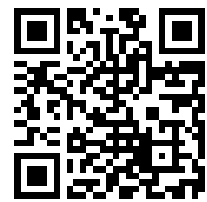
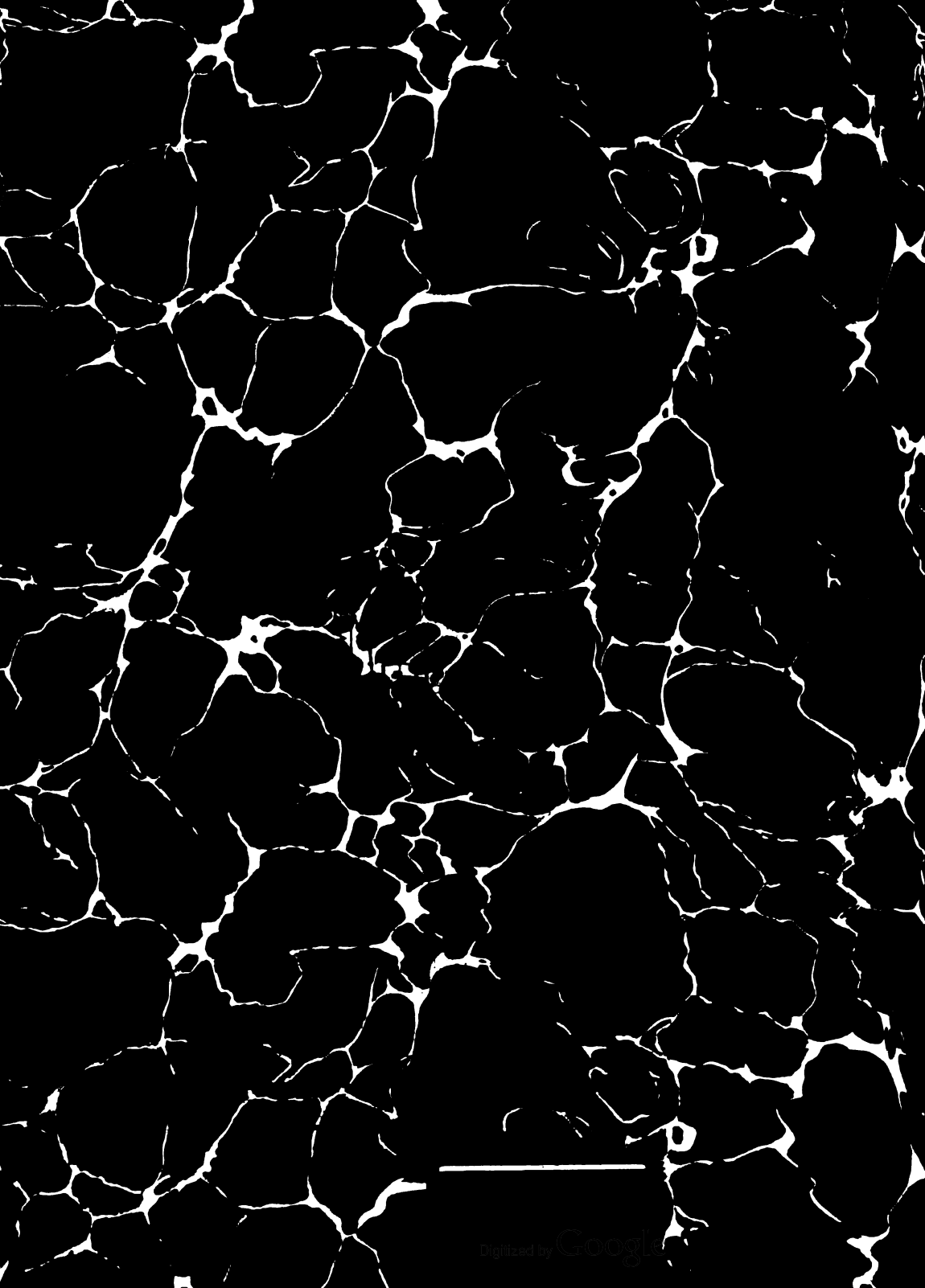
