower than the Eye, upon which all Right-lines measured thereon, are parallel to the Horizon; and upon this Plane, if a Person traversed the Universe, and at length returned to the identical Place departed from, it will readily be granted he must have travelled as many Leagues, Miles, or Poles, &c. southerly, as he did northerly; and as far easterly, as westerly; otherwise it would have been impossible for him to be at the Place from whence he departed. Yet, notwithstanding, when an Estate is surveyed by stationary Lines taken in the Surround thereof, there very frequently happens a Difference between the Northings and Southings, Eastings and Westings, which, to reconcile as near the Truth as possible, observe the following

Directions.

The Surveyor, with the Instrument, is supposed to begin on one Side of the Estate, and from thence, (as before observed) measures stationary Lines round the same: Directions for so doing will be met with in the following Examples.

Having found the Bearing and Distance of each stationary Line, your next Step will be to find the Difference of Latitude, and the Departure severally, by the following Tables, which being entered in peculiar Columns made not much unlike a traverse Table. *See the succeeding Examples.*

Cast up the Northings and Southings, Eastings and Westings, as they appear in their respective Columns, and compare the Northings with the Southings, Eastings with the Westings, which will most certainly disagree some Links; for it is unreasonable to expect those Columns to agree for the Reasons already given; however, if they differ only as many Links as there are

stationary

ſtationary Lines in the Survey, then you may conclude the Dimenſions were taken as accuratelyas poſſible; but if the Difference be 3 or more Links for every Station, then there is a Miſtake committed therein, and muſt be re-examined till you have obtained a Cloſe within a Link or two for each Station, which diſpoſe of thus:

Half the above-mentioned Difference being added to the leſſer, and taken from the greater, will cauſe the Columns to agree; for Inſtance, ſuppoſe 24 Stations in the Surround of an Eſtate, 12 of which were northerly, and the remaining 12 ſoutherly; admit then the Northings to exceed the Southings 18 Links, therefore 9 Links, (to wit, half the Difference) being taken from the Northings and added to the Southings, will make both equal.

But here note, The greateſt Difficulty lies in deducting and diſpoſing of the above-mentioned Difference, which may be effectually performed thus:

Firſt, When the oppoſite Angles in the Surround of an Eſtate be equally diſtanced from 90 Degrees, or nearly ſo, and the ſtationary Lines not very unequal, you may, in that Caſe, very ſafely diſtribute and deduct the above Differences equally amongſt the Stations; but here let me adviſe the young Learner, when there is not a Figure for every Station, as in the above, *viz.* 9 Links to be diſtributed equally amongſt 12; then let him make Choice of 9 of the longeſt Stations in both Columns, which he may increaſe and decreaſe 1 Link each, as above.

Secondly, When the oppoſite Angles are very unequal, to wit, ſome near, and others remote from 90, then add or ſubtract 2 Links (*inſtead of* 1) to or from the Difference of Latitude, &c. that ſubtends thoſe Bearings or Angles that are neareſt 90 Degrees; thus proceed until you have reconciled the above-mentioned Differences: In like Manner proceed with your Eaſtings and Weſtings.

And that no one may be doubtful concerning the Truth of this Method, with regard to adding and ſubtracting a Link or two, let us ſuppoſe A D and B C, *fig.* 11, two oppoſite Stations, and it be required to take 2 Links from B C, ſo that by adding them to A D, will cauſe no Miſtake.

DEMON-

Demonstration.

The Triangle *D f g*, is equal to the Triangle *g C e*, *by the 4th Prop. 1st Book of Euclid*: Hence the Area of the Figure *A B e f*, is equal to the Area of the Figure *A B C D*, therefore, by adding or ſubtracting a Link or two to, or from certain Differences of Latitude or Departures, will occaſion no Sort of Error Q. E D.

Irregular PLANES.

Nature hath given an ocular Type of ſuch Planes in every Country, and every Nation, and which are underſtood by the general Appellations of Mountains, Hills, and Dales; therefore when any ſuch occur or interpoſe in the Surround of an Eſtate, the Surveyor muſt proceed thereon as directed in Page 249, by which Means an horizontal Line may be procured, and alſo the Altitude or Depreſſion thereof, if required; but if great Care be not taken therein, either the Difference of Latitude, the Departure, or perhaps both, will greatly differ and diſagree.

For if the Hill's Direction be	Eaſt and Weſt,	the Northings and Southings,	will moſt certainly diſagree.
	North and South,	Eaſtings and Weſtings,	
	between Meridians and Parallels,	both Diff. Lat. & Depar.	

And in diſpoſing of thoſe Differences, proceed as directed in the preceding Page: But for the more effectual Comprehenſion of the foregoing Directions, obſerve the following

Definitions.

1. Every Tract of Land hath extreme Eaſt and Weſt, North and South Points.

2. The particular *Eaſting* or *Weſting*, is the Difference of Eaſting or Weſting between any Station and the next foregoing meaſured on a Parallel, *i. e.* the particular *Eaſting* of the Point C, *fig.* 13, is B C.

3. The

3. The abſolute *Eaſting* of any Station, is the Diſtance of that Station from the moſt weſterly Meridian counted on a Parallel; thus the abſolute *Eaſting* of the Point *b*, *fig*. 13, is *b D*.

4. The particular Northing or Southing of any Point or Station is the meridional Difference between that Station and the next preceding; namely, the particular *Northing* of the Point *e*, is *B E*; and of the Point *g*, is *g A*.

5. The abſolute *Northing* of any Station is the meridional Diſtance between that Station and the moſt ſouthern Parallel: Thus the abſolute *Northing* of the Point *c*, is *c m*; and of the Point *d*, is *d C*.

6. A *ſimple Figure* is that which proceeds from the extreme North Point *a*, to the extreme South Point *e*, by a ſoutherly Courſe, without any Change to the North; and from *e* returns again to *a* by a northerly Courſe, without any Change to the Southward.

Note, the Changes from Eaſt to Weſt, or from Weſt to Eaſt, are not here conſidered as a Prejudice to the Simplicity of the Figure.

7. A *complicated Figure* is that which alters the Direction of its Courſe from North to South, *ſee fig*. 14, between the extreme North, and the extreme South Points, and alſo between the Eaſt and Weſt Points; therefore the Alteration of the Courſe from North to South, and from Eaſt to Weſt, make this a complicated Figure.

8. The irregular Portions, or Parts *A a k i h g f M A*, and *a b c d L a*, are called *Excreſcences*.

Laſtly, A Figure is reckoned more or leſs complicated, when ſuch Excreſcences do more or leſs abound therein.

PROB.

PROBLEM I.

In any right-lined Figure, the Length of every Station, and alſo the Angles that are made by the Interſection of each Station with the Meridian being given, to find the particular Northing or Southing, Eaſting or Weſting of every Station, to wit, the Hypothenuſe and Angles being given, to find the Baſe and Perpendicular, *i. e.* the Departure and the Difference of Latitude.

The ANALOGIES

Founded on Problem I, *Caſe* 1, *plane Trigonometry.*

1. To find the Difference of Latitude, the Proportion is

As Radius is to the Diſtance chained, ſo is the Sine Complement of the Bearing, or given Angle, to the Difference of Latitude.

2. To find the Departure, the Proportion is

As Radius is to the Diſtance chained, ſo is the Sine of the Bearing to the Departure; that is, to the Eaſting or Weſting, according as the Angle varies from the Meridian of the next Station.

The Demonſtration of the above Analogies is evident; for in the right Angle Triangle *a m b*, *fig.* 13, the Side *a b* being given, and the Angle $L a b = a b m$, by 29 Prop. 1 Book of *Euclid*, the Baſe *a m*, or the particular Eaſting of the Point *b*, (*by Definition 2d*) is as the Sine of the given Angle *a b m*, and the Perpendicular *b m*, or the particular Northing of the Point *b*, by Definition 3d, is as the Co. Sine of the ſame given Angle, therefore, &c. Q, E, D.

PROB. II.

To find the extreme North and South Points of any right-lined Figure.

Take the meridional Difference between any two adjacent Stations, and write it down for the firſt Quantity, if it be Northing

ing with a positive Sign (provided the first Column in your Traverse Table be North) if Southing with a Negative.

1. If your first Quantity be a Positive, and the meridional Distance of the next Station be a Positive also, that is, both Quantities North, or both South; both East, or both West, enter their Sum for a second Quantity, with its proper Sign.

2. If the first Quantity be a Positive, and the second Negative, take the lesser Number from the greater, and enter the Remainder or Difference for a second Quantity, with the Sign of the greater.

3. In like Manner proceed through all your Stations, always remembering to add or subtract to or from the last sum entered, the meridional Difference of the next succeeding Station, to wit, Positives to Positives, Negatives to Negatives; subtract Negatives from Positives, and Positives from Negatives, namely, the Lesser taken from the Greater; the Difference being entered with the Sign of the Greater, from which is deduced the following

AXIOM.

When Quantities are alike, enter their Sum with its proper Sign, whether Positive or Negative; but if unlike, enter their Difference, with the Sign of the Greater.

Note, When there is no Sign prefixed to any Number, it is understood to be a positive Quantity.

<table>
<tr><td>4. Northings,
Southings,</td><td>} being Positives, {</td><td>the greatest of such positive Quantities, will be the meridional Distance between</td></tr>
</table>

the Point where you began to reckon, and the most { northern, / southern } Point.

<table>
<tr><td>5. Northings,
Southings,</td><td>} being Negatives, {</td><td>the greatest of such negative Quantities, will be the meridional Distance between</td></tr>
</table>

the Point where you began to reckon, and the most { northern, / southern, } Point.

So also of the Eastings and Westings.

6. When the Northings and Eastings are termed Positives, the Southings and Westings are Negatives, and on the contrary.

COROLLARY I.

Hence it follows that the greatest negative Quantity, but with a positive Sign, will be equal to the absolute Northing or Southing of the first Station; and being added to the greatest positive Quantity, the Sum will be equal to the Whole Meridian Line, that terminates the circumscribing Parallelogram.

COR. II.

The utmost East and West Points may be determined in like Manner, by collecting, at every Station, the Sum of the particular Eastings and Westings, but with contrary Signs, and consequently the Length of the Parallel between the extreme East and West Meridians may be found, and the circumscribing Parallelogram defined.

COR. III.

Hence the absolute Northing of every Station may be determined. To the absolute Northing of the first Station (found by *Cor.* III. of this *Problem*) add the meridional Difference between that and the next Station under its proper Sign; that is to say, add if it be Northing, and subtract if it be Southing, and the Sum or Difference, is the absolute Northing of the second Station. Proceed in like Manner through all the Stations, till the absolute Northing of every Station be obtained.

LEMMA.

The Area of the Trapezium *AabG*, is equal to the Rectangle comprehended under the Semi-sum of the parallel Sides *Aa*, *Gb*, and *AG*, the intermediate Distance, by Prop. V, Chap. IV, Page 117.

COR.

COR.

The Sides *A a*, and *C b*, are the absolute Northings of the two next adjacent Stations *a* and *b*, and *A C*, is the particular Easting or Westing between them; and therefore the Rect-angle made by the Semi-sum of the absolute Northings of the two next adjacent Stations, drawn into the particular Easting or Westing between them, is equal to the Area of such a Trapezium.

PROB. III.

To find the Area of any Right-lined Figure.

1. Let every particular Easting (*when Eastings are called Positives*) between two adjacent Stations, (*found by Prob.* I) be drawn into the Semi-sum of the absolute Northings (*found by Cor.* III, *Prob.* II,) of the same two Stations, and collect the Sum of such Rect-angles.

2. Let every particular Westing (*when Westings are called Negatives*) between two adjacent Stations, be drawn into the Semi-sum of the absolute Northings of the same Stations, and collect the Sum of such Rect-angles.

3. The Difference of these two Sums, is the Area sought.

DEMONSTRATION. Case 1.

Admit the Simple Figure (*fig.* 12, *Def.* 6,) *a b c d e f g h i k a*, be inscribed in a Parallelogram, whose Area is sought.

1. If from the Area of *A a b c d e f M A*, be taken the Area of *A a k i h g f M A*, the Remainder will be equal to the Area of the inscribed Figure.

2. But the Area of *A a b c d e f M A*, is equal to the Sum of all the Trapeziums, *i. e.* *A a b C* + *C b c D* + *D c d E* + *E d e I* + *I e f M* found (*by Cor. of Lem. in Prob.* II) by adding every two adjacent Stations together, and multiplying the several Sums by the absolute Northings or Eastings that respectively intercept the same.

 3. And

3. And the Area of *A a k i b g f M A*, is equal to the Sum of the Trapeziums and Triangles, to wit, *A a k b* + *B k i O* + *O i b* + *b g H* + *H g f M*, that is equal to the Sum of all the Trapeziums, &c. which are made by the particular Westings between every two adjacent Stations, drawn into the Semi-sum of the absolute Northings of the same two Stations.

4. This last Area being subducted from the former, the Remainder, or Difference, will be equal to the Area of the inscribed Figure, Q, E, D.

Case 2. *In the complicated Figure a b c d e f g h i k l m n a, fig.* 14.

1. The Area of the multilateral Figure *A a b c d e L A*, will be obtained by Article II, Case 1.

2. The Area *I f e L*, will also be found by Article III, Case 1, which is to be deducted.

3. The Area of *I f g h i k B I*, will be found by Article II, Case 1.

Lastly, The Area of *B k l m n a A B*, will be found by Article III, Case 1, which being taken from the Area of *A a b c d e f g h i k B A*, the Remainder will be the true Area sought.

Consequently the Area of the *Excrescence s d e f s*, is truly found, and likewise the Area of the whole Figure: And if a Figure had any Number of Excrescences, though ever so complicated, the Area thereof, as above, may be truly found. Hence the Area of any right-lined Figure will be obtained by the Pen several Ways.

1. For if from the Area of the compound Figure *a b c d e f M h i k a*, be taken the *Excrescence M f g h M*, there will remain the true Area of the Figure *a b c d e f g h i k a. See fig.* 12.

2. If from the *compound Figure a b c d e f g h A a*, be taken the *Excrescence A a k i h A*, there will remain the Area of *a b c d e f g h i k a*.

3. If

3. If from the Area of *N f g h i k a L N*, be taken the Area *L a b c d e f N L*, the Remainder will be the Area of *a b c d e f g h i k a*.

Laſtly, If from the Area of the Figure *M b i k a b c d N M*, be taken the Area *N d e f g h M N*, the Remainder will be the Area of *a b c d e f g h i k a*. Hence the Work will admit of Variety of Proofs.

SCHOLIUM.

Let a Sheet of Paper be ruled with ſeventeen Columns, and draw as many Lines acroſs the ſame with the Point of your Dividers, or with a Pencil, as there are Stations in the Survey. In the firſt Column, marked *Stat.* let the Stations be numbered regularly downwards 1, 2, 3, 4, *&c.* accounting that to be the firſt Station at which the Admeaſurement began.

In the ſecond Column, marked *Bearing*, write the Angle made at that Station, between the Line or Diſtance chained and the Meridian.

In the third, marked *Diſt.* enter the Side meaſured between the two Stations.

In the two ſucceeding Columns, marked *N*, *S*, enter the particular Northing or Southing, (found by *Prob.* I) and in the 11th and 12th Columns enter the Eaſting or Weſting, (found alſo by *Prob.* I) but ſo entered that the Difference of Latitude and Bearing found between the 1ſt and 2d Stations be wrote in a Line anſwering to the ſecond; and thoſe between the ſecond and third Stations anſwering to the third, and ſo on till you return to the firſt Station, where the Difference of Latitude and Departure will be thoſe found between the laſt Station and the firſt; for if the Courſe or Bearing be North Eaſt, the Northing and Eaſting found muſt belong to the latter, and not to the firſt Station.

When theſe Columns are compleated, if the Sums of the Columns *N* and *S* be equal, and alſo the Sums of the Columns *E* and

and *W*, then the Lines and Angles have been exhibited uncommonly exact; *but from what hath been already observed, this Exactness must never be expected in real Practice.*

The ſixth Column, marked *C*, is the *Criterion* by which the moſt ſoutherly Point of the Figure is determined, by *Prob.* II: And it is found thus: Let us ſuppoſe the firſt Station to be at *c*, then, in the ſecond Line anſwering to Station *d*, write the Difference of Latitude in *N*, or *S*, belonging to that Station, with a poſitive Sign if Northing, and Negative if Southing. Add to that the next Northing or Southing, with its proper Sign, and write the Sum in the next Line anſwering to Station *e*. Thus the Northing between *c* and *d*, is found to be *n d*, which is to be entered in the Column *C*, anſwering to *d*: The Southing between *d* and *e*, is found to be *d s*, therefore you are to write *n d*— *d s*, in the Column *C* anſwering to *e*; and ſo you are to proceed through all the Stations. Now the Lines *n d*, *d s*, *e t*, &c. being given (by *Prob.* I,) the greateſt of them having a negative Sign, anſwers to the moſt ſouthern Station (by *Prob.* II) Thus the greateſt Negative Line (as it may be called) is here found to be $dn - ds - et + wg - gH$, anſwering to the Station *h*, which therefore is the moſt Southern Point of the Figure.

The ſeventh Column marked *L*, ſhews the abſolute Northing of each Station: The abſolute Northing of the firſt Station *c*, is equal to the greateſt negative Line or Number in the Column *C*, but with a contrary Sign (by *Cor.* I, *Prob.* II): Therefore changing the Signs of the ſeveral Numbers which compoſe the greateſt negative Quantity in *C*, write or enter them down in Column *L*, anſwering to the Station *c*; thus $Hg - gw + te + ds - dn = Dc$. Add to that the Northing or Southing of the next Station, with its proper Sign, and write it down for the abſolute Northing of the next Station *d*, and ſo proceed.