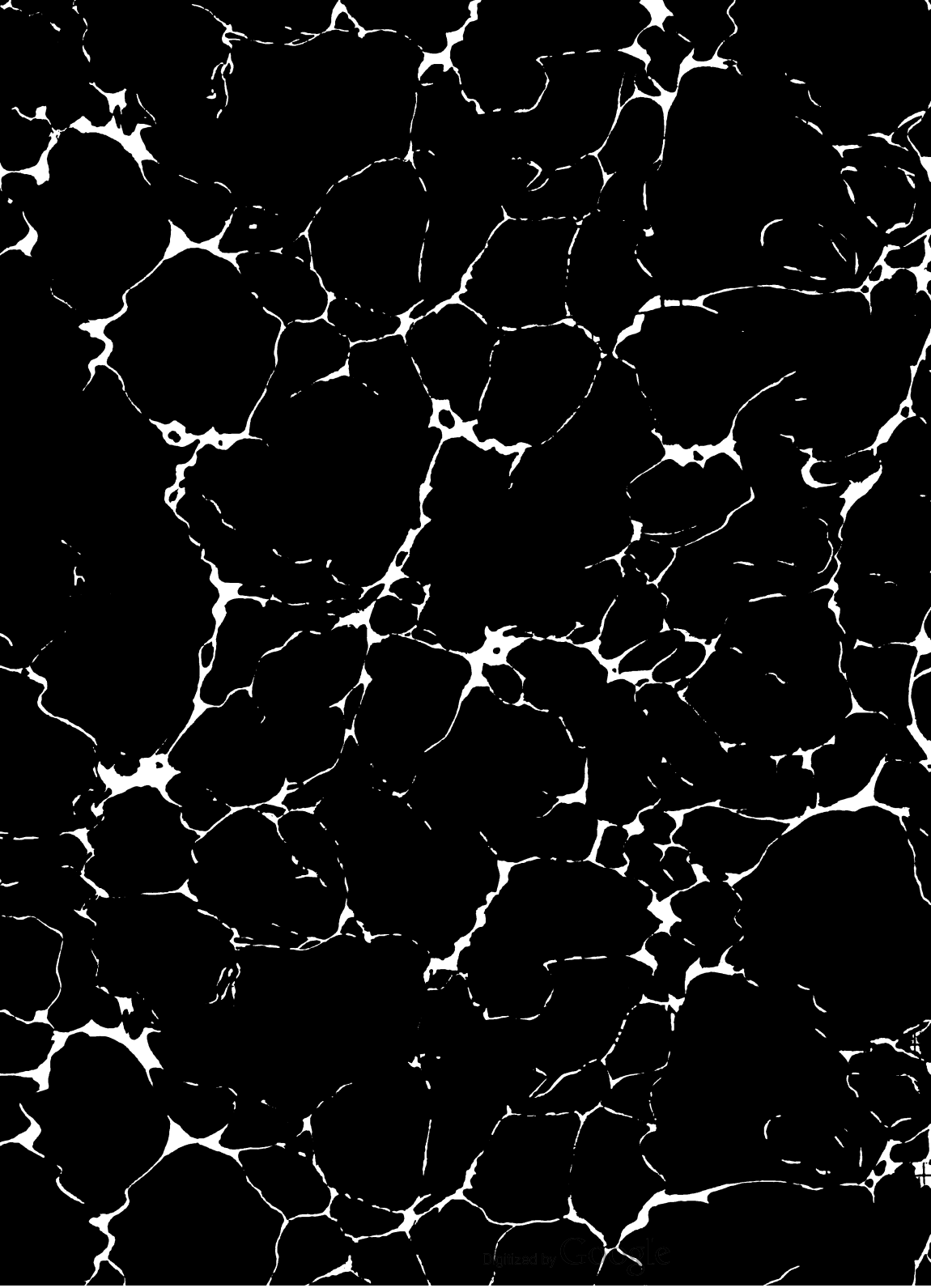


GEODAESIA

BY

John Love





Cumberland Bituminous Fluid, Sold by

J. King Chippingnorton 2:9

Thos Freeman

GEODÆSIA:

OR, THE

ART

OF

SURVEYING

AND

Measuring of Land,

Made EASIE.

SHEWING,

By Plain and Practical Rules, How to Survey, Protract, Cast up, Reduce or Divide any Piece of Land whatsoever; with New Tables for the ease of the Surveyor in Reducing the Measures of Land.

MOREOVER,

A more Facile and Sure Way of Surveying by the Chain, than has hitherto been Taught.

AS ALSO,

How to Lay-out New Lands in America, or elsewhere: And how to make a Perfect Map of a River's Mouth or Harbour; with several other Things never yet Publish'd in our Language.

By JOHN LOVE, Philomath.

Oculus mentis excæcatus & defessus, per sola Mathematica studia instauratur & excitatur, ut res ipsas cernere queat, & a rerum umbris simulachris ad veritatem, a tenebris ad lucem, a materiæ spelunca & vinculis, ad incorporeas, & invisibiles essentias sese erigere. Plato de Repub.

LONDON:

Printed for JOHN TAYLOR, at the *Ship* in S. *Paul's Church-Yard*, MDCLXXXVIII.

TO THE

HONOURABLE

ROBERT BOYLE, Esq;

A MOST

WORTHY PROMOTER

OF ALL

Truly Ingenious Knowledg,

And one of the

MEMBERS

OF THE

Royal Society:

This Small TREATISE of

GEODÆSIA,

Is humbly Dedicated, by the

Meanest of his Servants, the Author,

J. L.

Licenſed,

Feb. 16.
$168\frac{7}{8}$

ROB. MIDGLEY.

THE PREFACE TO THE READER.

WHat would be more ridiculous, than for me to go about to Praiſe an Art that all Mankind know they cannot live Peaceably without? It is near hand as ancient (no doubt on't) as the World: For how could Men ſet down to Plant, without knowing ſome Diſtinction and Bounds of their Land? But (Neceſſity being the Mother of Invention) we find the *Egyptians*, by reaſon of the *Nyles* over-flowing, which either waſht away all their Bound-Marks, or cover'd them over with Mud, brought this Meaſuring of Land firſt into an Art, and Honoured much the Profeſſors of it. The great

great Uſefulneſs, as well as the pleaſant and delightful Studie, and wholſom Exerciſe of which, tempted ſo many to apply themſelves thereto, that at length in *Egypt* (as in *Bermudas* now) every Ruſtick could Meaſure his own Land.

From *Egypt*, this Art was brought into *Greece*, by *Thales*, and was for a long time called *Geometry*; but that being too comprehenſive a Name for the Menſuration of a Superficies only, it was afterwards called *Geodæſia*; and what Honour it ſtill continued to have among the Antients, needs no better Proof than *Plato*'s ἀγεωμέτρητος οὐδεὶς ἐσιέτω. And not only *Plato*, but moſt, if not all the Learned Men of thoſe times, refuſed to admit any into their Schools, that had not been firſt entred in the *Mathematicks*, eſpecially *Geometry* and *Arithmetick*. And we may ſee, the great Monuments of Learning built on theſe Foundations, continuing unſhaken to this day, ſufficiently demonſtrate the Wiſdom of the Deſigners, in chuſing *Geometry* for their Ground-Plot.

Since

Since which the *Romans* have had ſuch an Opinion of this ſort of Learning, that they concluded that Man to be incapable of Commanding a Legion, that had not at leaſt ſo much *Geometry* in him, as to know how to Meaſure a Field. Nor did they indeed either reſpect Prieſt or Phyſitian, that had not ſome Inſight in the *Mathematicks*.

Nor can we complain of any failure of Reſpect given to this Excellent Science, by our Modern Worthies, many Noblemen, Clergymen, and Gentlemen affecting the Study thereof: So that we may ſafely ſay, none but Unadviſed Men ever did, or do now ſpeak evil of it.

Beſides the many Profits this Art brings to Man, it is a Study ſo pleaſant, and affords ſuch Wholſom and Innocent Exerciſe, that we ſeldom find a Man that has once entred himſelf into the Study of *Geometry* or *Geodæſia*, can ever after wholly lay it aſide; ſo natural it is to the Minds of Men, ſo pleaſingly inſinuating, that the *Pythagoreans* thought the Mathematicks to be only

a Reminiſcience, or calling again to mind things formerly learned.

But no longer to light Candles to ſee the Sun by, let me come to my buſineſs, which is to ſpeak ſomething concerning the following Book; and if you ask, why I write a Book of this nature, ſince we have ſo many very good ones already in our own Language? I anſwer, becauſe I cannot find in thoſe Books, many things, of great conſequence, to be underſtood by the Surveyor. I have ſeen Young men, in *America*, often nonplus'd ſo, that their Books would not help them forward, particularly in *Carolina*, about Laying out Lands, when a certain quantity of Acres has been given to be laid out five or ſix times as broad as long. This I know is to be laught at by a Mathematician; yet to ſuch as have no more of this Learning, than to know how to Meaſure a Field, it ſeems a Difficult Queſtion: And to what Book already Printed of Surveying ſhall they repair to, to be reſolved?

Alſo concerning the *Extraction of the Square Root*; I wonder that it has been ſo

ſo much neglected by the Teachers of this Art, it being a Rule of ſuch abſolute neceſſity for the Surveyor to be acquainted with. I have taught it here as plainly as I could deviſe, and that according to the Old way, verily believing it to be the Beſt, uſing fewer Figures, and once well learned, charging leſs the Memory than the other way.