The eighth Column marked *T*, ſhews the Sums of the abſolute Northings of every two adjacent Stations, and is formed by adding every two adjacent Perpendiculars or Quantities in *L* (as directed in Page 132) ſucceſſively, to wit, the 1ſt + 2d, the 2d + 3d, the 3d + 4th, &c.

The

The ninth Column, *T E*, ſhews the Rect-angles contained under each particular Eaſting, between two adjacent Stations, and the Sum of the two abſolute Northings of the ſame Stations, and is formed by multiplying each Quantity in *T*, into the reſpective Quantity lying in the ſame Line in *E*.

The tenth Column, *T W*, is formed in like Manner, by multiplying each Quantity in *T*, into its reſpective Quantity in *W*.

Thoſe Columns being thus formed, caſt up the ſeveral Products in Columns *T E* and *T W*; ſubtract the latter from the former, and half the Remainder is the Area. Q. E. D.

The thirteenth Column, marked *D*, is the *Criterion* by which the moſt Weſterly Point of the Figure is determined, and is formed out of the Columns *E* and *W*, in like Manner as the Column *C* was formed out of the Columns *N* and *S*.

The Columns *L* and *Z*, are formed as *L* and *T* were.

And laſtly, the Columns *Z N* and *Z S*, ſhew the Rect-angles contained under the particular Northing or Southing between any two adjacent Stations and the Sum of the two abſolute Eaſtings or Weſtings of the ſame Stations, and is formed by multiplying each Quantity in the Column *Z* into the reſpective Quantity lying in the ſame Line in the Columns *N* or *S*.

Theſe Columns being thus formed, caſt up the ſeveral Products in *Z N* and *Z S*; ſubtract the leſſer from the greater, and half the Remainder (if you have wrought true) will be the Area ſought, equal to the Area or Difference found between the Columns *T E* and *T W*, otherwiſe a Miſtake is committed, and muſt be found out by Re-examination.

Theſe Preliminaries being premiſed, point out and open an eaſy Road to real Practice, as will appear in the following Examples.

Example

Example I.

Admit *fig.* 14, to repreſent the Plan of an Eſtate whoſe Dimenſions were taken by an Inſtrument, as follow:

Directions how the following Dimenſions were taken in the Fields, both by the whole and quarter Card, or four Nineties.

1. Set up the Inſtrument at *a*, and having fixed the Index parallel to the Horizon, ſo that the Angle may be taken more accurately, turn it about till through the fixt Sights you eſpy the Mark ſet up at *b*, then ſee what Degree (in the Diviſion of the Box before ſpoken of) the Needle points to, which let be $303\frac{3}{4}$d, or, by the quarter Card, *NE* $56\frac{1}{4}$; then chain the ſtationary Line *a b* = equal 21 Chains, .62 Links, this being entered as follows.

2. Set the Inſtrument up at *b*, direct the Sights to a Mark which your Aſſiſtant ſet up at *c*, and ſee what Degree the Needle cuts, which ſuppoſe $333\frac{1}{2}$d: or, by the quarter Card, *NE* $26\frac{1}{2}$; then meaſure the Line *b c*, and make Entry thereof. Thus proceed with every Station, chaining every Line, and taking up every Angle, until you come to the Place where you began; then will your Dimenſions ſtand as follow; but be careful to take up the Off-ſets that occur upon each Station; Directions for ſo doing were given in Part the firſt.

The

The FIELD BOOK.

Stat.	Bearing.	Bear. prepared.	Distance. C. L.
1	303¾	N E 56¼	21.60
2	333½	N E 26½	13.44
3	251½	S E 71½	18.96
4	206½	S E 26½	13.44
5	108½	S W 71½	18.96
6	225	S E 45	8.47
7	243½	S E 63½	13.44
8	315	N E 45	8 47
9	206½	S E 26½	13.44
10	135	S W 45	8.47
11	116½	S W 63½	13.44
12	76	N W 76	27.73
13	36¾	N W 36¾	30.00

The Angles in the second and third Columns of the above Field Book, were pointed to by the Needle, and taken to a quarter of a Degree nearest to the Truth, the Instruments used for observing or taking Angles in the Field not being capable to take them to a greater Nicety; and for that Reason the Tables of Latitude and Departure in this Treatise are made to answer only to Degrees and Quarters; but observe in Practice, one of the above Columns respecting the Angles will be sufficient.

Note, The Surveyor might have begun his Dimensions at any other Place, and might also have left the Land to be surveyed on the Left-hand instead of the Right; but then he must have turned the Flower de Luce (as heretofore observed) before; otherwise when the Land to be measured be left on the Right-hand, if the Surveyor chuses he may go before, and take up the Bearing of each Station by Back-sights, as they are called.

Note also, All the Off-sets or Insets that are taken in the Survey must be cast up by the Pen, as you were taught in Part the first.

The Dimenſions being obtained, the next Step will be to prepare Columns whereby the ſame may be caſt up by the Pen ſeveral Ways, all agreeing, two of which are given in this Example; but becauſe the young Practitioner may not readily comprehend this *Method*, and as this Treatiſe is chiefly intended to free the Practice of Inſtruments, *at leaſt*, from the *Errors of the Scale and Protractor*, the following Table of Columns for determining the Content of this Figure, is a Precedent or Model for any Figure whatſoever; and therefore by explaining how the ſeveral Columns therein are filled up, the young Surveyor will readily perceive, and learn how to compoſe Columns for the Dimenſions of any other Survey.

Fig. 14. Suppoſe then the firſt Station to be *a*, the ſecond *b*, and ſo on; and let the Angles and Sides, according to the Field Book, be as in the ſecond and third Columns following.

The Angle at *a*, made by the Meridian *D a*, and the Side *a b*, is 56 $\frac{1}{4}$ Degrees N. E. and the Side *a b*, 21 Chains, 60 Links.

To find the Eaſting, make this Analogy, *by Prob.* I.

As Radius is to the Diſtance chained = 21 Chains, 60 Links, ſo is the Sine of the Bearing 56 $\frac{1}{4}$ d to the Eaſting = 17.999 = 18 nearly.

The Eaſting 18 thus found, write it in the Column *E*, againſt *b*, the ſecond Station; though if it was wrote or entered in a Range with *a*, the firſt Station to which it belongs, it would occaſion no Miſtake in the Reſult.

To find the Northing, make this Analogy or Proportion, *by Prob.* I.

As Radius is to the Diſtance chained 21.60, ſo is : Co-Sine of the Bearing = 33 $\frac{3}{4}$ d to the Northing = 12.00026, or 12 Chains, which Northing 12 enter in the Colomn *N*, anſwering to *b*, the ſecond Station: In the ſame Manner the four Columns *N S E W* might be compleated; but the Trouble of multiplying the given Side between every two Stations into the Sine and

and Co-Sine of the Angle or Bearing, will be avoided by the Tables of Latitude and Departure before mentioned.

When the Columns *N S E W*, are compleated, caſt up the Figures in the Columns *N* and *S*, and alſo thoſe in the Columns *E* and *W*. Now if the Amount of the Column *N*, be equal to the Column *S*, and likewiſe the Columns *E* and *W* equal, then the Sides and Angles have been exhibited uncommonly exact; *but from what hath been already obſerved, this Exactneſs muſt never be expected in real Practice.*

The ſixth Column *C*, is the Criterion by which the moſt ſouthern Point of the Figure is determined, and is thus formed.

Take the Northing of *b*, the ſecond Station, and enter it in the Column *c*, in a Line with *b*; the next Station *c* having alſo a northern Bearing 12, add that to the laſt Number entered in *C*, which gives the Number 24 to be placed in Column *C*, in a Line with *c*; the ſucceeding Station *d* having a Southing 6 Chains, it is to be taken from the laſt Number 24, and leaves 18 to be wrote in *C*, in a Line with *d*. Thus proceed, adding the Northing, and ſubtracting the Southing of each ſucceeding Station to or from the Number laſt ſet down in the Column *C*, and ſo go on till you come to the Station *f*, where 0 is entered againſt it in the Column *C*, which ſhews that this Station hath no Difference of Northing or Southing from the Point *a*, but lies in the ſame Parallel of Latitude. The Station from *f* to *g* having a Southing 6, it muſt be entered in *C* as a negative Quantity thus, — 6, and in a Range with *g*, the next Station *h* having alſo a Southing — 6, which being added to — 6, the laſt Number placed in *C*, the Sum is — 12, to be entered in *C*, in a Line with *h*; and in this Manner fill up the Column *C*, ſo that if the laſt Number entered in the Column *C* be equal to the Number 24 omitted in the firſt Station, you may then conclude that your Proceedings ſo far have been truly exhibited, otherwiſe not.

The Column *L* is thus formed; look in the Column *C* for the greateſt Number with a negative Sign, which appears to be — 30 ſtanding againſt the Station *m*, which ſhews that *m* is the moſt

 ſouthern

The Column *T E*, is formed, as already said, by multiplying every Number in *T*, by the Number lying in the Line with it in the Column *E*.

The Column *T W* is formed by multiplying every Number in *T*, by the Number in *W*, lying in the same Line. When these Columns are thus formed, cast up severally the Products in the Columns *T E* and *T W*; subtract the latter from the former, and the Remainder will be half square Chains, which being multiplied by 8, as heretofore taught, gives the Content of the Survey in square Perches.

The Columns *D*, *L*, *Z*, are formed out of the Columns *E* and *W*, in like Manner as *C*, *L*, *T*, were formed out of the Columns *N* and S: But *here note*, when there is no negative Quantity or Number in the Columns *C* or *D*, as above, enter a Cypher in the Column *L*, in a Range with *a*, and then the succeeding Numbers in *L*, will be the same with those in *D*.

The Column *N Z* is formed by multiplying every Number in *N*, by the Number in Z lying in the same Line; and the Column *S Z*, is formed by multiplying every Number in *S* by the Number in Z lying in the same Line. These Columns being compleated, cast up the several Products in *N Z* and *S Z*, and take the lesser from the greater: If the Remainder be equal to the Difference between the Columns *T E* and *T W*, all your Proceedings are justly exhibited; otherwise if they disagree, a Mistake is committed in the Work, and must be discovered by examining the Whole.

Example II.

Admit *fig.* 1, *plate* 5, to represent an Estate, and it be required to survey the same by the Help of an Instrument.

The Field Proceedings of this Example, are performed as directed in the foregoing one, with this additional Difference, to wit, the Off-sets upon each stationary Line, together with the Bearing of all the Hedges that are met with and crossed in the Surround thereof are entered, as appears in the Dimensions.

In

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planning
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B.

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0
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C.

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2,0
,00

Bearing and
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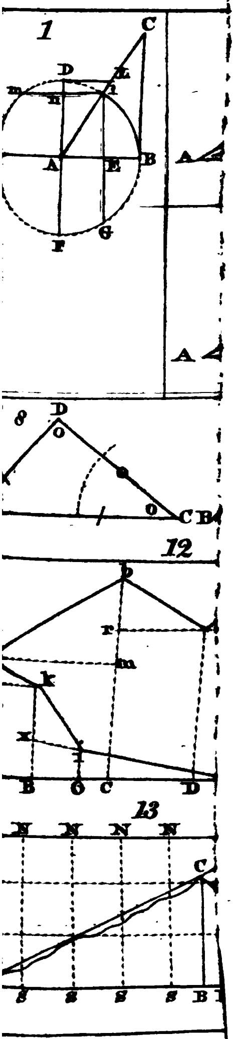
as.

Field

IV.



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In a large Survey the Dimenſions of the Boundaries ſo taken when protracted, will greatly aſſiſt the young Tyro in planning the Dimenſions of the inner Cloſes, which are taken up by the Chain, as directed in Part the firſt.

Dimenſions.

	Bearing.	Diſtance.
	Degrees.	C. L.
1	$324\frac{3}{4}$	11,12
2	270	12,05
3	180	16,60
4	$129\frac{3}{4}$	10,96
5	$34\frac{3}{4}$	17,66

1ſt Stat. Off. A B.

Hedge bears 267.

$127\frac{1}{2}$

0 ——— ——— ——— 0
4,0 ——— ——— ——— 1,20
7,3 ——— ——— ——— 1,0
11,20 ——— ——— ——— 00

2d Stat. Off. B C.

$15\frac{1}{4}$

0 ——— ——— ,08
5,70 ✝ h 150 d.
12,10 ——— ——— ——— ,08

3d Stat. Off. C E.

$412\frac{1}{2}$

0,——————— 0
8,10 ✝ h 98 d ,10
13,40——————— 4,40
16,60 ——— ——— ——— 4 0

4th Stat. Off. E F.

$231\frac{3}{4}$

0 — — — — — 0
2,0 ——————— 1,0
2,10 ——— ——— 3,0
10,96 ——— ——— ,10

5th Stat. Off. F A.

523.

0 ——— ——— ——— 0
2,50 ——— ——— 1,80
7,60 ✝ h 285 ——— ,60
9,20 ——— — ——— 3,50
16,40 ——— ——— 2,0
17,66 ——— ——— ,00

Before the above Dimenſions (with regard to the Bearing and Diſtance) can be caſt up, they muſt be reduced to a quarter Card, as already directed, then will the Field Book ſtand thus.

Field

	Field Book.		Diff. Lat.		Departure.		Preparative Columns.			Rect-angles.	
Stat	Bearing.	Distance	N	S	E	W	D'	L	Z	Z N	Z S
1	N E $34\frac{1}{2}$	11,12	9,09	—	6,42	—	—	6,42	6,42	58,3578	—
2	E - -	12,05	—	—	12,05	—	12,05	18,47	24,89	—	—
3	S - -	16,60	—	16,60	—	—	12,05	18,47	36,94	—	613,240
4	S W $50\frac{1}{4}$	10,96	—	7,0	—	8,41	3,64	10,06	28,53	—	199,710
5	N W $34\frac{3}{4}$	17,66	14,51	—	—	10,06	6 ,42	0	10,06	145,9706	—
			23,60	23,60	18,47	18,47				204,3284	812,950 204,3284

The Area in half square Chains — — — 608,6216

The Area of the Off-set on the 1 Station — — — 15,96
2 — — — 19,36
3 — — 51,54
4 — — — 28,98
5 — — — 65,42

772,4576

Having, as before directed, found the Difference of Latitude and Departure (by the Help of the following Tables) of each Station, enter the fame (as directed in the foregoing Example) in the Columns N, S, E, W; then blank the firft Column *D*, and enter 12 Chains, 5 Links, in a Range with the fecond Column, which call a pofitive Quantity, the third Station having no Departure, re-enter the laft Number in *C*, *viz.* 12,05, becaufe there is nothing to be added to or taken therefrom. The Departure of the 4th Station 8 Chains, 41 Links, being a Wefting or a negative Quantity, muft be taken from 12 05, and the Remainder = 3.64 entered in *D*, in a Range with the 4th Station. The Departure of the 5th and laft Station being a Wefting alfo = 10 Chains 6 Links, the laft Number 3.64 entered in *D* being lefs, muft be taken therefrom, and the Remainder 6.42 entered in *D*, in a Range with the laft Station, as a Negative, which compleats the Column *D*: Now as the laft Number in *D* is the fame with that omitted in the firft Line in Column *E*, proves that all the Proceedings in the Column *D* are truly exhibited. The Columns *L* and *Z* are filled up and compleated in like Manner as the Columns *L* and *Z* were in the foregoing Example: And laftly, the Columns *Z N*, and *Z S*, are formed out of *N S* and Z, to wit, by multiplying every Number in the Column *Z* by its refpective Number in *N* and *S*, the feveral Products being placed accordingly in *Z N*, or *Z S*, and refpectively collected as before, their Difference is the Area of *A B C E F A* in half fquare Chains, *viz.* 608.6216, equal to 30 Acres, 1 Rood, $29\frac{1}{2}$ Perches, to which add the Area of the Off-fets taken upon each ftationary Line, *viz.* 8 Acres, $29\frac{3}{4}$ Perches, and the Sum will be 38 Acres, 2 Roods, $19\frac{1}{4}$ Perches, equal to the true Area fought.

The Dimenfions of this Survey were protracted from a Scale of 10 Chains to an Inch, according to the Directions given in Page 271; which when done, thofe Off-fets that were taken up in each Station feverally being laid down as heretofore directed, together with the Bearing of the Hedges therein croffed or met with, being laid down alfo as they appear in the Field Notes, then is the Plan finifhed.

Now if any Practitioner chuses to protract the foregoing Dimensions, or any other from ever so many Scales, and afterwards measure the Plan by Scale and Dividers, according to that universal Method of reducing them severally into Triangles and Trapeziums, by the Help of random balancing Lines, he'll find the Content of each Plan to differ more or less from the Truth, and then, if not before, the Invaluableness of this *Method* will appear. Yet, notwithstanding, when the many Inconveniencies are considered that pertain to Instruments in practical Surveys, and compared with the Truth, Expedition, and Correctness of the Chain alone in Practice, (as appears in Part the first) it will readily be granted that the Chain, as observed in the Introduction, very justly claims and merits the Preference to a great Degree; therefore well might Mr. *John Love*, in his Treatise, with great Propriety and Justice, say, *What Need is there of a Horse Load of Brass Circles, and Semi-circles, heavy Ball Sockets, Wooden Tables and Frames, and three-legged Staffs,* cum multis aliis, *unless to amuse the ignorant Countryman to make him more freely pay the Surveyor. See the Appendix in* Love's *Survey, Page* 7.

CHAP.

CHAP. IV.

Containeth several useful Things relating to Surveying, necessary to be understood by all those who are desirous to become accomplished Surveyors.

SECTION I.