Moreover, the Sounding the Entrance of a River, or Harbour, is a Matter of great Import, not only to Seamen, but to all ſuch as Seamen live by; I have therefore done my endeavour to teach the Young Artiſt how to do it, and draw a fair Draught thereof.

Many more things have I added, ſuch as I thought to be New, and Wanting; for which I refer you to the Book it ſelf.

As for the Method, I have choſe that which I thought to be the eaſieſt for a Learner; adviſing him firſt to learn ſome Arithmetick, and after teaching

him how to Extract the Square-Root. But I would not have any Neophyte discouraged, if he find the *First* Chapter too hard for him; for let him rather skip it, and go to the *Second* and *Third* Chapters, which he will find so easie and delightful, that I am perswaded he will be encouraged to conquer the Difficulty of learning that one Rule in the *First* Chapter.

From *Arithmetick*, I have proceeded on to teach so much *Geometry* as the Art of *Surveying* requires. In the next place I have shewed by what Measures Land is Surveyed, and made several Tables for the Reducing one sort of Measure into another.

From which I come to the Description of Instruments, and how to Use them; wherein I have chiefly insisted on the Semi-circle, it being the best that I know of.

The *Sixth* Chapter teacheth how to apply all the foregoing Matters together, in the Practical Surveying of any Field, Wood, *&c.* divers Ways, by divers Instruments; and how to lay down

down the ſame upon Paper. Alſo at the end of this Chapter I have largely inſiſted on, and by new and eaſie ways, taught Surveying by the Chain only.

The *Seventh, Eighth, Ninth, Tenth* and *Eleventh* Chapters, teach how to caſt up the Contents of any Plot of Land; How to lay out New Lands; How to Survey a Mannor, County or Country: Alſo, how to Reduce, Divide Lands, *Cum multis aliis.*

The *Twelfth* Chapter conſiſts wholly of *Trigonometry.*

The *Thirteenth* Chapter is of Heights and Diſtances, including amongſt other things, how to make a Map of a River or Harbour. Alſo how to convey Water from a Spring-head, to any appointed Place, or the like.

Laſtly, At the end of the Book, I have a Table of Northing or Southing, Eaſting or Weſting; or (if you pleaſe to call it ſo) A Table of Difference of Latitude and departure from the Meridian, with Directions for the Uſe thereof. Alſo a Table of Sines and Tangents, and a Table of Logarithms.

I have taken Example from Mr. *Holwell* to make the Table of *Sines* and *Tangents*, but to every Fifth Minute, that being nigh enough in all ſenſe and reaſon for the Surveyor's Uſe; for there is no Man, with the beſt Inſtrument that was ever yet made, can take an Angle in the Field nigher, if ſo nigh, as to Five Minutes.

All which I commend to the Ingenious Reader, wiſhing he may find Benefit thereby, and deſiring his favourable Reception thereof accordingly. I conclude,

READER,

Your Humble Servant,

J. L.

ADVERTISEMENT.

THE

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CHAP. XII.

This Chapter shews first the Use of the Tables of Sines and Tangents. And Secondly, contains Ten Cases for the Mensuration of Right-lin'd Triangles, very necessary to be understood by the Surveyor.

CHAP. XIII.

Of Heights and Distances.

A Cata-

A Catalogue of Books Printed for and Sold by John Taylor *at the* Ship *in* S. Paul's Church-Yard.

1. THe Travels of *Monſieur de Thevinot* into the *Levant*; in Three Parts, *viz.* I. Into *Turkie*, II. *Perſia*, III. The *Eaſt-Indies*; New done out of *French*, in *Folio*.

2. A Free Enquiry into the Vulgarly Receiv'd Notion of *Nature*; made in an Eſſay, Addreſs'd to a Friend. By the Honourable *Robert Boyle*, Eſq; Fellow of the Royal Society. The ſame is alſo in Latin, for the Benefit of Foreigners.

3. The Martyrdom of *Theodora* and of *Didymus*; by a Perſon of Honour.

4. The Declamations of *Quintilian*, being an Exercitation or Praxis upon his Twelve Books, concerning the Inſtitution of an Orator. Tranſlated (from the *Oxford*-Theatre Edition) into *Engliſh*, by a Learned and Ingenious Hand, with the Approbation of ſeveral Eminent School-Maſters in the City of *London*.

5. *England's Happineſs*, in a Lineal Succeſſion, and the Deplorable Miſeries which ever attended Doubtful Titles to the Crown; Hiſtorically demonſtrated from the Wars between the Two Houſes of *York* and *Lancaſter*.