To reduce a large Plan into a lesser Compass, according to any given Proportion; and, on the contrary, how to enlarge one.

THERE are contracting Dividers, and also Machines lately invented for this Purpose, but it may be as effectually performed by Parallels, thus: Encompass the Plan with one large Square, (*see plate* 5, *fig.* 2,) and afterwards divide that into as many little Squares as you shall see convenient: Also make the same Number of little Squares upon a fair Piece of Paper, according to the Proportion given: (*see fig.* 3, *plate* 5,) This done, see in what Square, and Part of the same Square, the Lines or any remarkable Incidents lie, and accordingly trace off, or draw the same with a black Lead Pencil in the lesser Squares, the Squares in both Plans being numbered alike with 1, 2, 3, &c. This cannot be better explained than by comparing the abovementioned Figures, to wit, the 2d *and* 3d *fig. plate* 5, wherein the Plan *A B C D E F A*, is laid down by a Scale of 40 Poles to an Inch, and is reduced into the Plan *G H I K L M G*, equal to 16 Poles to an Inch; which is compleated by drawing every Line or Incident that appears in each Square of the first Plan, in the same Squares of the smaller Plan; the Situation of the Lines, &c. with regard to the corresponding ones in each Plan, will direct you to proceed by imitating in the lesser every Line, Turn, Incident, and Accident that appears in the greater.

 But

But if the Plan be too small, as if you were to enlarge the Figure *G H I K L M G*, in that Case proceed as before directed, by imitating all the Turns, Incidents, and Lines in the large Plan that are in the lesser. Many other Methods of reducing Plans might here be given, but they would serve rather to amuse than edify; for to know one Method well, in this Case, will be sufficient for any Practitioner.

SECT. II.

To turn or Change one Measure into another.

R U L E.

Say as the square Yards that are in the Pole or Perch of any given Measure, are to the Content in that Measure, so is the square Yards in the Pole or Perch of any other Measure to the Content thereof.

Example I.

Admit it were required to know how many Plantation Acres there are in 20 Statute Acres? Answer, 12 A. 1 R. 14 P.

Say as 30.25 : 20 : : 49
20

		A.	R.	P.
49)605.00(12.34	=	12	1	14

49
115
98
17

Example. II.

Admit a Field measured 11 Acres and a Half Statute Measure, and it were required to know how many Acres are therein of *Lancashire* Measure.

Note,

Note, In *Lancashire* they uſe two cuſtomary Meaſures, *viz.* 64 ſquare Yards in a Perch (or Rood as they call it) of their large Meaſure, the ſame as in *Cheshire*, and 56 $\frac{1}{4}$ in a Perch of their leſſer Meaſure.

```
                  ſq.Yds.   A.   ſq.Yds.
First, Say, As 30.25 : 11.2 : : 64
                       30.25
                       -----
                         560
                        224
                      3360
                      ------
              64)338.800(5.29 Acres large Meaſure.
                 320
                 ---
                 188
                 128
                 ---
                 600
                 576
                 ---
                  24, &c.

Secondly, As 30.25 : 11.2 : : 56.25
                     30.25
                     -----
                       560
                      224
                    3360
                    ------                A. R. P.
           56.25) 338.800 ( 6.023 = 6  0  3½ leſſer Meaſure.
                  33750        4
                  -----     ----
                  13000     .092
                  11250       40
                  -----     ----
                  17500    3.680
                  16875
                  -----
                    625
```

Example

Example III.

I demand how many Statute Acres are in 10 Plantations Acres? Answer, 16 A. $31\frac{1}{2}$ Perches. Thus the Learner may change any Measure whatsoever into any other, as proposed.

Example IV.

To know the Scale that any Plan was laid down by, when the Quantity of any Inclosure therein be known.

First measure the Inclosure (whose Quantity is known) by the Help of any Scale of equal Parts, *as the Chain cannot be used thereon*, and then say,

As the Content found, is to the Square of the Scale you made Use of, so is the true Content to the Square of the true Scale which the Plan was laid down by, the Root whereof is the Answer sought.

Admit the Plan or Map of an Estate be returned wherein no Scale appears; and suppose you measured one Field therein by a Scale of 44 Poles, or 11 Chains to an Inch, by which you found it to contain 24 Acres, 32 Perches, which, by the Return in the Map, appears to be no more than 20 Acres.

```
                              11                   20
                              11                    4
                     P.      ----      P.          ---
24  0  32   Say, as 3872 : 121 : : 3200            80
 4                          3200                   40
---                        -----                  -----
96                         24200                  3200
40                         363
----                       -----
3872              3872)387200(100 the square Root
                       3872     whereof is 10, the Ans.
                       ----     that is, the true Scale
                         00     by which the Plan was
                                laid down is 10 Chains
                                to an Inch.
```

Now

Now if the Learner should think the foregoing Examples too few, he may set himself Examples until he becomes ready therein.

SECT III.

To find the Altitude and the Base, or horizontal Line of an Hill by the Help of an Instrument.

Mr. *John Love* says, when you measure a Hill, you must measure the Superficies or Surface thereof, and accordingly cast up the Contents: But when you plot it down, because you cannot make a convex Superficies upon the Paper, you must only plot the horizontal or base Line thereof, which you must shadow over with the Resemblance of an Hill, that other Surveyors, when they apply your Scale thereto, may not say you were mistaken.

The horizontal or base Line of a Hill, is found by Trigonometry, to wit, the Altitude being taken by a Quadrant, or other Instrument, and the Slant or Hypothenuse Line by the Chain.

Example.

Suppose *ACDBA*, *fig.* 4, *plate* 5, to represent an Hill whose Base is sought; set up your Instrument at *A*, and cause a Mark to be set up at *C* as high above the Top of the Hill, as the Instrument is above the Ground at *A*; then fixing or making your Instrument horizontal, take the Altitude of the Point *C*, to wit, the Angle $BAC = 58$ Degrees; measure the slant Distance between *A* and $C =$ equal 16 Chains, 80 Links, then say,

As Radius : *AC* : : S, *BCA* : *AB*, or Part of the Base *AD*
C. L. C. L.
S, 90 : 16.80 : : S, 32 : 8.90.

Being on the Hill at *C*, take the Depression of the Valley on the other Side thereof, to wit, the Angle made by the vertical Line *BC*, and the Hill Side *CD*, which suppose 46 Degrees; measure also the Distance $CD = 21$ Chains, and say, As Radius : C D : : S, D C B : B D, the remaining Part of the Base. C. L.

S, 90 : 21 : : S, 46 d : 15.11,

Which 15.11, added to 8.90, make 24 Chains 1 Link, for the whole Base *A D*, which is to be plotted, and not *A C* and *C D*, although they are to be measured when the superficial Content of the Land is required.

Note, When the Surveyor ends on the Side of a Hill, he needs only account for the base Line thereof so far, when he comes to plan the Dimensions.

Note also, If a Church, Gentleman's Seat, or any remarkable Object appears at some small Distance, and it be desired to shew the same in the Map, (though this is seldom done) you may, by your Instrument, or Chain, take the Bearing thereof from any Station contiguous thereto; and when you have gone a competent Distance from that Station, so as to have considerably altered the Bearing of the Church, Seat, &c. then take a second Bearing thereof; and when you come to plan your Dimensions, these two Bearings being laid down, will cross or intersect in the Place where the Object stood.

SECT IV.

Of LEVELLING.

To know whether Water may be made to run from a Spring-head to any Place appointed, though at a considerable Distance.

' Being provided with a Spirit, or Water Level, which may ' be had at most Mathematical-Instrument-Makers, and also two ' Poles about 8 or 10 Feet long, divided into Feet, Inches, and ' Parts, having a small circular Board, &c. (about 4 Inches Dia- ' meter) so fixt on each Pole or Staff, so that it may be shifted ' down or up at Pleasure; then, by the Help of two Assistants, ' *viz.* one for each Staff, after having fastened some white ' Paper on the above-mentioned small Boards, with a black Line ' drawn across the Middle thereof, to which your Observation

hath

'hath Respect: Then make for the Spring head, and there 'cause your first Assistant to fix his Staff perpendicular; direct 'the other to go about 100 or 200 Yards (as you shall find most 'convenient) towards the Place designed for bringing the Water 'to; there let him stand and hold his Staff perpendicular also; 'then set your Instruments about Mid-way between them, mak-'ing it stand level, that is, horizontal; look through the Sights 'thereof to your first Assistant's Staff, he moving the above-'mentioned white Paper up and down the Staff according to the 'Signs you make to him, till, through the Sights, you espy the 'black Line on the Paper; then, by a Sign, make him to un-'derstand that you have done with him; and let him write 'down how many Feet, Inches, and Parts the Paper rested 'upon: Also, going to the other End of your Level, do the 'same by the second Assistant, and let him write down also 'what Number of Feet, &c. the Paper was from the Ground. 'This done, let your first Assistant come to the second Assis-'tant's Place, and there let him again stand with the Staff; and 'let the second Assistant go forward 100 or 200 Yards, as be-'fore, and placing yourself and Instrument in the Midst between 'them, take your Observations altogether as before, and let them 'put them down in the like Manner: And so must you do till 'you come to the Place whereto the Water is to be conveyed; 'then examine the Notes of both your Assistants, and if the 'Notes of the second Assistant exceed that of the first, you may 'be sure the Place is lower than the Spring-head, and that there-'fore Water may be well conveyed; but if the First's Notes 'exceeds the Second's, you may conclude it impossible without 'Engines, or the like.

The first Assistant's Notes.

Stat.	Ft.	In.	Parts.
'01	4	3	5
'02	12	4	2
'03	3	5	1
	20	0	8

The second Assistant's Notes.

Stat.	Ft.	Inch,	Parts.
01	14	5	1
02	4	6	3
03	9	9	4
	28	1	8

'Here you may see the second Assistant's Notes exceed the 'first 8 Feet, 1 Inch, which is enough to bring the Water with 'a strong Current, and to make it also rise up 6 or 7 Feet in 'the House, if Occasion be; for such as have written of this 'Matter allow but 4 Inches and half Fall in a Mile, to make 'the Water run.

SECT. V.

Of such Colours as perhaps some may chuse to wash or shade their Maps with, and how to prepare the same.

This Section is partly an Extract of what Mr. *Henry Wilson* relates upon the Subject, who not only describes the several Colours, but also gives an Account of the proper Liquids to mix them with, which renders them both transparent and durable; so that Lines, Trees, Edifices, or whatsoever else is necessary, and that may be thought ornamental to a Map, may be drawn on Paper without injuring or sinking therein, so as not to destroy the original Beauty of the Paper or Colours: And these Waters are made as follow:

To make ALLUM WATER.

Take a Pound of Allum and beat it to Powder, then put it into a Gallon of Water, and boil it till the Allum be melted, and when cold, put it in a Vessel for Use.

Note, *If you wet your Paper with it before you lay the Colours on, it will not only keep them from sinking into it, but also add a Lustre and Beauty to them when laid on.*

To make GUM-WATER.

Take a Quantity of the whitest and clearest Gum-Arabic, and bruise it into small Pieces; then put them into a fine Linen Rag, and hang the same in clean Water till it be dissolved, then put your Fingers into the Water and try its Stiffness, for if it feel too glutinous add Water, but otherwise add more of the Gum at your Discretion.

Note, *You temper most of your Colours with this Water.*

The

The Names of COLOURS *proper to wash and adorn Maps*, &c.

GREENS.

Verdigreaſe, Sap-green, Verditer, Bice.

YELLOWS.

Saffron, Yellow-berries, Maſticot, Gambogia.

BLUES.

Ultramarine is the beſt Blue, Indigo, Logwood, Bice, Verditer, Litmoſe.

BLACKS.

Lamp-black, Printers-black, *Indian* Ink, burnt Shavings of Ivory or Hartſhorn, &c.

WHITES.

White-lead in Flakes.

BROWNS.

Soot of Wood, Rinds of Walnuts, *Spaniſh* Brown, and Umber.

REDS.

Carmine is the beſt, *Indian* Cakes, Vermilion, Red-lead, Roſſet, Turnſoil, Brazil, Scarlet, Flocks, Lake, *&c.*

Now as theſe Colours (according to their Nature) are to be ground, waſhed, ſteeped, or diſſolved, boiled, or perhaps burnt before they are ground, here follow the various Methods of ordering them:

To grind a Colour.

Put the Colour on the Grinding-ſtone, and break it pretty ſmall with your Muller, if it be in Lumps, and pour a little Water at a Time to it, as Occaſion requires, and ſo grind it with your Muller till it be very fine, and then put it into any thing, and when dry reſerve it for Uſe.

Note, *The Colours that want grinding, are Vermilion, Lake, Indigo, White-lead, and Masticot.*

To wash Colours.

Put the Colour and some clean Water into a Bason, often stirring it together; then let the Colour settle, and pour the Water off, and put in some more clean, doing as before; so repeating the Method till the Water you pour off has nothing of Filth swimming at the Top. Now, before you take the Colour out of the Bason, daub it thin about its Sides, and as it dries some will drop down, though what at last sticks to the Sides, is the better Colour; all which Things put on a Sheet of Paper, the better still to dry it, and it is done.

Note, *The Colours to be washed, are Red-lead, Bice, Rosset, Verditer, and* Spanish *Brown.*

To steep Colours.

Is to dissolve them in Liquor either hot or cold; and the Colours to be dissolved in cold Liquors are Litmose, Saffron, Yellow-berries, Sap-green, *Indian* Cakes, and Gambogia; but the Colours to be steeped or boiled, are Rinds of Walnuts, *French* Verdigrease, Turnsoil, Brazil, Logwood, and Wood Soot.

Note, *Colours steeped in hot Liquors, are to be kept close in Glasses.*

To burn Colours.

Put your Colour and Water into a Crucible, and cover the Crucible with Clay, setting it into a hot Place of the Fire till it be red, then take it out of the Fire, and the Colour out of the Crucible when it is cold, and it is fit to grind.

Note, *Colours requiring burning, are Lamp-black, Hartshorn,* Spanish *Brown, Ivory, Printers Black, Umber, and other gross ones.*

To temper Colours.

Put your Colour into a deep Shell, and some Gum-water to it, which will soon mollify it, and with your Finger do the

Colour

Colour againſt the Shell till all the Knots be diſſolved; then with your Pencil ſtroke the Colour from the Side of the Shell to the Bottom and it is done; only obſerving if it be be too thick, to add more of the Gum-water to it.

Note, *Waſhed Colours are thus to be tempered, but as to ſteeped ones the Liquor of them is only to be uſed.*

The ordering each Colour, without Commixture, to the beſt Advantage.

REDS.

Vermilion, if ground and tempered with weak Gum-water, gives a deep Red, or Scarlet Colour.

Roſſet, waſhed and tempered with Gum-water, is at firſt almoſt like Lake, though ſubject to fading; but tempered with Brazil-water, it will be of a deep Colour.

Carmine, tempered with Gum-water, not ſtiff, gives the beſt of Reds.

Lake, ground or tempered with Gum-water, is a deep Pink, or bloom Colour.

Red-lead waſhed, is a Colour betwen a Red and an Orange.

Turnſoil, put into Vinegar, with ſome Gum-water, over a Chafing-diſh, and well ſqueezed in the Liquor, will give a good Colour for ſhadowing any Yellow with.

Indian-cake, thus managed, is a good tranſparent Red.

Brazil, the Filings or Raſping, in Vinegar and ſmall Beer, in an earthen Veſſel, with Powder of Allum boiled to heighten the Colour, gives a light Violet Colour.

Note, *After you have ſtrained it off, it is proper to add a little Gum-Arabic to it.*

Scarlet-flocks, boiled gently in Water about five Hours, putting in a Spoonful of Soap-lees, gives a tranſparent Red or Scarlet Colo[illegible]

GREENS.

Verditer, washed and tempered with Gum-water, makes no transparent Green; but half a Pound of *French* Verdigrease, with an Ounce of Argol boiled in a Quart of Water, makes a good transparent Green, inclined to a Blue.

Note, *This Colour requires about five Hours gentle boiling, and when it is done, it must stand a considerable Time settling, that you may pour the Clear from it.*

Bice, washed and tempered with Gum-water, makes a good Green, though not transparent.

Sap-green, steeped in Water, with a little Allum powdered, is a green to shadow with.

YELLOWS.

Saffron, steeped at Night in Water, makes an excellent clear Gold Colour.

Yellow-berries, steeped in Allum-water, is a transparent Yellow.

Masticot, ground and tempered with Gum-water, is a good, though no transparent Yellow.

Gambooge, with Water only, does at last make the best and most transparent Yellow.

BLUES.

Ultramarine, tempered with weak Gum-water, is the best Blue.

Indigo, tempered and ground with Gum-water, is a deep Blue, and fit to shadow Blues with.

Logwood, managed as Brazil, (which see among the Reds) is a very good Purple.

Bice, washed and tempered with Gum-water, is a good Blue, though not transparent, of which there are several Sorts, lighter or darker.

Verditer,

Verditer ſo managed, is a good Blue, but not tranſparent.

Litmoſe, cut into ſmall Slices, and ſteeped in weak Water (made of Gum-black) a Day or more, is a tranſparent Blue.

BLACKS.

Lamp-black, Printers Black, Ivory and Hartſhorn Shavings, burnt, ground, and tempered with Gum-water, are all good Blacks.

Indian-Ink, ground and tempered with a weak Gum-water, is the beſt Black to ſhadow deeper Blacks with.

WHITES.

White-lead, ground and tempered with Gum-water, is the beſt White.

Wood ſoot, or Rinds of Wall-nuts, boiled in Water and ſtrained, with ſome Gum-water to it, either of them is a good Colour to diſtinguiſh Roads, &c. by.