6. *Academia Scientiarum*: Or, The Academy of Sciences. Being a Short and Eaſie Introduction to the Knowledg of the Liberal Arts and Sciences; with the Names of thoſe Famous Authors that have written on every particular Science. In *Latin* and *Engliſh*. By *D. Abercromby*, M. D.

7. Publick Devotion, and the Common-Service of the Church of *England* Juſtified, and Recommended to all Honeſt and Well-meaning (however Prejudic'd)

dic'd) Diſſenters. By a Lover of his Country, and the Proteſtant Religion.

8. The Beſt Exerciſe. To which is added, a Letter to a Perſon of Quality, concerning the Holy Lives of the Primitive Chriſtians. By *Anthony Horneck*, Preacher at the *Savoy*.

9. The Mother's Bleſſing: Or, The Godly Counſel of a Gentlewoman not long ſince Deceas'd, left behind for her Children. By Mrs. *Dorothy Leigh*.

10. The Inchanted Lover: Or, The Amours of *Narciſſus* and *Aurelia*, a Novel. By *Peter Bellon*, Author of the Pilgrim.

11. Good and Solid Reaſons why a Proteſtant ſhould not turn Papiſt, in a Letter to a *Romiſh* Prieſt.

12. Curious Enquiries, being Six brief Diſcourſes, *viz.* I. Of Longitude, II. the Tricks of Aſtrological Quacks, III. of the Depth of the Sea, IV. of Tobacco, V. Of *Europes* being too full of People, VI. The Various Opinions concerning the Time of Keeping the Sabbath.

13. The Works of Dr. *Thomas Comber*, in Four Parts, *Folio*.

14. Weekly Memorials for the Ingenious; or an Account of Books lately ſet forth in ſeveral Languages, with other Accounts relating to Arts and Sciences.

15. *Legrand*'s *Hiſtoria Sacra*.

16. Poetical Hiſtory, by *Gualtruchius*.

17. *London* Diſpenſatory, by *Nicholas Culpeper*.

18. Father *Simon*'s Critical Hiſtory of the *Eaſtern* Nations.

19. ——Hiſtory of the Progreſs of Eccleſiaſtical Revenues.

26. The Several Ways of Reſolving Faith by the Controvertiſts of the Church of *England* and the Church of *Reme*.

GEODÆSIA:

GEODÆSIA:

OR, THE

ART

OF

Measuring Land, &c.

CHAP. I.

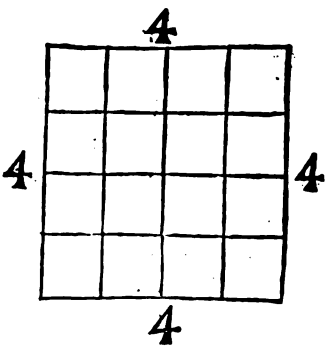
Of Arithmetick.

IT is very neceſſary for him that intends to be an Artiſt in the Meaſuring of Land, to begin with Arithmetick, as the Ground-work and Foundation of all Arts and Sciences Mathematical: and at leaſt not to be ignorant of the five firſt and Principal Rules thereof, *viz. Numeration*, *Addition*, *Subſtraction*, *Multiplication* and *Diviſion*: Which ſuppoſing every Perſon, that applies himſelf to the Study of this Art to be skilled in; or if not, referring him to Books or Maſters, every where to be found,

to learn: I ſhall name a ſixth Rule, as neceſſary, (if not more) to be underſtood by the Learner; which is the Extraction of the Square Root; without which (though ſeldom mentioned by Surveyors in their Writings) a Man can never attain to a competent Knowledg in the Art: I ſhall not therefore think it unworthy my Pains (though perhaps other Men have better done it before me) to ſhew you eaſily and briefly how to do it.

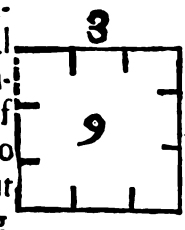
How to Extract the Square Root.

In the firſt place it is convenient to tell you what this Square Root is: It is to find out of any Number propounded a leſſer Number, which leſſer Number being multiplyed in it ſelf, may produce the Number propounded. As for Example, ſuppoſe 81 be a Number given me, I ſay 9 is the Root of it, becauſe 9 multiplyed in it ſelf, *viz.* 9 times 9, is 81. Now 8 could not be the root, for 8 times 8 is but 64: nor could 10, for 10 times 10 is 100, therefore I ſay 9 muſt needs be the Root, becauſe multiplyed in it ſelf, it makes neither more nor leſs, but juſt the Number propounded, *viz.* 81.



Again, ſuppoſe 16 be the number given, I ſay the Root of it is 4, becauſe 4 multiplyed in it ſelf makes 16. For your better underſtanding ſee this Figure, which is a great Square, containing 16 little Squares; any ſide of which great Square contains 4 little Squares: which is called the Square Root. Or

Or, ſuppoſe a plain Square Figure be given you as this in the Margent, and it be required of you to divide it into 9 ſmall Squares: Your Buſineſs is to know into how many Parts to divide any one of the Side Lines, which here muſt be into 3, and that is the Root required. But now how to do this readily is the thing I am going to teach you. The Roots of all Square Numbers under 100, you have in your Multiplication Table, however ſince it is good for you to keep them in your Mind, take this ſmall Table of them.



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 25 is 5, the Root of 64 is 8, and ſo of the reſt.

So far as 100 in whole Numbers, your Memory will ſerve you to find the Root; but if the Number propounded, whoſe Root you are to ſearch out, exceed 100, then put a Point over the firſt Figure on the Right-hand, which is the place of Unites, and ſo proceeding to the Left-hand, miſs the ſecond Figure, and put a Point over the third, then miſſing the fourth, Point the fifth; and ſo (if there be never ſo many Figures in the Number) proceed on to the end, pointing every other Figure, as you may ſee here, and ſo many Points as there are, of ſo many Figures your Root will conſiſt, which is very material to remember: Then begin at the firſt Figure on the Left-hand that has a Point over it, which will always be the firſt or ſecond Figure, and ſearch out the Root

. . . .
1234567

of that one Figure, or both joyned together if there be two, and when you have found it, or the nigheſt leſs to it, which you may eaſily do by the Table above, or your own memory, draw a little crooked Line, as in Diviſion, and there ſet it down. For Example, Let 144 be the Number whoſe Root I am to find; I ſet it down, and prick the Figures thus: Then going to the firſt Figure on the Left-hand, that has a Price over it, which is 1, and ſee what the Root of it is, which is 1 alſo; I therefore draw a crooked Line, as in the Margent, and ſet down 1 in the Quotient, then if 1 admitted of any Multiplication, I ſhould multiply it by it ſelf, but ſince once 1 is but 1, I ſubſtract it out of the firſt prick'd Figure on the Left-hand, and there remains 0, ſo that I cancel that firſt Figure, as having wholly done with it: If any thing had remained after the Subſtraction, I ſhould have put the remainder over it. The next thing to be done, is to double what is already in the Quotient, which makes 2, which 2 I write down under the next Figure, *viz.* 4, which has no Point over it, and then ſee how oft I can have 2 in 4: Anſwer, twice; I therefore ſet down 2 in the Quotient, and 2 likewiſe under the next pointed Figure, which in this Example is 4, then that 22 which ſtands under the 44 muſt be multiplyed by the 2 in the Quotient, whoſe Product is 44, which ſubſtracted out of 44, there remains 0: But you may multiply and ſubſtract together thus, twice 2 is 4, which I take out of 4, and there remains 0, then I cancel the firſt 4 and 2 to the Left-hand, as having done with them; then again, twice 2 is 4, which taken out of 4 leaves 0, and then I cancel the laſt 4 and 2, and the Queſtion is anſwered,

ed,

ed, for there is 12 in the Quotient, which is the Root of 144, which may eaſily be proved by multiplying 12 by 12.

Take another Example: Let the ſumm be 54756 (2
Firſt ſee what the Root of 5 is, which is 2, and place it in the Quotient, and under the firſt pointed Figure both, as you ſee here, then ſay two times 2 is 4, which taken out of 5, there remains one, and ſo have you done with the firſt Point. Next double the Quotient, which makes 4, and place it as you ſee here, under the Figure void of a Point, then ſee how many times 4 you can have in 14, anſwer 3 times, which 3 place both in the Quotient, and under the next pointed Figure, which is 7; then multiply and ſubſtract, ſaying three times 4 is 12, which taken out of 14 leaves 2, which 2 write over the 4, and cancel both the 4 and the 1, as you do in Diviſion: And three times 3 is 9, which taken out of 27, reſts 18; which write over head, and cancel what Figures you have done with, no otherwiſe than in Diviſion, and ſo have you done with the firſt two Points. Now for the third pointed Figure, or if there were never ſo many more of them, they are done altogether as the ſecond: *viz.* Double again your Quotient, it makes 46, which put down as you ſee here, always obſerving this Rule, That the laſt Figure of the doubled Quotient, I mean that in the place of Unites, ſtand under the next, void of Points: And thoſe of your Left hand of him, *viz* in the places of Tens or Hundreds, in order before him, as you do in Diviſion, as you may ſee here: Then proceed, and ſay, how many times 46 can

1
128
54756(23
2436
4

can I have in 185, or rather how many times 4 in 18: here Essay, as you do in Division, and see if you can have it four times, remembring the 4 that must be put down under the pointed Figure, and when you find you can have it four times, write it down in the Quotient, and also under your last pointed Figure; then say four times 4 is 16, out of 18, there rests 2, which write down, and cancel the 18 and 4. Again, four times 6 is 24, out of 25, rests 1; which put down, and cancel the 2, 5, and 6. Again, four times 4 is 16, out of 16, rests 0: and so have you done, and find the Root to be 234.