Umber burnt, ground, and tempered with Gum-water, is a good Straw Colour, and looks well on Gold.

Spaniſh-brown ſo ordered, makes a good Liver Colour.

Now, as theſe Colours are in all Reſpects ſufficient in themſelves to beautify any Draught, I ſhall only inſtance how they may be made ſadder or lighter, by mixing thoſe of different Kinds together, as Greens with Yellows, &c. for though the Colours mentioned be ſufficient, yet it may be requiſite it ſhould be paler or ſadder; therefore, as to a Green, Verdigreaſe Water, and Yellow-berry Water, according as they are mixed, make a lighter or darker Green; and, as being tranſparent, is a Colour better for this Uſe.

And you may obſerve alſo, that a different Colour may be produced by mixing different Colours together; as a deep Green may be made of Litmoſe and Yellow-berry Water mixed together, *viz.* a Blue and a Yellow, &c.

Knowing

Knowing how to make a Colour lighter or sadder, you are able to make Colours proper to shadow with, as light Colours are always shadowed with sadder of the same Nature, *viz.* lighter Greens with deeper, &c. as for Instance observe:

Verdigrease may be shadowed with Indigo, and Yellow-Berry Water, mixed together.

Gambooge and Yellow-Berries may be shadowed with Umber, mixed with Red-Lead or Vermilion.

Verditer and Bice with Indigo.

Spanish-Brown may be shadowed with burnt Umber, and Brazil-Water, mixed together.

Wood-Soot and Walnuts with burnt Umber, &c.

Which is obvious to any that can rightly distinguish Colours singly of themselves, and have a Notion of producing others by co-mixing those of different Kinds, &c. as I have already instanced, having your Colours ready for shadowing, and all in Order to lay them on your Draught, it is pre-supposed you are stocked with Pencils, so as to have Pencils of different Sizes for each Colour, to prevent the Trouble of frequently cleansing them (in Water with a Linen Rag) as you see Occasion to use different Colours for one Use or another.

Chuse Pencils by their Fulness of Hair next the Quill, which ought gradually to lessen to the End in a Point, as you may try by drawing it through your Lips.

Now, as to the actual laying on the Colour: Suppose you had the Plan of a Survey only in its Lines, and would lay the Colour about a Field in it; dip your Pencil into the Colour, and draw it along of an equal Breadth about the Field, in the Inside thereof, broader or narrower, as the Field is more or less in Quantity; then just wet your Pencil in Water, and pencil off by Degrees what you before did, towards the middle of the Field; only, *Note*, You are to pencil off only from the Inside of the colour'd Breadth; for by this Means the Colour from the Outside of the Field will seem by Degrees to vanish, and to look the more beautiful to the Eye. And, when Landskips are divided into several Tenures or great Estates so divided, 'tis proper

per in one intire Colour to ſtrike out each Parcel, and a different Colour to each Parcel is needful: And it is adviſeable that every adjacent Field ſhould be bounded with a Colour ſomewhat different, which muſt be referred to the Judgment of the Artiſt, as the colouring of Maps is not always for Ornament only. So much concerning Colours, however, before the young Surveyor uſes them to Maps, &c. let him conſult what is delivered in Page 240 upon that Head.

The Use *of the following* TABLES.

THEY ſhew, by Inſpection, the Alteration of Latitude and Departure, to every Degree and Quarter of a Degree on the Compaſs, and that for any Diſtance, not exceeding 1000 Chains.

In the uppermoſt Rank of every Diviſion are placed the ſeveral Angles, and their Complements, to 45 Degrees, including the Quarter, Half, and three Quarters of each Degree, and in the Left Hand Column, are the Lengths of the meaſured or ſtationary Lines of the Field Works, and in the common Areas are the Difference of Latitude and Departure. By the Table thus formed, no more is requiſite to find the Alteration of Latitude and Departure, but to ſeek for the Angle in the Head Column, and the Length of the Line in the Side Column, and the Requiſites appear in the common Areas: The Tables are ſo order'd that the Latitude is always under the given Angle, the Departure under its Complement.

An Example or two will make the Matter plain and eaſy.

Suppoſe the Angle to be *N. E.* $27\frac{1}{2}$ Degrees, and the ſtationary Line of the Field meaſured 6 Chains, and it be required to find the Northing and Eaſting of that Station. I find in the Tables under $27\frac{1}{2}$ Degrees, and anſwering to 6 in the Left Hand Column, the Number in the common Area 5.3221, which ſhews the Northing, and under $62\frac{1}{2}$ (which is the Complement to that Angle) anſwering the ſame Number in the Side Column, I find 2.7705, which ſhews the Eaſting of that Station.

If the Angle be the ſame, and the Line be 60 Chains, it is but removing the Decimal Point one Place backwarder in the former Anſwers, ſo that in this Caſe the Northing would be, 53.221, which is 53 Chains, 22 Links, and $\frac{1}{10}$ of a Link, and the Eaſting would be 27.705, which is 27 Chains, 70 Links and a half. In like Manner, if the Line was 600 Chains, and the Angle remaining the ſame, the Northing would be 532 Chains, 21 Links, and the Eaſting 277 Chains .05 Links.

If the meaſured Line doth not conſiſt of an exact Number of Tens, as ſuppoſe its Length to be 75 Chains 34 Links; then the proper Requiſites may be thus found: The Angle is ſuppoſed to be 27½ Degrees, and the ſtationary Line 75 Chains, 34 Links.

In the TABLE under 27½ Degrees, I find the Northings of the following Numbers to be,

For 70 Chains ——	62.091
For 5 Chains ——	4.435
For 30 Links ——	0.266
For 4 Links ——	0.035
The Northing of 75.34 —	66.827

In the TABLE under 62½ Degrees, the Complement to 27½, I find the Eaſtings of the following Numbers,

For 70 Chains ——	32.322
For 5 Chains ——	2.308
For 30 Links ——	0.138
For 4 Links ——	0.018
The Eaſting of 75.34 —	34.786

TABLES

TABLES of Latitude and Departure.

	N. S.	E. W.	N S	E W	N S	E W	N S	E W
			0 ¼	89 ¾	0 ½	89 ½	0 ¾	89 ¼
1	—	—	0.9999	0.0043	0.9999	0.0087	0.9999	0.0131
2	—	—	1.9999	0.0087	1.9999	0.0174	1.9998	0.0262
3	—	—	2.9999	0.0131	2.9998	0.0261	2.9997	0.0392
4	—	—	3.9999	0.0174	3.9998	0.0349	3.9996	0.0523
5	—	—	4.9999	0.0218	4.9998	0.0436	4.9995	0.0654
6	—	—	5.9999	0.0262	5.9997	0.0523	5.9994	0.0785
7	—	—	6.9999	0.0305	6.9997	0.0611	6.9993	0.0916
8	—	—	7.9999	0.0349	7.9997	0.0718	7.9992	0.1047
9	—	—	8.9999	0.0393	8.9996	0.0785	8.9991	0.1178
	1	89.	1 ¼	88 ¾	1 ½	88 ½	1 ¾	88 ¼
1	0.9998	0.0174	0.9997	0.0218	0.9996	0.0262	0.9995	0.0305
2	1.9997	0.0349	1.9995	0.0436	1.9993	0.0523	1.9990	0.0610
3	2.9995	0.0523	2.9993	0.0654	2.9989	0.0785	2.9986	0.0916
4	3.9994	0.0698	3.9990	0.0872	3.9986	0.1047	3.9981	0.1221
5	4.9992	0.0872	4.9988	0.1090	4.9982	0.1309	4.9976	0.1527
6	5.9991	0.1047	5.9985	0.1309	5.9979	0.1570	5.9972	0.1832
7	6.9989	0.1221	6.9983	0.1527	6.9976	0.1832	6.9967	0.2137
8	7.9988	0.1396	7.9981	0.1745	7.9972	0.2094	7.9962	0.2443
9	8.9986	0.1570	8.9978	0.1963	8.9969	0.2356	8.9958	0.2748
	2	88.	2 ¼	87 ¾	2 ½	87 ½	2 ¾	87 ¼
1	0.9994	0.0349	0.9992	0.0392	0.9990	0.0436	0.9988	0.0479
2	1.9987	0.0698	1.9984	0.0785	1.9981	0.0872	1.9977	0.0969
3	2.9981	0.1047	2.9977	0.1178	2.9971	0.1308	2.9965	0.1439
4	3.9975	0.1396	3.9969	0.1570	3.9962	0.1745	3.9954	0.1919
5	4.9969	0.1745	4.9961	0.1963	4.9952	0.2181	4.9942	0.2399
6	5.9963	0.2094	5.9954	0.2355	5.9943	0.2617	5.9931	0.2878
7	6.9957	0.2443	6.9946	0.2748	6.9933	0.3053	6.9919	0.3358
8	7.9951	0.2792	7.9938	0.3141	7.9924	0.3489	7.9908	0.3838
9	8.9945	0.3141	8.9930	0.3533	8.9914	0.3926	8.9896	0.4318
	3	87.	3 ¼	86 ¾	3 ½	86 ½	3 ¾	86 ¼
	0.9986	0.0523	0.9984	0.0567	0.9981	0.0610	0.9978	0.0654
	1.9973	0.1047	1.9968	0.1134	1.9963	0.1221	1.9957	0.1308
	2.9959	0.1570	2.9952	0.1701	2.9944	0.1831	2.9936	0.1962
	3.9945	0.2093	3.9935	0.2268	3.9925	0.2442	3.9914	0.2616
	4.9931	0.2617	4.9919	0.2835	4.9907	0.3052	4.9893	0.3270
	5.9918	0.3140	5.9903	0.3402	5.9888	0.3663	5.9871	0.3924
	6.9904	0.3664	6.9888	0.3968	6.9869	0.4273	6.9850	0.4578
	7.9890	0.4187	7.9871	0.4535	7.9851	0.4884	7.9829	0.5232
	8.9877	0.4710	8.9855	0.5102	8.9832	0.5494	8.9807	0.5886
	E. W.	N S	E W	N S	E W	N S	E W	N S

TABLES

TABLES of LATITUDE and DEPARTURE.

	N S	E W	N S	E W	N S	E W	N S	E
	4	86.	4 ¼	85 ¾	4 ½	85 ½	4 ¾	85
1	0.9976	0.0697	0.9972	0.0741	0.9969	0.0784	0.9965	0,08
2	1.9951	0.1395	1.9944	0.1482	1.9938	0.1569	1.9931	0,16
3	2.9927	0.2093	2.9916	0.2223	2.9907	0.2354	2.9897	0,24
4	3.9902	0.2790	3.9888	0.2964	3.9877	0.3138	3.9863	0,33
5	4.9878	0.3488	4.9862	0.3705	4.9846	0.3923	4.9828	0,41
6	5.9855	0.4185	5.9835	0.4446	5.9815	0.4707	5.9794	0,49
7	6.9829	0.4883	6.9807	0.5187	6.9784	0.5492	6.9759	0,57
8	7.9805	0.5580	7.9780	0.5928	7.9753	0.6277	7.9725	0,66
9	8.9780	0.6278	8.9752	0.6670	8.9722	0.7061	8.9691	0,74
	5	85	5 ¼	84 ¾	5 ½	84 ½	5 ¾	84
1	0.9961	0.0871	0.9958	0.0915	0.9954	0.0958	0.9949	0,10
2	1.9923	0.1743	1.9916	0.1830	1.9908	0.1917	1.9899	0,20
3	2.9884	0.2615	2.9874	0.2745	2.9862	0.2875	2.9849	0,30
4	3.9846	0.3486	3.9832	0.3660	3.9816	0.3834	3.9799	0,40
5	4.9808	0.4358	4.9790	0.4575	4.9770	0.4792	4.9748	0,50
6	5.9769	0.5229	5.9748	0.5490	5.9724	0.5751	5.9698	0,60
7	6.9731	0.6101	6.9706	0.6405	6.9678	0.6709	6.9648	0,70
8	7.9692	0.6972	7.9664	0.7320	7.9632	0.7668	7.9597	0,80
9	8.9654	0.7844	8.9622	0.8235	8.9586	0.8626	8.9547	0,90
	6	84	6 ¼	83 ¾	6 ½	83 ½	6 ¾	83
1	0.9945	0.1045	0.9940	0.1088	0.9935	0.1132	0.9930	0,11
2	1.9890	0.2090	1.9881	0.2177	1.9871	0.2264	1.9861	0,23
3	2.9836	0.3136	2.9821	0.3266	2.9807	0.3396	2.9792	0,35
4	3.9781	0.4181	3.9762	0.4355	3.9743	0.4528	3.9723	0,47
5	4.9726	0.5226	4.9703	0.5443	4.9678	0.5660	4.9653	0,58
6	5.9671	0.6272	5.9643	0.6532	5.9614	0.6792	5.9584	0,70
7	6.9617	0.7317	6.9584	0.7621	6.9559	0.7924	6.9515	0,82
8	7.9562	0.8362	7.9524	0.8709	7.9486	0.9056	7.9445	0,94
9	8.9507	0.9408	8.9465	0.9798	8.9421	1.0188	8.9376	1,05
	7	83	7 ¼	82 ¾	7 ½	82 ½	7 ¾	82
1	0.9925	0.1218	0.9920	0.1262	0.9914	0.1305	0.9908	0,13
2	1.9851	0.2437	1.9840	0.2524	1.9829	0.2610	1.9817	0,26
3	2.9776	0.3656	2.9760	0.3786	2.9743	0.3916	2.9726	0,41
4	3.9702	0.4874	3.9680	0.5048	3.9657	0.5221	3.9635	0,53
5	4.9627	0.6093	4.9600	0.6310	4.9572	0.6526	4.9543	0,67
6	5.9553	0.7312	5.9520	0.7572	5.9487	0.7831	5.9452	0,80
7	6.9478	0.8531	6.9440	0.8834	6.9401	0.9137	6.9361	0,94
8	7.9404	0.9750	7.9360	1.0096	7.9315	1.0442	7.9269	1,07
9	8.9320	1.0968	8.9280	1.1358	8.9230	1.1747	8.9178	1,21
	E W	N S	E W	N S	E W	N S	E W	N

TABL

TABLES of LATITUDE and DEPARTURE.

	N S	E W	N S	E W	N S	E W	N S	E W
	8	82	8 ¼	81 ¾	8 ½	81 ½	8 ¾	81 ¼
1	0,9902	0,1391	0,9896	0,1435	0,9890	0,1478	0,9883	0,1521
2	1,9805	0,2783	1,9793	0,2870	1,9780	0,2956	1,9767	0,3042
3	2,9708	0,4175	2,9689	0,4305	2,9670	0,4434	2,9651	0,4564
4	3,9611	0,5567	3,9586	0,5740	3,9560	0,5912	3,9534	0,6085
5	4,9513	0,6959	4,9483	0,7175	4,9451	0,7390	4,9418	0,7606
6	5,9416	0,8350	5,9379	0,8605	5,9341	0,8868	5,9302	0,9127
7	6,9319	0,9742	6,9276	1,0044	6,9231	1,0347	6,9185	1,0649
8	7,9221	1,1134	7,9172	1,1479	7,9121	1,1825	7,9069	1,2170
9	8,9124	1,2526	8,9069	1,2914	8,9011	1,3303	8,8952	1,3691
	9	81	9 ¼	80 ¾	9 ½	80 ½	9 ¾	80 ¼
1	0,9877	0,1564	0,9870	0,1607	0,9863	0,1650	0,9855	0,1693
2	1,9754	0,3129	1,9740	0,3215	1,9726	0,3301	1,9711	0,3387
3	2,9631	0,4693	2,9610	0,4822	2,9589	0,4951	2,9566	0,5080
4	3,9508	0,6257	3,9480	0,6430	3,9451	0,6602	3,9422	0,6774
5	4,9384	0,7822	4,9350	0,8037	4,9314	0,8252	4,9278	0,8467
6	5,9261	0,9386	5,9220	0,9644	5,9177	0,9903	5,9133	1,1061
7	6,9138	1,0950	6,8090	1,1252	6,9040	1,1553	6,8989	1,1854
8	7,9015	1,2515	7,8960	1,2859	7,8903	1,3204	7,8844	1,3548
9	8,8892	1,4079	8,8830	1,4467	8,8766	1,4854	8,8700	1,5241
	10	80	10 ¼	79 ¾	10 ½	79 ½	10 ¾	79 ¼
1	0,9848	0,1736	0,9840	0,1779	0,9832	0,1822	0,9824	0,1865
2	1,9696	0,3473	1,9681	0,3559	1,9665	0,3645	1,9649	0,3730
3	2,9544	0,5209	2,9521	0,5338	2,9497	0,5467	2,9473	0,5595
4	3,9392	0,6946	3,9362	0,7118	3,9330	0,7289	3,9298	0,7460
5	4,9240	0,8682	4,9202	0,8897	4,9163	0,9112	4,9123	0,9325
6	5,9088	1,0419	5,9042	1,0676	5,8995	1,0933	5,8947	1,1190
7	6,8937	1,2155	6,8883	1,2456	6,8828	1,2756	6,8772	1,3055
8	7,8785	1,3892	7,8723	1,4235	7,8660	1,4579	7,8596	1,4920
9	8,8633	1,5628	8,8564	1,6015	8,8493	1,6401	8,8421	1,6758
	11	79	11 ¼	78 ¾	11 ½	78 ½	11 ¾	78 ¼
1	0,9816	0,1908	0,9808	0,1951	0,9799	0,1993	0,9790	0,2036
2	1,9633	0,3816	1,9616	0,3902	1,9598	0,3987	1,9581	0,4073
3	2,9449	0,5724	2,9422	0,5853	2,9398	0,5981	2,9371	0,6109
4	3,9265	0,7632	3,9231	0,7804	3,9197	0,7975	3,9162	0,8145
5	4,9081	0,9540	4,9039	0,9755	4,8996	0,9968	4,8952	1,0182
6	5,8898	1,1449	5,8847	1,1705	5,8796	1,1962	5,8743	1,2218
7	6,8714	1,3357	6,8655	1,3656	6,8595	1,3956	6,8533	1,4255
8	7,8530	1,5265	7,8463	1,5607	7,8394	1,5949	7,8324	1,6291
9	8,8346	1,7173	8,8271	1,7558	8,8193	1,7943	8,8114	1,8327
	E W	N S	E W	N S	E W	N S	E W	N S

TABLES of LATITUDE and DEPARTURE.

	N S	E W	N S	E W	N S	E W	N S	E W
	12	78	12 ¼	77 ¾	12 ½	77 ½	12 ¾	77 ¼
1	0,9781	0,2079	0,9772	0,2122	0,9763	0,2164	0,9753	0,2207
2	1,9563	0,4158	1,9544	0,4244	1,9526	0,4329	1,9507	0,4414
3	2,9344	0,6237	2,9317	0,6365	2,9289	0,6493	2,9260	0,6621
4	3,9126	0,8316	3,9089	0,8487	3,9052	0,8657	3,9014	0,8828
5	4,8907	1,0396	4,8861	1,0609	4,8815	1,0822	4,8767	1,1035
6	5,8689	1,2475	5,8634	1,2730	5,8578	1,2986	5,8520	1,3242
7	6,8470	1,4554	6,8406	1,4852	6,8341	1,5151	6,8274	1,5449
8	7,8252	1,6633	7,8178	1,6974	7,8104	1,7315	7,8027	1,7656
9	8,8033	1,8712	8,7951	1,9096	8,7867	1,9479	8,7781	1,9863
	13	77	13 ¼	76 ¾	13 ½	76 ½	13 ¾	76 ¼
1	0,9744	0,2249	0,9734	0,2292	0,9724	0,2334	0,9713	0,2377
2	1,9487	0,4499	1,9467	0,4584	1,9447	0,4669	1,9427	0,4754
3	2,9231	0,6749	2,9201	0,6876	2,9171	0,7003	2,9140	0,7131
4	3,8975	0,8998	3,8934	0,9168	3,8895	0,9338	3,8854	0,9507
5	4,8718	1,1248	4,8669	1,1460	4,8619	1,1672	4,8567	1,1884
6	5,8462	1,3497	5,8403	1,3752	5,8343	1,4007	5,8280	1,4261
7	6,8206	1,5746	6,8136	1,6044	6,8067	1,6341	6,7994	1,6638
8	7,7950	1,7996	7,7870	1,8336	7,7790	1,8676	7,7707	1,9015
9	8,7693	2,0246	8,7604	2,0628	8,7515	2,1010	8,7421	2,1392
	14	76	14 ¼	75 ¾	14 ½	75 ½	14 ¾	75 ¼
1	0,9703	0,2419	0,9692	0,2461	0,9681	0,2504	0,9670	0,2545
2	1,9406	0,4838	1,9385	0,4923	1,9363	0,5008	1,9341	0,5092
3	2,9109	0,7258	2,9077	0,7385	2,9044	0,7511	2,9011	0,7638
4	3,8812	0,9677	3,8769	0,9846	3,8726	0,8014	3,8682	1,0184
5	4,8515	1,2096	4,8461	1,2308	4,8407	1,2519	4,8352	1,2730
6	5,8218	1,4515	5,8154	1,4769	5,8089	1,5023	5,8023	1,5276
7	6,7921	1,6935	6,7846	1,7231	6,7770	1,7527	6,7693	1,7822
8	7,7624	1,9354	7·7538	1,9692	7,7452	2,0030	7,7364	2,0368
9	8,7327	2,1773	8,7231	2,2154	8,7133	2,2534	8,7034	2,2914
	15	75	15 ¼	74 ¾	15 ½	74 ½	15 ¾	74 ¼
1	0,9659	0,2588	0,9648	0,2630	0,9636	0,2672	0,9624	0,2714
2	1,9319	0,5176	1,9296	0,5261	1,9273	0,5345	1,9249	0,5429
3	2,8978	0,7765	2,8944	0,7891	2,8909	0,8017	2,8874	0,8143
4	3,8637	1,0353	3,8591	1,0521	3,8545	1,0689	3,8498	1,0858
5	4,8296	1,2941	4,8239	1,3152	4,8182	1,3362	4,8123	1,3572
6	5,7956	1,5529	5,7887	1,5782	5,7818	1,6034	5,7747	1,6286
7	6,7615	1,8117	6,7535	1,8412	6,7454	1,8707	6,7372	1,9001
8	7,7274	2,0706	7,7183	2,1042	7,7090	2,1379	7,6996	2,1715
9	8,6933	2,3294	8,6831	2,3673	8,6727	2,4051	8,6621	2,2430
	E W	N S	E W	N S	E W	N S	E W	N S

TABLES of LATITUDE and DEPARTURE.

	16	74	16 ¼	73 ¾	16 ½	73 ½	16 ¾	73 ¼
1	0.9612	0.2756	0.9600	0.2789	0.9588	0.2840	0.9575	0,2882
2	1.9225	0.5513	1.9201	0.5596	1.9176	0.5680	1.9151	0,5764
3	2.8838	0.8269	2.8801	0.8395	2.8765	0.8520	2.8727	0,8646
4	3.8450	1.1025	3.8402	1.1193	3.8353	1.1361	3.8303	1,1528
5	4.8063	1.3782	4.8002	1.3991	4.7941	1.4201	4.7878	1,4410
6	5.7676	1.6538	5.7603	1.6790	5.7525	1.7041	5.7454	1,7292
7	6.7288	1.9295	6.7203	1.9588	6.7117	1.9881	6.7030	2,0174
8	7.6901	2.2051	7.6804	2.2386	7.6705	2.2721	7.6606	2,3056
9	8.6513	2.4807	8.4404	2.5185	8.6294	2.5561	8.6181	2,5938
	17	73	17 ¼	72 ¾	17 ½	72 ½	17 ¾	72 ¼
1	0.9563	0.2924	0.9550	0.2965	0.9537	0.3007	0.9523	0,3048
2	1.9126	0.5847	1.9100	0.5931	1.9074	0.6014	1.9048	0,6097
3	2.8689	0.8771	2.8651	0.8896	2.8611	0.9021	2.8572	0,9146
4	3.8252	1.1695	3.8201	1.1862	3.8149	1.2028	3.8096	1,2195
5	4.7815	1.4619	4.7751	1.4827	4.7686	1.5035	4.7620	1,5243
6	5.7378	1.7542	5.7301	1.7792	5.7223	1.8042	5.7144	1,8292
7	6.6941	2.0466	6.6851	2.0758	6.6760	2.1049	6.6668	2,1340
8	7.6504	2.3390	7.6402	2.3727	7.6297	2.4056	7.6192	2,4389
9	8.6067	2.6313	8.5952	2.6689	8.5834	2.7063	8.5716	2,7438
	18	72	18 ¼	71 ¾	81 ½	71 ½	18 ¾	71 ¼
1	0.9510	0.3090	0.9497	0.3131	0.9483	0.3173	0.9469	0,3214
2	1.9021	0.6180	1.8994	0.6263	1.8966	0.6346	1.8939	0,6429
3	2.8532	0.9271	2.8491	0.9395	2.8450	0.9519	2.8408	0,9643
4	3.8042	1.2361	3.7988	1.2527	3.7933	1.2692	3.7877	1,2857
5	4.7553	1.5451	4.7485	1.5658	4.7416	1.5865	4.7346	1,6072
6	5.7063	1.8541	5.6982	1.8790	5.6899	1.9038	5.6816	1,9286
7	6.6574	2.1631	6.6479	2.1921	6.6383	2.2211	6.6285	2,2501
8	7.6084	2.4721	7.5976	2.5053	7.5866	2.5384	7.5754	2,5715
9	8.5595	2.7812	8.5473	2.8185	8.5349	2.8557	8.5224	2,8929
	19	71	19 ¼	70 ¾	19 ½	70 ½	19 ¾	70 ¼
1	0.9455	0.3255	0.9441	0.3297	0.9426	0.3338	0.9412	0,3379
2	1.8910	0.6511	1.8882	0.6594	1.8853	0.6676	1.8823	0,6758
3	2.8366	0.9767	2.8323	0.9891	2.8279	1.0014	2.8235	1,0137
4	3.7821	1.3023	3.7764	1.3188	3.7706	1.3352	3.7647	1,3517
5	4.7276	1.6278	4.7204	1.6484	4.7132	1.6690	4.7059	1,6896
6	5.6731	1.9534	5.6645	1.9781	5.6558	2.0028	5.6471	2,0275
7	6.6186	2.2790	6.6086	2.3078	6.5985	2.3366	6.5882	2,3654
8	7.5641	2.6045	7.5527	2.6375	7.5411	2.6705	7.5294	2,7033
9	8.5097	2.9301	8.4968	2.9672	8.4838	3.0043	8.4706	3,0412
	E W	N S	E W	N S	E W	N S	E W	N S

TABLES of LATITUDE and DEPARTURE.

	N S	E W	N S	E W	N S	E W	N S	E W
	20	70	20 ¼	69 ¾	20 ½	69 ½	20 ¾	69 ¼
1	0.9397	0.3420	0.9382	0.3461	0.9366	0.3502	0.9351	0.3543
2	1.8794	0.6840	1.8764	0.6922	1.8733	0.7004	1.8703	0.7086
3	2.8191	1.0261	2.8146	1.0383	2.8100	1.0506	2.8054	1.0629
4	3.7588	1.3681	3.7528	1.3845	3.7467	1.4008	3.7405	1.4172
5	4.6985	1.7101	4.6910	1.7306	4.6834	1.7510	4.6757	1.7715
6	5.6381	2.0521	5.6291	2.0767	5.6200	2.1012	5.6108	2.1257
7	6.5778	2.3941	6.5673	2.4228	6.5567	2.4514	6.5459	2.4800
8	7.5175	2.7362	7.5055	2.7689	7.4934	2.8016	7.4811	2.8343
9	8.4572	3.0782	8.4435	3.1150	8.4300	3.1519	8.4162	3.1886
	21	69	21 ¼	68 ¾	21 ½	68 ½	21 ¾	68 ¼
1	0.9336	0.3583	0.9320	0.3624	0.9304	0.3665	0.9288	0.3705
2	1.8672	0.7169	1.8640	0.7249	1.8608	0.7330	1.8576	0.7411
3	2.8007	1.0751	2.7960	1.0873	2.7913	1.0995	2.7864	1.1117
4	3.7344	1.4335	3.7280	1.4497	3.7217	1.4660	3.7152	1.4822
5	4.6079	1.7918	4.6600	1.8122	4.6521	1.8325	4.6440	1.8528
6	5.9015	2.1502	5.5920	2.1746	5.5825	2.1990	5.5729	2.2233
7	6.5351	2.5086	6.5240	2.5371	6.5129	2.5655	6.5017	2.5939
8	7.4686	2.8669	7.4560	2.8995	7.4433	2.9320	7.4395	2.9644
9	8.4022	3.2253	8.3880	3.2619	8.3738	3.2985	8.3593	3.3350
	22	68	22 ¼	67 ¾	22 ½	67 ½	22 ¾	67 ¼
1	0.9272	0.3746	0.9252	0.3780	0.9239	0.3827	0.9222	0.3867
2	1.8544	0.7492	1.8511	0.7573	1.8478	0.7654	1.8444	0.7734
3	2.7816	1.1238	2.7766	1.1359	2.7716	1.1480	2.7666	1.1601
4	3.7087	1.4984	3.7022	1.5146	3.6955	1.5307	3.6888	1.5468
5	4.6359	1.8730	4.6277	1.8932	4.6194	1.9134	4.6110	1.9335
6	5.5631	2.2476	5.5532	2.2719	5.5433	2.2961	5.5332	2.3202
7	6.4903	2.6222	6.4788	2.6505	6.4671	2.6788	6.4554	2.7069
8	7.4175	2.9968	7.4043	3.0292	7.3910	3.0615	7.3776	3.0936
9	8.3447	3.3715	8.3299	3.4078	8.3149	3.4441	8.2998	3.4803
	23	67	23 ¼	66 ¾	23 ½	66 ½	23 ¾	66 ¼
1	0.9205	0.3907	0.9188	0.3947	0.9170	0.3987	0.9153	0.4027
2	1.8410	0.7815	1.8376	0.7895	1.8340	0.7975	1.8306	0.8055
3	2.7615	1.1722	2.7564	1.1842	2.7512	1.1962	2.7459	1.2082
4	3.6820	1.5629	3.6752	1.5790	3.6682	1.5950	3.6612	1.6110
5	4.6025	1.9537	4.5939	1.9737	4.5853	1.9937	4.5766	2.0137
6	5.5230	2.3444	5.5127	2.3685	5.5024	2.3925	5.4919	2.4165
7	6.4435	2.7351	6.4315	2.7632	6.4194	2.7912	6.4072	2.8192
8	7.3640	3.1258	7.3503	3.1579	7.3365	3.1900	7.3225	3.2220
9	8.2845	3.5166	8.2691	3.5527	8.2535	3.5887	8.2378	3.6247
	E W	E W	E W					

TABLES

TABLES of LATITUDE and DEPARTURE.

	N S	E W	N S	E W	N S	E W	N S	E W
	24	66	24 1/4	65 3/4	24 1/2	65 1/2	24 3/4	65 1/4
1	0,9135	0,4067	0,9117	0,4107	0,9099	0,4147	0,9081	0,4186
2	1,8277	0,8135	1,8235	0,8214	1,8199	0,8294	1,8163	0,8373
3	2,7406	1,2202	2,7353	1,2322	2,7299	1,2441	2,7244	1,2560
4	3,6542	1,6264	3.6470	1,6429	3,6398	1.6588	3,6326	1,6746
5	4,5677	2,0337	4.5588	2,0536	4,5498	2,0735	4,5407	2,0933
6	5,4813	2,4404	5.4706	2,4643	5,4598	2,4882	5,4489	2,5122
7	6,3948	2,8472	6,3823	2,8750	6,3697	2,9029	6,3570	2,9306
8	7,3084	3,2539	7,2941	3,2857	7,2797	3,3175	7,2651	3,3493
9	8,2219	3,6606	8,2058	3,6965	8,1896	3,7322	8,1733	3,7679
	25	65	25 1/4	64 3/4	25 1/2	64 1/2	25 3/4	64 1/4
1	0,9063	0,4226	0,9044	0,4265	0,9026	0,4305	0,9007	0,4344
2	1,8126	0,8452	1,8089	0,8531	1,8052	0,8610	1,8014	0,8688
3	2,7189	1.2679	2,7134	1,2797	2,7077	1,2915	2,7021	1,3032
4	3,6252	1,6905	3,6178	1,7063	3,6103	1,7220	3,6028	1,7376
5	4,5315	2,1131	4,5223	2,1328	4,5129	2,1525	4,5035	2,1720
6	5,4378	2,5357	5,4267	2,5594	5,4155	2,5831	5,4042	2,6064
7	6,3442	2,9583	6,3312	2,9860	6,3181	3,0136	6,3049	3,0408
8	7,2505	3,3809	7,2356	3,4125	7,2207	3,4441	7,2056	3,4752
9	8,1568	3,8036	8,1401	3,8391	8,1233	3,8746	8,1063	3,9096
	26	64	26 1/4	63 3/4	26 1/2	63 1/2	26 3/4	63 1/4
1	0,8988	0,4384	0,8969	0,4423	0,8949	0,4462	0,8930	0,4501
2	1,7976	0,8767	1,7939	0,8846	1,7899	0,8924	1,7859	0,9002
3	2,6964	1,3151	2,6908	1,3269	2,6848	1,3386	2,6789	1,3503
4	3,5952	1,7535	3,5875	1,7692	3,5797	1,7848	3,5719	1,8004
5	4,4940	2,1919	4,4843	2,2115	4,4746	2,2310	4,4649	2,2505
6	5,3928	2,6302	5,3812	2,6537	5,3696	2,6772	5,3579	2,7006
7	6,2916	3,0686	6,2781	3,0960	6,2645	3,1234	6,2508	3,1507
8	7,1904	3,5070	7,1750	3.5383	7,1594	3,5696	7,1438	4,6008
9	8,0891	3.9453	8,0718	3,9806	8,0544	4,0158	8,0368	4,0509
	27	63	27 1/4	62 3/4	27 1/2	62 1/2	27 3/4	62 1/4
1	0,8910	0,4540	0,8890	0,4578	0,8870	0,4617	0,8850	0,4656
2	1,7820	0,9080	1,7780	0,9157	1,7740	0,9235	1,7700	0,9312
3	2,6730	1,3620	2,6670	1,3736	2,6610	1,3852	2,6550	1,3968
4	3,5640	1,8160	3,5561	1,8315	3,5480	1,8470	3,5400	1,8624
5	4,4550	2,2699	4,4451	2,2894	4,4350	2,3087	4,4250	2,3281
6	5,3460	2,7239	5,3341	2,7472	5,3220	2,7705	5,3099	2,7937
7	6,2370	3,1779	6,2231	3,2051	6,2091	3,2322	6,1949	3,2591
8	7,1280	3,6319	7,1121	3,6630	7,0961	3,6940	7,0799	3,7249
9	8,0191	4,0859	8,0011	4,1209	7,9831	4,1557	7,9649	4,7905

TABLES of LATITUDE and DEPARTURE.