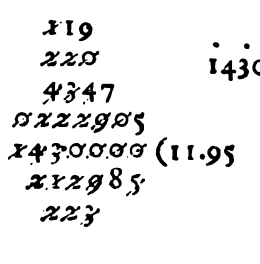
12
128.10
54756(234
24364
4

I'll add but one Example more for your practice: Let the Number, whose Root is required be 12345678, see the working of it.

2 0
3 04549
12345678(3513
3650123
770

But in this you see there is a Fraction remains, and so there will be in most Numbers, for we seldom happen upon a Number exactly Square: the Fractional Part must therefore thus be taken: before you begin to extract, add to your Number given two Cyphers, if you desire to know but to the tenth part of an Unite; but if to an hundredth part add four Cyphers, if to a thousandth part of an Unite, add six Cyphers, and then work, as before, as if it was all one entire Number, and look how many Points were placed over the Number first given, so many places of Integers will be in the Root; the rest of the Root towards the Right-hand, will be the Numerator of a Decimal Fraction. For Example, let 143 be the Number given to be extracted, and to

to know the Decimal Fraction as near as to the hundredth part of an Unite; I write it down as before, annexing four Cyphers to the end of it, as you see hereunder; and after having wrought it, there comes out in the Quotient 1195, but because I had but two Points over the first Number given, *viz.* 143, I therefore at the end of two Figures in the Quotient put a Point, which parts the whole Number from the Fraction; that 11 on the Left-hand being Integers, and the 95 on the Right Centesms of an Unite, which you may either write as above, or thus, $11\frac{95}{100}$ if you please.



There are other ways taught by Arithmeticians for finding out the Square Root of any Number; but I know no way so concise as this, and after a little practice, so easie and ready, or to be wrought with as few Figures. To do it indeed by the Logarithms or Artificial Numbers, is very easie and pleasant, but Surveyors have not always Books of Logarithms about them, when they have occasion to extract the Square Root: However I will briefly shew you how to do it, and give you one Example thereof.

When you have any Number given whose Square Root you desire, seek for the given Number in the Tables of Logarithms under the Title Numbers, and right against it, under the Title Logarithms, you will find the Logarithm of the said Number, the half of which is the Logarithm

rithm of the Root desired: Which half seek for under the Title Logarithm, and right against it under the Title Number, you will find the Root.

EXAMPLE.

Let 625 be the Number whose Root is desired: First I seek for it under the Title Numbers, and right against it I find this *Log.* 2,795880, which I divide by 2, or take the half of it as you see: *Half.* 1,397940, And finding that half under the Title Log. right against it is 25, the Root desired. See the same done by the former way with less trouble.

$$\begin{array}{l} x\ 0 \\ \dot{6}x\dot{5}(25\ \text{Root.} \\ x\dot{4}\dot{5} \end{array}$$

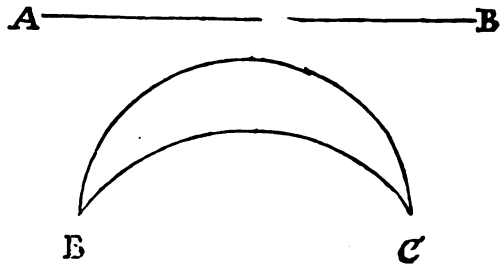
CHAP.

CHAP. II.

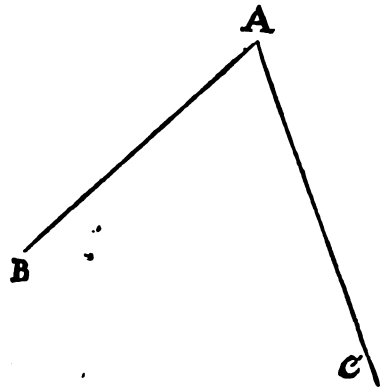
Geometrical Definitions.

A Point is that which hath neither Length nor Breadth, the leaſt thing which can be imagined, and which cannot be divided, commonly marked as a full Stop in Writings thus(.)