	N S	E W	N S	E W	N S	E W	N S	E W
	28	62	28 ¼	61 ¾	28 ½	61 ½	28 ¾	61 ¼
1	0,8829	0,4694	0,8809	0,4733	0,8788	0,4771	0,8767	0,4810
2	1,7659	0,9389	1,7618	0,9466	1,7576	0,9543	1,7534	0,9620
3	2,6488	1,4084	2,6427	1,4199	2,6364	1,4315	2,6302	1,4430
4	3,5318	1,8779	3,5236	1,8933	3,5153	1,9086	3,5069	1,9239
5	4.4147	2,3474	4,4045	2,3666	4,3941	2,3858	4,3836	2,4049
6	5,2977	2,8168	5,2853	2,8399	5,2729	2,8629	5,2604	2,8859
7	6,1806	3,2863	6,1662	3,3132	6,1517	3,3401	6,1371	3,3669
8	7,0636	3,7558	7,0472	3,7866	7,0305	3,8173	7,0138	3,8479
9	7,9465	4.2252	7,9280	4,2599	7,9093	4,2944	7,8905	4,3289
	29	61	29 ¼	60 ¾	29 ½	60 ½	29 ¾	60 ¼
1	0,8746	0,4848	0,8725	0,4886	0,8703	0,4924	0,8682	0,4962
2	1,7492	0,9696	1,7450	0,9772	1,7407	0,9848	1,7364	0,9924
3	2,6239	1,4544	2,6175	1,4659	2,6111	1,4773	2,6046	1,4886
4	3,4985	1,9392	3,4900	1,9545	3,4814	1,9697	3,4728	1,9849
5	4.3731	2,4240	4,3628	2,4431	4,3518	2,4621	4,3410	2,4811
6	5,2477	2.9089	5,2350	2,9317	5,2221	2,9545	5,2092	2,9773
7	6,1223	3,3937	6,1075	3,4202	6,0925	3,4469	6,0774	3,4735
8	6,9970	3,8785	6,9800	3,9090	6,9628	3,9394	6,9456	3,9697
9	7,8716	4,3633	7,8525	4,3976	7,8332	4,4318	7,8138	4,4659
	30	60	30 ¼	59 ¾	30 ½	59 ½	30 ¾	59 ¼
1	0,8660	0,5000	0,8638	0,5038	0,8616	0,5075	0,8594	0,5113
2	1,7320	1,0000	1,7277	1,0075	1,7232	1,0151	1,7188	1,0226
3	2,5981	1,5000	2,5915	1,5113	2,5849	1,5226	2,5782	1,5339
4	3,4641	2,0000	3,4553	2,0151	3,4465	2,0301	3,4376	2,0452
5	4,3301	2,5000	4,3192	2,5189	4,3081	2,5377	4,2970	2,5564
6	5,1961	3,0000	5,1830	3,0226	5,1698	3,0452	5,1564	3,0677
7	6,0622	3,5000	6,0468	3,5264	6,0314	3,5528	6,0156	3,5790
8	6,9282	4,0000	6,9107	4,0302	6,8930	4,0603	6,8752	4,0903
9	7,9942	4,5000	7.7745	4,5339	7,7547	4,5678	7,7346	4,6016
	31	59	31 ¼	58 ¾	31 ½	58 ½	31 ¾	58 ¼
1	0,8571	0,5150	0,8549	0,5188	0,8526	0,5225	0,8503	0,5262
2	1,7143	1,0301	1,7098	1,0375	1,7053	1,0450	1,7007	1,0524
3	2,5715	1,5451	2,5647	1,5563	2,5579	1,5675	2,5510	1,5786
4	3,4287	2,0602	3,4196	2,0751	3,4106	2,0900	3,4014	2,1048
5	4,2858	2,5752	4,2745	2,5939	4,2632	2,6125	4,2518	2,6311
6	5,1430	3,0902	5,1295	3,1126	5,1158	3,1350	5,1021	3,1573
7	6,0002	3,6053	5,9844	3,6314	5,9685	3,6575	5,9525	3,6835
8	6,8573	4,1203	6,8393	4,1502	6,8211	4,1800	6,8028	4,2097
9	7,7145	4,6353	7,6942	4,6689	7,6738	4,7025	7,6532	4,7359

TABLES

	N S	E W	N S	E W	N S	E W	N S	E W
	32	58	32 ¼	57 ¾	32 ½	57 ½	32 ¾	57 ¼
	0.8480	0.5299	0.8457	0.5336	0.8434	0.5373	0.8410	0,5409
	1.6961	1.0598	1.6914	1.0672	1.6868	1.0746	1.6821	1,0819
	2.5441	1.5897	2.5372	1.6008	2.5302	1.6119	2.5231	1,6229
	3.3922	2.1197	3.3829	2.1344	3.3736	2.1492	3.3642	2,1639
	4.2402	2.6496	4.2286	2.6681	4.2169	2.6865	4.2052	2,7049
	5.0883	3.1795	5.0744	3.2017	5.0603	3.2238	5.0462	3,2458
	5.9363	3.7094	5.9201	3.7353	5.9037	3.7611	5.8873	3,7868
	6.7844	4.2394	6.7658	4.2689	6.7471	4.2984	6.7283	4,3278
	7.6324	4.7693	7.6115	4.8025	7.5905	4.8357	7.5694	4,8688
	33	57	33 ¼	56 ¾	33 ½	56 ½	33 ¾	56 ¼
	0.8386	0.5446	0.8363	0.5483	0.8339	0.5519	0.8314	0,5555
	1.6773	1.0893	1.6726	1.0966	1.6678	1.1039	1.6629	1,1111
	2.5160	1.6339	2.5089	1.6449	2.5017	1.6558	2.4944	1,6667
	3.3547	2.1786	3.3451	2.1932	3.3355	2.2077	3.3259	2,2223
	4.1937	2.7232	4.1814	2.7415	4.1694	2.7597	4.1573	2,7778
	5.0320	3.2678	5.0177	3.2898	5.0033	3.3116	4.9888	3,3334
	5.8707	3.8125	5.8540	3.8381	5.8372	3.8635	5.8203	3,8890
	6.7094	4.3571	6.6903	4.3863	6.6711	4.4155	6.6518	4,4446
	7.5480	4.9018	7.5264	4.9346	7.5050	4.9674	7.4832	5,0001
	34	56	34 ¼	55 ¾	34 ½	55 ½	34 ¾	55 ¼
1	0.8290	0.5592	0.8266	0.5628	0.8241	0.5664	0.8216	0,5700
2	1.6581	1.1184	1.6532	1.1256	1.6482	1.1328	1.6433	1,1400
3	2.4871	1.6776	2.4798	1.6884	2.4724	1.6992	2.4649	1,7100
4	3.3162	2.2368	3.3063	2.2512	3.2965	2.2656	3.2866	2,2800
5	4.1452	2.7960	4.1329	2.8140	4.1206	2.8320	4.1082	2,8500
6	4.0742	3.3552	4.9595	3.3768	4.9447	3.3984	4.9299	3,4200
7	5.8033	3.9144	5.7861	3.9396	5.7689	3.9648	5.7515	3,9900
8	6.6323	4.4735	6.6127	4.5024	6.5930	4.5313	6.5732	4,5600
9	7.4613	5.0327	7.4393	5.0652	7.4171	5.0977	7.3948	5,1300
	35	55	35 ¼	54 ¾	35 ½	54 ½	35 ¾	54 ¼
1	0.8191	0.5736	0.8166	0.5771	0.8141	0.5807	0.8116	0,5842
2	1.6383	1.1472	1.6333	1.1543	1.6282	1.1614	1.6231	1,1683
3	2.4575	2.7207	2.4499	1.7314	2.4423	1.7421	2.4347	1,6527
4	3.2766	2.2943	3.2666	2.3086	3.2565	2.3228	3.2463	2,3370
5	4.0958	2.8679	4.0832	2.8857	4.0706	2.9035	4.0579	2,9212
6	4.9149	3.4415	4.8998	3.4629	4.8847	3.4842	4.8694	3,5055
7	5.7341	4.0150	5.7165	4.0400	5.6988	4.0649	5.6810	4,0897
8	6.5532	4.5886	6.5331	4.6172	6.5129	4.6456	6.4926	4,6740
9	7.3724	5.1622	7.3498	5.1943	7.3270	5.2263	7.3042	5,2582

TABLES of LATITUDE and DEPARTURE.

	NS	EW	NS	EW	NS	EW	NS	EW
	36	54	36 ¼	53 ¾	36 ½	53 ½	36 ¾	53 ¼
1	0.8090	0.5878	0.8064	0.5913	0.8038	0.5948	0.8012	0.59
2	1.6181	1.1756	1.6129	1.1826	1.6077	1.1896	1.6025	1.19
3	2.4271	1.7634	2.4193	1.7739	2.4116	1.7845	2.4038	1.79
4	3.2361	2.3511	3.2258	2.3652	3.2154	2.3793	3.2050	2.39
5	4.0451	2.9389	4.0322	2.9565	4.0193	2.9741	4.0063	2.99
6	4.8541	3.5267	4.8387	3.5478	4.8231	3.5689	4.8075	3.58
7	5.6631	4.1145	5.6451	4.1391	5.6270	4.1638	5.6088	4.18
8	6.4721	4.7023	6.4516	4.7304	6.4308	4.7586	6.4100	4.78
9	7.2812	5.2901	7.2580	5.3217	7.2347	5.3534	7.2111	5.38
	37	53	37 ¼	52 ¾	37 ½	52 ½	37 ¾	52 ¼
1	0.7986	0.6018	0.7960	0.6053	0.7933	0.6087	0.7907	0.612
2	1.5973	1.2036	1.5920	1.2106	1.5867	1.2175	1.5814	1.224
3	2.3959	1.8054	2.3880	1.8159	2.3801	1.8263	2.3721	1.83
4	3.1945	2.4073	3.1840	2.4212	3.1734	2.4350	3.1628	2.44
5	3.9932	3.0091	3.9800	3.0265	3.9668	3.0438	3.9534	3.06
6	4.7918	3.6109	4.7760	3.6318	4.7601	3.6526	4.7441	3.67
7	5.5904	4.2127	5.5720	4.2371	5.5535	4.2613	5.5348	4.28
8	6.3891	4.8145	6.3680	4.8424	6.3468	4.8701	6.3255	.89
9	7.1877	5.4163	7.1640	5.4476	7.1402	5.4788	7.1162	5.50
	38	52	38 ¼	51 ¾	38 ½	51 ½	38 ¾	51 ¼
1	0.7880	0.6156	0.7853	0.6191	0.7826	0.6225	0.7799	0.62
2	1.5760	1.2313	1.5706	1.2382	1.5652	1.2450	1.5598	1.25
3	2.3640	1.8470	2.3559	1.8573	2.3478	1.8675	2.3397	1.87
4	3.1520	2.4626	3.1314	2.4764	3.1304	2.4900	3.1195	2.50
5	3.9401	3.0783	3.9266	3.0955	3.9130	3.1125	3.8994	3.129
6	4.7281	3.6940	4.7119	3.7146	4.6956	3.7351	4.6793	3.755
7	5.5161	4.3096	5.4972	4.3337	5.4782	4.3576	5.4592	4.381
8	6.3041	4.9253	6.2825	4.9528	6.2608	4.9801	6.2391	5.007
9	7.0921	5.5409	7.0678	5.5718	7.0434	5.6026	7.0190	5.63
	39	51	39 ¼	50 ¾	39 ½	50½	39 ¾	50
1	0.7771	0.6293	0.7744	0.6327	0.7716	0.6361	0.7688	0.63
2	1.5543	1.2586	1.5488	1.2654	1.5432	1.2621	1.5377	1.37
3	2.3314	1.8880	2.3232	1.8981	2.3140	1.9082	2.3065	2.91
4	3.1086	2.5173	3.0976	2.5308	3.0865	2.5443	3.0754	2.55
5	3.8857	3.1466	3.8719	3.1635	3.8581	3.1804	3.8442	3.19
6	4.6629	3.7759	4.6463	3.7962	4.6297	3.8165	4.6130	3.83
7	5.4400	4.4052	5.4207	4.4289	5.4014	4.4525	5.3819	4.47
8	6.2172	5.0346	6.1951	5.0616	6.1730	5.0886	6.1507	5.11
9	6.9943	5.6639	6.9695	5.6943	6.9446	5.7247	6.9196	5.75

TABLES of LATITUDE and DEPARTURE.

N S	E W	N S	E W	N S	E W	N S	E W
40	50	40 ¼	49 ¾	40 ½	49 ½	40 ¾	49 ¼
0.7660	0.6428	0.7632	0.6461	0.7604	0.6494	0.7575	0.6527
1.5321	1.2856	1.5265	1.2922	1.5208	1.2989	1.5151	1.3055
2.2981	1.9284	2.2897	1.9384	2.2812	1.9483	2.2727	1.9583
3.0642	2.5711	3.0529	2.5845	3.0416	2.5978	3.0303	2,6110
3.8302	3.2139	3.8162	3.2306	3.8020	3.2472	3.7878	3.2638
4.5963	3.8567	4.5794	3.8767	4.5624	3.8967	4.5454	3.9166
5.3623	4.4995	5.3425	4.5229	5.3228	4.5461	5.3029	4.5693
6.1284	5.7423	6.1059	5.1690	6.0832	5.1956	6.0605	5.2221
6.8944	5.7851	6.8691	5.8151	6.8436	5.8450	6.8181	5.8748
41	49	41 ¼	48 ¾	41 ½	48 ½	41 ¾	48 ¼
0.7547	0.6560	0.7518	0.6593	0.7489	0.6626	0.7460	0.6659
1.5094	1.3121	1.5037	1.3187	1.4979	1.3252	1.4921	1.3318
2.2641	1.9682	2.2555	1.9780	2.2468	1.9879	2.2382	1.9976
3,0188	2.6242	3.0074	2.6374	2.9958	2.6505	2.9842	2.6635
3.7735	3.2803	3.7592	3.2967	3.7447	3.3131	3.7303	3.3294
4.5283	3.9364	4.5110	3.9560	4.4937	3.9757	4.4764	3.9953
5.2830	4.5924	5.2629	4.6154	5.2426	4.6383	5.2227	4.6612
6.0377	5.2485	6.0147	5.2747	5.9916	5.3010	5.9685	5.3270
6.7924	5.9045	6.7666	5.9341	6.7405	5.9636	6.7145	5.9929
42	48	42 ¼	47 ¾	42 ½	47 ½	42 ¾	47 ¼
0.7431	0.6691	0.7402	0.6723	0.7373	0.6756	0.7343	0.6788
1.4863	1.3383	1.4804	1.3447	1.4746	1.3512	1.4686	1.3576
2.2294	2.0074	2.2207	2.0171	2.2118	2.0268	2.2029	2.0364
2.9729	2 6765	2.9609	2.6895	2.9491	2.7024	2.9373	2.7152
3.7157	3.3457	3.7011	3.3618	3.6864	3.3779	3.6716	3.3940
4.4589	4.0148	4.4413	4.0342	4.4837	4.0535	4.4059	4.9728
5 2020	4.6839	5.1815	4.7066	5.1610	4.7291	5.1402	4.7516
5.9452	5.3530	5.9218	5.3789	5.8982	5.4047	5.8746	5.4304
6.6883	6.0222	6.6620	6.0513	6.6355	6.0813	6.6089	6.1092
43	47	43 ¼	46 ¾	43 ½	46 ½	43 ¾	46 ¼
0.7313	0.6820	0.7283	0.6852	0.7253	0.6883	0.7223	0.6915
1.4627	1.3640	1.4567	1.3704	1.4507	1.3767	1.4447	1.3830
2.1941	2.0460	2.1851	2.0555	2:1761	2.0651	2.1671	2.0745
2.9254	2.7280	2.9135	2.7407	2.9015	2.7534	2.8894	2.7660
3.6568	3 4100	3.6418	3.4259	3.6269	3 4418	3.6118	3.4576
4.3881	4.0920	4.3702	4.1111	4.3522	4.1301	4.3342	4.1491
5.1195	4.7740	5.0986	4.7963	5.0776	4,8185	5.0565	4.8406
5.8508	5.4560	5.8269	5.4814	5.803c	5.5068	5.7789	5.5321
6.5822	6.1380	6.5553	6.1666	6.5284	6.1952	6.5013	6 2236

TABLES of LATITUDE and DEPARTURE.

	N S	E W	N S	E W	N S	E W	N S	E W
	44	46	44 ¼	45 ¾	44 ½	45 ½	44 ¾	45 ¼
1	0,7193	0,6946	0,7163	0,6978	0,7132	0,7009	0,7102	0,704
2	1,4387	1,3893	1,4326	1,3956	1,4265	1,4018	1,4204	1,408
3	2,1580	2,0840	2,1489	2 0934	2,1397	2,1027	2,1305	2,112
4	2,8774	2,7786	2,8652	2,7912	2,8530	2,8036	2,8407	2,816
5	3,5967	3,4733	3,5815	3,4889	3,5662	3,5045	3,5509	3,520
6	4,3160	4,1679	4,2978	4,1867	4,2795	4,2054	4,2611	4,224
7	5,0354	4,8616	5,0141	4,8845	4,9927	4,9063	4,9713	4,928
8	5,7547	5,5573	5,7304	5,5823	5,7060	5,6072	5,6815	5,632
9	6,4741	6,2519	6,4467	6,2801	6,4192	6,3081	6,3917	6,336
	45	45						
1	0,7071	0,7071						
2	1,4142	1,4142						
	2,1213	2,1213						
	2,8284	2,8284						
	3,5355	3,5355						
	4,2426	4,2426						
	4,9497	4,9497						
	5,6569	5,6569						
	6,3640	6,3640						
	E W	N S	E W	N S	E W	N S	E W	N S

APPENDI

The APPENDIX,

Containing an Essay upon SOLIDS and Artificers Work;

Wherein not only the practical Methods of measuring Boards, Round Timber, Bricklayers and Plaisterers Work; but also Marl-pits and Hay are rendered plain and easy; the Whole being illustrated with peculiar Explanations, Rules, Examples and Operations.

SECT. I.

A Surveyor is (by most Country People) looked upon as unqualified for his Profession if he be unacquainted with Stereometry, to wit, a Branch of the Mathematics, which treats particularly about the Mensuration of Solid Bodies; and therefore, that this Treatise may be rendered every Way useful for the Country Man (for whom it is chiefly intended) I have herein given some necessary Rules and Directions *(with regard to real Practice)* how to measure Boards, round Timber, Bricklayers and Plaisterers Work, together with the practical Methods of measuring Marl-pits and Hay, and first of

Board Measure.

Boards, according to the general Method are measured by taking the Length and Breadth thereof in Feet and Inches, and to find the Content observe this

Rule: Multiply the Length by the Breadth, and the product is the Content.

Note, 12 Inches make one Foot in Length, 144 Square Inches, one Square Foot, and 400 Square Feet, one Rood of Boards.

Note, Also, in taking the Length of a single Board or Log of Boards, any thing under six Inches is seldom noticed.

Example 1. Admit a Board 9 feet long and 10 inches broad, how many feet are contained therein?

	F.	I.	
Length	9	0	
Breadth	0	10	
Answer	7	6	0

Example 2. Admit a Log of Boards (10 in number) 8 feet long and 6 feet 8 inches broad, how many square feet of boards therein?

	F.	*I.*	
Length	8	0	
Breadth	6	8	
	5	4	0
	48	0	
Ans:	53	4	0

Or thus

	F.	*I.*
	6	8
	12	
inches	8	0
feet		8
12)	640	
	53	4

Note, Multiplication of feet and inches, is called *Duodecimal Arithmetic*, and is partly wrought the same way as Multiplication of Money, always remembering, that inches multiplied by inches produce parts, and that inches by feet produce inches.

More Examples:

Logs.	Lgth. *F.*	*I:*	Bdth. *F.*	*I.*	Cts. *F.*	*I.*	Logs.	Lh. *F.*	Bdh. *F.*	*I.*	Contents: *F.*	*I.*
1	7	0	10	4	72	4	1	9½	11	3	106	10½
2	8	0	9	8	77	4	2	10	14	9	147	6
3	5½	0	12	3	67	4½	3	10½	11	8	122	6
4	6	0	9	6	57	0	4	8½	15	7	132	5½
5	9	0	5	10	52	6	5	9	12	9	114	9
							6	12½	8	8	108	4
			Answer		326	6½				*Answer*	732	5
										One Rood of Boards	400	
										Answer, One Rood	332	5

OF

Of Round Timber.

The common Way of measuring Round Timber Trees, when butted and headed.

I. The Length is taken in Feet (but any thing under half a Foot is not regarded) and the Girt in Inches about the middle Length, or any where between that and the Root or butt end (if the Buyer chuses) and this Girt thus taken divided by 4, is called the quarter Girt, and is esteemed as the side of a Square equal, at the Place where the Tree was Girt, therefore if you multiply the Square of the quarter Girt by the Length of the Tree, you'll have the solidity the customary way.

Example 1. If the quarter Girt be 8 Inches, and the Length 9 Feet, how many Feet of Timber in that Tree. *Note*, if the quarter Girt be less than 6 Inches, it is not reckoned Timber.

	8 inches		
	8 do.		
	64 =	5	4
Length			9
Answer	4	0	0

Explanation.
The quarter girt = 8, multiplied by itself = 64 square parts, which divided by 12 gives 5 inches 4 parts, and this last product being multiplied by 9 feet (the length) gives the content.

Example 2. If the quarter girt be $10\frac{1}{2}$ inches, and the length 8 feet, what is the content?

		In.		
		10	6	
		10	6	
		5	3	0
	8	9	0	
	9	2	3	0
				8
6	1	6	0	0

Ans. 6 feet 1 in. & 6 parts or $\frac{1}{2}$ in.

Example 3. The $\frac{1}{4}$ girt $16\frac{1}{2}$ inches, the length $16\frac{1}{2}$ feet, the contents required?

$16\frac{1}{2}$ inches =			1	4	6
			1	4	6
			8	3	0
		5	6	0	
	1	4	6		
	1	10	8	3	0
Length				16	6
	11	4	1	6	
30	3	0	0		
31	2	4	1	6	

Note. The annexed answer is a series of sub-divisions, and are thus expressed, 31 feet, 2 inches, 4 primes, 1 second, and 6 thirds.

Example 4. If the circumference of a tree in the girting place be 57 inches, and the length 17 feet, how many feet of timber therein?

4) 57

		F.	I.	Pts.		
	$14\frac{1}{4}$ =	1	2	3	squared
		1	2	3	
		3	6	9	
	2	4	6		
1	2	3			
1	4	11	0	9	
Length				17	
23	11	8	0	9	*Ans.*

Otherwise thus, *In.*

```
          14.25
          14.25
          ------
           7125
          2850
         5700
         1425
        --------
Length  203.0625
              17
        --------
       14214375
       2030625
       ---------- feet.
144) 3452.0625 (23.97
       As before.
```

Example

Example 5. Admit the $\frac{1}{4}$ girt 39 inches and Length 19 feet 6 inches what is the content?

			3	3
			3	3
			9	9
		9	9	
	10	6	9	
Length			19	6
	5	3	4	6
	200	8	3	
solidity	205	11	7	6

Note, If the annexed solidity was to be expressed in words, it would be thus, 205 feet, 11 inc. 7 primes, and 6 seconds: *Note* also, if a tree be measured with the bark on, $\frac{1}{10}$th or $\frac{1}{12}$th of the girt is commonly allowed upon that account in oak, but in elm, beech, ash, &c. something less is to be deducted, tho' in most places an inch for bark is allowed.

Example 6. How many loads of timber in that tree, the length whereof is 28 feet 6 inches, and the quarter girt 2 feet 9 inches? *Note*, 40 feet of timber measured the common way, or 50 the true way, is accounted a load, or 1 ton weight.

		2	9	
		2	9	
	2	0	9	
	5	6		
	7	6	9	
Length		28	6	
	3	9	4	6
	211	9	0	
Ans. 215	6	4	6	

By Decimals.

2.75
2.75
1375
1925
550
7.5625
28.5
378125
605000
151250
40) 215.53125

5 ton 15 feet ans.

Of the true Way of measuring Round Timber.

The former Method is the common way of measuring such Timber as hath not been squared, and is proper enough when there

there is much Sap and loſs, but is ſhort of the Truth in the proportion of 11 to 14, as may thus be proved. If the circumference of a Tree be 1 Foot, the quarter Girt is 3 Inches or .25, but this cannot be the ſide of a Square equal in Area to that Circle, for the Square root of the Area of any Figure, is the ſide of a Square equal in Area to that Figure, but the Area of a Circle whoſe periphery or circumference is 1, is .0795775, or .08 nearly, the Square Root whereof is .2821 nearly, and which is the true ſide of a Square equal. And if any one be deſirous to know the true Content of ſuch Timber, let him obſerve the following

RULES.

1. Multiply the Girt or Circumference in Inches, by .2821, and the Product will be the true ſide of a Square equal, with which proceed as before.

2. Multiply the Square of the Trees Circumference or Girt in Feet by the Length, and that Product by .07958, (or by .08 which will anſwer ſufficiently near) gives the Solidity.

3. Find the Solidity the common way, under this write its $\frac{1}{5}$ part, $\frac{1}{5}$ of this $\frac{1}{5}$ and $\frac{1}{10}$ of that $\frac{1}{3}$ the ſum of theſe 4 Lines will be the Solidity very near; the two firſt Rules are beſt adapted to Decimals, and the laſt to Duodecimals; alſo as 11 : 14, ſo is the common way to the true way nearly, or as is 14 to 11, ſo is the true way to the common way as near.

Admit it were required to know how many Feet of Timber (according to the true way) in that Tree mentioned in Example 6, foregoing, the Content whereof according to the common way of meaſuring is 215, 53125 Feet.

Say, as 11 : 14 :: 215.53125 : 274.3125 Feet of Timber, according to the true way of meaſuring, nevertheleſs, tho' I have given the above Rules concerning the true Solidity of Round Timber, yet notwithſtanding, I don't imagine it will be the Means of aboliſhing thoſe cuſtomary Rules which Time and Practice therein have eſtabliſhed almoſt every where.

SECT. II.

OF BRICKLAYERS AND PLAISTERERS WORK,

And firſt of the Bricklayers Work.

The Work of theſe Artificers is in moſt Country Places meaſured

ſured by the Yard, and returned Square Yards, for which they are paid accordingly, ſo that if the Wall be Brick-Breadth i. e. $4\frac{1}{2}$ Inches, 9 Inches, i. e. Brick Length, Brick and half or two Bricks, &c. in thickneſs, the Workman is paid ſo much the more per Yard, and therefore ſuch Walls muſt be meaſured ſeverally, and the Contents entered with their reſpective Prices per Yard, by which Means an exact Account of the ſame may be obtained, to effect which, obſerve this

RULE.

Multiply the Length and Height together in Yards and Decimal Parts, and the Product will be the Content in Square Yards.

Note, There is ſeldom any Deduction made for Door Places or Windows, unleſs mentioned before the Work was engaged.

EXAMPLE.

I demand what a Wall comes to at $3\frac{1}{2}$ per Yard (to wit 3d $\frac{1}{2}$ when all Materials are found, or 3s. 6d. when the Workman finds the Materials) the Dimenſions are

	yd.	d.	yds.	*l.*	*s.*	*d.*	
Length =36.37 yds. Then if	1 :	3.5 :	172.75 :	2	10	$4\frac{1}{2}$.	*Anſ.*
Height = 4.75							

18185
25459
14548

172.7575 Square yards.

Otherwiſe at 3s. 6d. per yd. it would amount to 30l. 4s. $7\frac{1}{2}$d.

Example 2. What does the Brick Work of a Building amount to, the ſeveral Dimenſions and reſpective Prices thereof are as under?

		Yards.	*Yards.*		*£.*	*s.*	*d.*
Front wall - - - - -	Length Height	17.3 6.84	Cont. $118\frac{1}{4}$	at 6d.	2	19	$1\frac{1}{2}$
Gable end and back part	Length Breadth	34.4 6.84	ditto $235\frac{1}{4}$	4d.	3	18	5
Two gable ends above the ſquare - - - - -	Breadth Height	7.0 5.0	ditto 35	4d.	0	11	8

INNER

INNER WALLS.

Pantry walls, &c. - - -	Length 9.4 Height 2.6	ditto	24¼	2d.	0	4	0½
One wall - - - - - - -	Length 6.0 Height 6.8	ditto	40¼	3d.	0	10	2¼
Another wall - - - -	Length 6.0 Heigth 6.8	ditto	40¼	3d.	0	10	2½
A triangular wall up stairs	Length 6.0 ½ Height 2.4	ditto	14¼	3d.	0	3	6¼
Another ditto - - - -	Length 6.0 ½ Height 2.4	ditto	14¼	3d.	0	3	6¼

TWO CHIMNIES.

Girt at bottom 4.2	Mean girt, bottom = 4 x 3 do.	12.0	45.3		
do. at middle 3.8	ditto top = 3.7 x 9 do.	33.3	2		
do. at top 3.6					

doubled 90.6

Height bottom part 3 0 ditto top part 9 0 at 4d. 1 10 2

Second chimney contains the same, &c. 90½ 4d. 1 10 2

Two MIDFEATHERS, i. e. one in each chimney.

1st Height 9.0 Breadth 0.6	Contains 5.4	= 10 8 yards	at 2d.	0	1	9½
2d Height 9 0 Breadth 0.6	3.4					

Answer 12 2 10½

Example 3. Admit a Brick Wall 10 Yards long, 3 Yards high, and 3½ Bricks thick, I demand how many statute Yards of Brick Work therein? i. e. 1½ Brick thick.

Rule. Multiply the Square Yards in the Wall, by the number of half Bricks in its Thickness, and divide that Product by 3, (that is the number of half Bricks, in statute thickness) and the Quotient will be the number of statute Yards sought.

Length 10 Yards.
Height 3

Square Yards in the Wall 30
Half Bricks in thickness 7

3) 210

Yards of statute thickness 70

Or

Of Plaisterers Work.

Plaisterers most commonly work by the Square Yard, so that a Decimal Yard is likewise necessary to take the Dimensions of such Work.

Note. If you are to measure the Plaistering of the Rooms in a House, do thus.

1. Take the Girt of the Room with a String, and measure the same with the Yard, which enter with the name of the Room, then take the Height thereof and enter it under the Girt, Multiply the Height by the Girt, and the Product will be the Content.

2. Take the Length and Breadth of the Cieling, and Multiply one by the other, and the Product will be the Square Yards therein: proceed in the Manner with every Room you are to measure, but observe, Custom seldom makes Allowance for Doors, Windows or Chimnies, and the String in taking the Girt and Height must go into every dint or cornice thereof, &c.

Example. Suppose a room measure in girt 37 6 yards, and in height 3 yards, the cieling being 9 yards long and 8 broad, how many yards of plaistering are therein?

		Girt of the room	37 6 yards
Cieling, long	9 yards	Heigth of ditto	3.
broad	8		
	—		112 8
Square yards	72	The cieling	72.0
		Anf. $184\frac{4}{5}$ yds.	184.8

Of Marl Pits.

Marl is an excellent manure for land, and very much used, not only in Cheshire, but most of the adjoining counties; also, whereof the inhabitants (who are more immediately concerned in agriculture) annually enjoy the emoluments arising therefrom; however, it is not my design in this place, to expatiate on the properties or quantities of *marl*, but to direct and shew how to measure a cast or fallen pit, but before this can be effectually performed, let us consider the nature of this irregular vacuity.

First.

First. A marl pit may be supposed to represent an irregular solid, or rather an irregular vacancy in the earth made by poor labourers, who commonly lay out the pit at first, in imitation of a square or rectangle, but the consequence of working such pits so true and upright is exceeding dangerous, and too often attended with broken bones and loss of lives.

Secondly. As workmen are generally paid for marl pits by the rood; I shall in the next place explain what a rood is, and then teach how to find how many roods there are contained in the most irregular marl pits.

First. Then, 8 yards long, 8 broad and 1 deep, = 64 cubical yards were formerly accounted a rood of marl, but custom hath established in Cheshire, and some of the adjacent counties, 9 yards long, 8 broad, and 1 deep, equal 72 cubical yards to the rood; now as such pits are allowed to represent *irregular bodies*, consequently whoever would attempt to measure or find the true contents thereof, should not be a stranger to or unacquainted with the mensuration of *regular solids*; yet, notwithstanding, how oft do we see numbers in this country who can scarcely define a line, or construct a square, much less measure a carved space, or an irregular solid; nevertheless, will arrogantly assume such boasting pretensions to this art, as if they were perfectly acquainted with *planimetry*, *stereometry and geometry*, by which means they too oft intrude upon the credulity of their well meaning neighbours. And therefore for want of such necessary qualifications, how frequently do we see the industrious farmer, or perhaps the poor laborious workmen imposed upon by employing some bungler or other (to measure their work) whose incapacity must render them obnoxious to every individual who hath any knowledge of *superfices* and *solids*? the consequence of employing an unqualified person upon the occasion, cannot fail of proving injurious to one or the other concerned therein, so that if the poor labourers should be injured (though contrary to their master's desire) their indigent families must necessarily undergo the burthen of the loss, while the poor men reflect on the many long and sultry days, sweat flowed from each thro' emulating labour and violent exercise, in hopes that at the end their indefatigable pains would amply meet that just reward which universally sweetens labour; but, on the other hand, should the

the miſtake commited be in favour of the poor labourers, the caſe would be equally as bad; for altho' the farmers are allowed to be the ſupport of the nation; notwithſtanding, that is no reaſon why they ſhould be wronged, or pay more than what is right: And therefore, I think it greatly behoves both the maſter and workmen to make choice of ſuch a perſon upon this occaſion, whoſe knowledge and abilities can direct throughout the moſt difficult undertaking without injuring or wronging either ſide; ſuch a man's return will moſt certainly afford pleaſure and ſatisfaction to both ſides. To affect this material point, let us conſider theſe irregular bodies to be comprehended under the three following varieties, viz.

RECTANGULAR, OBLIQUE ANGULAR, and CURVILINEAL.

Of theſe in their order.

And firſt, to meaſure a rectangular pit, the angles whereof are right ones, or nearly ſo, and the ſides and backs are nearly ſtraight.

Rule. Multiply the mean length of the pit's body, by the mean breadth, and that product by the mean depths, this laſt product will be the content in cubical yards. Secondly, multiply the mean length, mean breadth, and mean depth of the pace (or ſpace as it is commonly called) together, and the product will be the content thereof in cubical or ſolid yards which add to the content of the body of the pit, and divide the ſum by 64 or 72, (according to the cuſtom of the country) and the quotient will be the number of roods of marl the pit did contain.

Note, The mean length of a pit may be thus found, take the length of one ſide about the middle depth with a ſtring, in which place ſtick or faſten a pin, and then with a decimal yard meaſure it and enter the ſame, do ſo at every three yards acroſs the pit, but obſerve, you need only meaſure to or from the pin you firſt faſtned in the ſtring, then add or ſubtract the difference to or from the firſt length entered, which done divide the ſum of the lengths by the number thereof, and the quotient will be a mean length. In like manner find the mean breadth, the mean depth according to practical cuſtom is thus obtained, being provided with a pole about

4 or

4 or 5 yards long, divided into yards and decimal parts alſo, take the depth therewith perpendicular to the floor of the pit on each ſide thereof, about 3 yards aſunder; but ſee you don't meddle with the back part unleſs you take the depth of the front alſo, which may be performed by holding the ſtring or line at full ſtretch, level with the graſs or ſurface, &c. on each ſide the pit, exactly over the place where the ſpace and body of the pit divides, then with the pole and decimal yard take as many depths as you did at the oppoſite ſide or back part, add all theſe depths together, and divide the ſum by the number thereof, the quotient will be a mean depth; proceed in like manner to find the length, breadth, and depth of the *ſpace*, then will your dimenſions of the pit be compleated.

Example. Admit *fig* 5, *plate* 5, to repreſent a marl-pit, the ſides whereof are nearly perpendicular, and the angles nearly right, i. e. neither much obtuſe nor acute, the content whereof is ſought.

Note, The lines *b*, *b*, are the different lengths taken by a packthread in the pit about the middle of the depth, and the lines *a*, *a*, are the different breadths taken in like manner; the depths were taken at every three yards on each ſide of the pit, but neither at the *back* nor *ſpace* as the ſurface appeared horizontal.

DIMENSIONS.

Lengths in yds.	Breadth in yds.	Depth in yds.
14.65	10.55	4.48
14.72	10.32	4.56
14.76	10.25	4.70
14.64	10.20	4.94
14.60	10.24	5.04
14.43	10.24	4.90
14.40		4.68
	6) 61.80	4.58
7) 102.20		4.42
	10.3	
14.6		9) 42.30
		4.7

Mean	Length	14.6
	Breadth	10.3
		4.38
		1460
		150.38
Mean depth		4.7
		1052.66
		6015.2
		706.786

Anſwer. 706.786 *cubical yards in the body of the pit.*

Length

SPACE.

Length	Breadth	Depth	Mean length	3.25
3.30	6.10	2.10	Mean breadth	6.1
3.20				
2) 6.50				3.25
				1950
3.25				19.825
			Mean depth	2.1
				19825
				39650
			Solid yards in the ſpace	41.6325
			in the body	706.786

Anſwer. The pit contained, cubical yards 748.4185

Then divide 748 yards by { 64 or / 72 } = { 11 roods 44 yards / 10 roods 28 yards } according to the cuſtom of Cheſhire and other counties.

Example 2 Admit *fig.* 6, *plate* 5, to repreſent a marl pit, the ſides whereof are indifferently ſtreight, but the angles therein both obtuſe and acute, I demand how many roods were contained therein? *Note*, When the angles in a pit are very obtuſe or acute, the ſame ought to be meaſured as a trapezium, and the depths taken as before.

Dimenſions in yards, &c.	Depths.		½ ſum of the perpendiculars = 6.18
		diagonal	20.4
5.10	4.44		24.72
20.40—7.26	4.90		1236
	4.98		
2) 12.36	4.87	Square yards	126.072
	4.65	Depth	4.64
6.18	4.0		
			504288
	6) 27.84		756472
			504288
	4.64		
		Cubical yards	584.97408

SPACE.

SPACE.

Mean length 2.3
Mean breadth 5.2

46
115

1196
Mean depth 1.8

9568
1196

Solid yards 21.528

Solid yards in the body 584.974
in the ſpace 21.528

72) 606.502 (8 roods, 30 yards, Cheſhire meaſure, the content.
576

30

Note, If there be any ſideſlip, bends or curved turnings in a pit, take them as directed in the following example.

Of Curvilineal Pits.

The body of curvilineal pits ſhould be taken as directed in the two foregoing examples, and if a ſide ſlip occur therein, ſtretch a line along that ſide the pit at every yard in height, and with your decimal yard take as many breadths from the ſtring (at full ſtretch) to the back of the ſlip as you ſhall ſee neceſſary, add theſe breadths together, and divide the ſum by the number thereof, the quotient will be the mean breadth of the ſlip, then take the length and height thereof, with which proceed as before.

Example 3. Admit *fig*. 7, *plate* 5, to repreſent an irregular marl pit, and it were required to know how many roods of marl were contained therein.

DIMENSIONS.

L.	B.	D.
Yds.	*Yds.*	*Yds.*
12.01	8.40	6.20
11.95	8.52	6.42
12.0	8.65	6.86
12 04	8.78	6.94
12.0	8.90	6.82
5) 60	9.10	6.60
Mean 12	6) 52.35	6.14
	Mean 8 72	5.90
		8) 51.88
		Mean 6.48

	L.	B.	D.
Space	4 27	6.46	1.75

Body of the pit.

Mean length 12.
Do. breadth 8.72

Sq. yards 104.64
Mean depth 6 48

83712
41856
62784

Solid yds. 678.0672

The ſpace.

Mean length 4.27
Do. breadth 6.46

2562
1708
2562

27.5842
Mean depth 1.75

1379210
1930894
275842

Cubical yards in the ſpace 48.272350
Ditto in the body of the pit 678.0672

Dimenſions

Dimenſions of two parcels in the ſouth ſide of the pit.

The part A.

	Lgth.	Bdth.	Depth.
	2.50	2.40	6.10
	2.70	2.60	5.90
	2)5.20	2)5.00	2)12.00
Mean	2.6	2.50	6

Mean length	2.6
Mean breadth	2.5
	130
	52
Square yds.	6 50

Square yards	6.50
Depth	6
Cubical yards	39.00
in part A	

The part B.

	Lgth.	Bdth.	Dh.
	4.20	2.10	6.8
	4.60	2.30	6.6
	2)8.80	2)4.40	2)13.4
Mean	4.4	2.2	6.7

Mean length	4.4
Mean breadth	2.2
	88
	88
Square yards	9.68
Mean depth	6.7
	6776
	5808
Cubical yards	64.856

A ſlip in the back part.

	Lgth.	Bdth.	Height.
At bottom	5.25	.60	6.40
At top	5.15	.86	6.90
		1.10	
	2)10.40	.80	2)13.30
		.60	
Mean	5.20		Mean 6.65
		5)3.96	
		Mean .79	

Mean length	5.2
Mean breadth	.79
	468
	364
Square yards	4.108
Mean height	6.65
	20540
	24648
	24648
Cubical yards	27.318

The several parts collected	The body of the pit	678
	space	$48\frac{1}{4}$
	part A	39
	part B	$64\frac{3}{4}$
	slip	$27\frac{1}{4}$
		72) $857\frac{1}{4}$
The contents of the pit are, 11 roods $65\frac{1}{4}$ yards.		11 $65\frac{1}{4}$

These three examples, well understood, will undoubtedly enable the young learner to measure the most irregular marl pit truly, as they contain variety sufficient whereby any other pit may be effectually understood and measured.

Of HAY.

Hay is likewise an irregular solid, and is measured and returned in cubical yards, but the weight of the yard solid differs according to the place and quality of the hay, to wit, a cubical yard (or square yard as it is commonly called) in the bottom of some hay reeks of one, two, or three years standing, will weigh near two hundred weight, and another of the same size and standing, a yard perhaps will not weigh one hundred weight; however, the measurer hath nothing more to do than to find the number of cubical yards in the hay reek or cock, and let the buyer and seller order about the weight thereof: And though the form of hay reeks and hay cocks are many, nevertheless if the learner will endeavour to understand the following examples, they will enable him to measure any hay reek or hay cock whatever.

PROBLEM I.

Teacheth to measure a Hay Reek, the ends whereof are equal.

Rule. Multiply the superficial area of the end in square yards, by the length, and the product will be the cubical yards therein.

Example 1. Admit *fig.* 8, *plate* 5, to represent a hay reek, the ends being equal, and the dimensions as follow, how many solid yards are contained therein?

DEMIN-

Bottom part	Breadth	DC at bulge	4.60	= 8.6 half for a mean		4.3
		AB at bottom	4.			
	Height	FG	2.		Height	2.
						8.6

Top part	Breadth	DC at bulge	4.60	= 6 half for a mean		3.
		E at Top	1.40			
	Height	GE	4.5		Height	4.5

Length of the reek 10.50	Area of the top part or end	13.5
	Area of the bottom part or end	8.6
	Area of one end	22.1
	Length of the reek	10.5
		1105
		2210
	Answer	232.05

PROBLEM II.

Teacheth to measure a reek the ends whereof are unequal, and do nearly represent an irregular parabolic space: To find the content thereof, the following directions will answer sufficiently for practical purposes.

Rule. Having found the area of each end, multiply the mean area (between the two ends) by the length of the reek, and the product will be the solid content.

Note, The *area* of each end may be thus found; mark out the ends of the reek in two parts, viz. top and bottom, then at every yard in height of the upper part of each end take a breadth, (but as for the bottom part only two breadths will do, one at the bottom and the other at the bulge) divide the sum of the breadths pertaining to each part and end by the number taken therein, the quotient will be a mean breadth near enough, which multiply by the whole height of the part and end you are measuring, and the product will be the *area* sought; then to find a mean *area* between the two ends proceed thus: To the square root of the rectangle of the *area* of the two ends (found as above) add those two *areas* together, and one third part of the sum will be the MEAN AREA, which is to be multiplied by the length as above directed.

It often happens that a reek is longer on one side or in one place than another, in that case take the length as often as you shall think proper or see needful, add them together, and divide the sum by the number taken, the quotient will be the mean length by which you are to multiply, the mean area to find the solidity.

Example 2. Let *fig*. 9, *plate* 5, represent a large hay reek, the length whereof is 20 yards, and the other dimensions as underneath, how many solid yards are contained therein?

DIMENSIONS.

Bottom part of east end. yds.

Breadth C L at bulge 5.10 } = 9.70 half for a mean 4.85
Breadth P q at bottom 4.60 }
Height M N 1.90

Top part of east end.

Breadth at bulge 5.10

Breadths, each a yard higher than the other { 5.0, 4.90, 3.30, 2.60 }

Breadth at the top 1.30

6) 22 20

Mean breadth 3.7
Height N O 4.5

Bottom part of west end.

Breadth at bulge 4.60 } = 8.6 half for a mean 4.3
Breadth at bottom 4.0 }
Height 1.60

Top part of west end.

Breadth at bulge 4 60

Breadths, each a yard higher than the other { 4.26, 3 82, 2.18, 1.64 }

5) 16 50

Mean breadth 3.3
Height 4.0

Mean area 22.908
Length 20

Solidity 458.16

---

half for a mean 4.85
height 1.9
4365
485
Area of bottom part of east end 9.215
Mean breadth of top part 3.7
height 4.5
185
148
Area of top part of east end 16.65
Area of bottom part of east end 9.215
Area of the east end 25.865

half for a mean 4.3
height 1.6
258
43
Area of bottom part of west end 6.88
Mean breadth of top part 3.3
height 4
Area of top part of west end 13.2
Area of the west end 20.08
Area of the east end 25.865

10040
12048
16064
10040
4016

519.36920 (22.78
4
42) 119
84
447) 3536
3129
4548) 40792
36384
,4408

22.78
20.08
25.865
3)65.728
22.908
mean.

PRO-

PROBLEM III.

Teacheth to measure a hay cock or hay stack, the top and bottom part whereof do represent the frustum of a cone—This figure must likewise be measured in two parts by the following

Rule. Multiply the square of the circumference of the bottom, bulge, and top severally, by .07958 (the area of a circle whose circumference is 1, as may be seen in page 338) or by .08 which in these cases will answer near enough, and the products will be the areas at those places, then find a *mean area* between the area at the bottom and the area at the bulge, thus, To the square root of the rectangles of the two areas, add the two areas, and one third part of the sum will be the *mean area* sought, which multiply by the perpendicular height of the bottom part, and the product will be the solidity thereof; then to find the solidity of the *upper or remaining part* proceed in the same manner, namely, find a *mean area* between the areas at the *bulge* and *top*, by adding these two areas, (found as above-mentioned) to the square root of their rectangle, and taking one third part of their sum, the quotient will be the *mean area* between the bulge and top areas which multiply by the perpendicular, (and not the slant height) of *this* part, and the product will be the solidity thereof, which add to the solidity of the other, viz. the bottom part and the sum will be the solidity of the whole stack.

Example 3. Admit *fig* 10, *plate* 5. to represent a hay stack or hay cock, the dimensions whereof are as follow: How many solid yards are contained therein?

DIMENSIONS.

Girt at the bulge 32. x 32 = 1024 x .08 = 81.92 the bulge area
Girt at the bottom 30. x 30 = 900. x .08 = 72.0 the bottom area

Top part.

Girt at bulge 32 x 32 = 1024 x .08 = 81.92 the bulge area
Girt at top 4 x 4 = 16 x .08 71.28 the top area
Height 5 yards.

The square root of the rectangle contained under these areas is 76.8
Bulge area 81.9
Bottom area 72.
3) 230.7
Mean area of bottom 76.9

The

The square root of the rectangle contained under these areas	10.24	3)	The mean area of the bottom part	76.9
Area at bulge	81.92	= 93.44	Height	1.6
Area at top	1.28			4614
The mean area	= 31.14			769
The perpendicular height	5.		Bottom part	123.04
Solidity of the top part	155.70		Top part	155.70
			Answer	278.74
				Solid yards.

PROBLEM IV.

Teacheth to measure a hay stack, the form whereof doth nearly represent a parabolic spindle. This figure may be measured in sundry parcels, according to the irregularity of its form, and the content of each parcel being collected, gives the solid yards in the hay stack, the solidity of each parcel may be obtained by the following

Rule: Find a mean area (as directed in the preceding rule) between every adjacent girts or circumferences, and multiply the same by the perpendicular between these two girts you made use of, and the product will be the content or solidity of that part, and in like manner proceed with each part or parcel.

Example 4. Admit figure 11, plate 5, to represent a hay stack, the dimensions whereof are as follows: I demand how many solid yards are contained therein?

Dimensions. BOTTOM PART.

Girt at bulge	30 x 30 = 900 x .08 = 72.	mean area	67.35
Girt at bottom	28 x 28 = 784 x .08 = 62.72	height	2
		Content of bottom part	734.70

TOP PART.

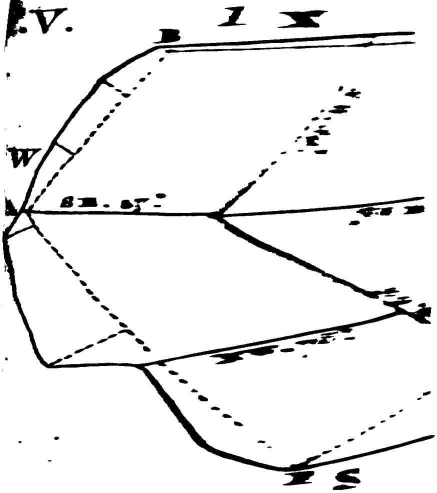
Girt at bulge	30 x 30 = 900 x .08 = 72.	Mean area	67.35
Girt 1 yard higher	28 x 28 = 784 x .08 = 62.72	Height	1
Height	1		67.35

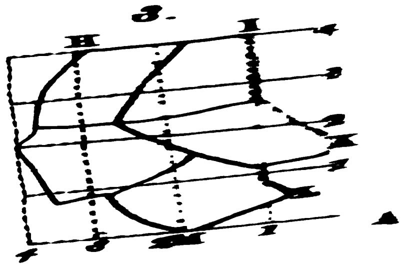
Girt 1 yard above bulge	28 x 28 = 784 x .08 = 62.72	Mean area	44.88
Girt 2 yards above do.	20 x 20 = 400 x .08 = 32.00	Height	1
			44.88

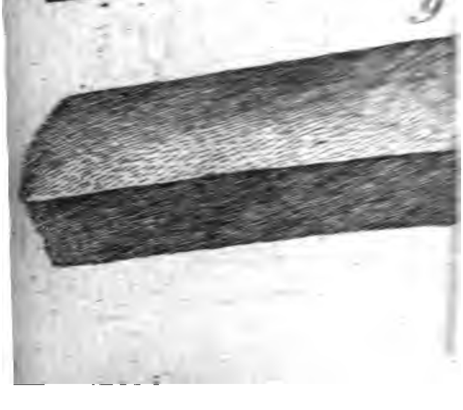
Girt 2 yerds above bu'ge	20 x 20 = 400 x .08 = 32.00	Mean area	21.62
Girt at top	4 x 4 = 16 x .08 = 12.8	Height	1.8
Height of this part	1.80		7296
			2162
			38.916

Content

V.







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yards are

Girt at b
Girt at b

Girt at b
Girt 1 y
Height

Girt 1 y
Girt 2 y

Girt 2 y
Girt at
Height

Content of the bottom part	134.70	Solid
Ditto of top { 1	67.35	
2	44.88	
3	38.916	

The content of the haycock is 285.846 solid yds. i. e. $285\frac{3}{4}$ yds.

Many more examples might herein be given, but these already proposed, will, I hope be thought sufficient, as they shew the nature of this subject with regard to real practice, I shall therefore beg leave to conclude; humbly hoping that an endeavour to supply the failure of so many eminent writers on the useful subject of surveying will not be deemed arrogant, and the making use of a few introductory lines be accounted plagiarism, however shall submit to the discretionary opinion or censure of the public, not doubting, as the whole is founded upon principles of the utmost accuracy, consequently will be esteemed an useful treatise, and most certainly merit the approbation of the impartial and judicious, and if it should happily meet with due encouragement from the public, it will afford infinite satisfaction to the author; whose sincerest wish attends not only the public weal, but likewise the improvment and promotion of all arts and sciences, and would chearfully contribute thereto whatever lies in the power and ability of the author,

Arthur Burns.