A Line has Length, but no Breadth nor thickneſs, and is made by many Points joyned together in length, of which there are two ſorts, *viz.* Streight and Crooked. As, A B is a Streight Line, B C two Crooked Lines.

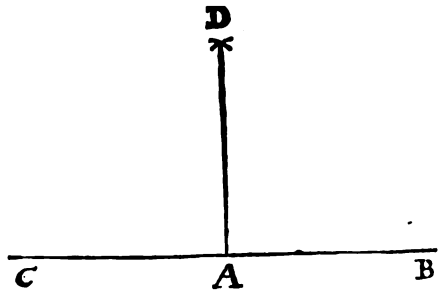


An Angle is the meeting of two Lines in a Point; provided the two Lines ſo meeting, do not make one Streight Line, as the Line A B, and the Line A C, meeting together in the Point A, make the Angle B A C.



Of which Right-lined Angles there are three ſorts, *viz.* Right Angled, Acute, Obtuſe.

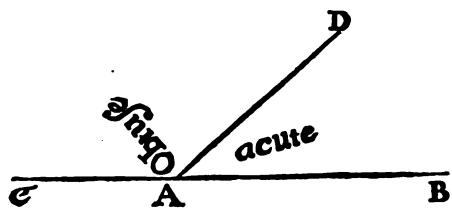
When a Line falleth perpendicularly upon another Line, it maketh two Right Angles.



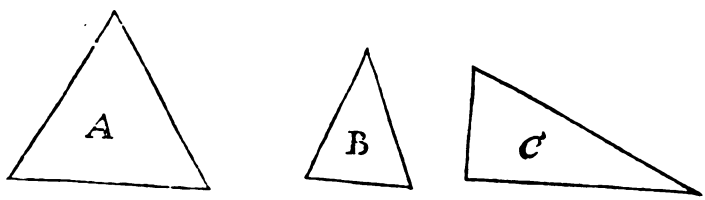
E X A M P L E.

Let C A B be a Right Line, D A a Line Perpendicular to it, that is to ſay, neither leaning towards B or C, but exactly upright; then are both the Angles at A, *viz.* D A B, and D A C, Right Angles; and contain

contain each juſt 90 Degrees, or the fourth part of a Circle; but if the Line D A had not been Perpendicular, but had leaned towards B, then had D A C been an Obtuſe Angle, or greater than a Right Angle, and D A B an Acute Angle, or leſſer than a Right Angle, as you ſee hereunder.



All Figures contained under three Sides are called Triangles, as A, B, C.



Where note, The Triangle A hath three equal ſides, and is called an Equilateral Triangle.

The Triangle B hath two Sides equal, and the third unequal, and is called an Iſoſceles Triangle.

The Triangle C hath three unequal Sides, and is called a Scalenum.

Of four Sided Figures there are theſe Sorts :

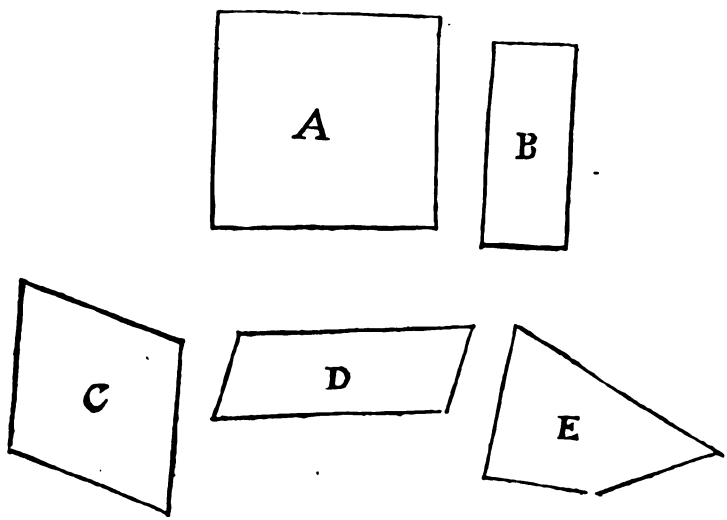
Firſt, a Square, whoſe Sides are all equal, and Angles Right, as A.

Secondly, A Long Square, or Parallelogram, whoſe Oppoſite Sides are equal, and Angles Right, as B.

Thirdly, A Rhombus, whoſe Sides are all Equal, but no Angle Right, as C.

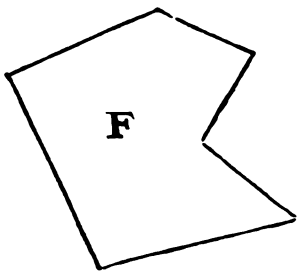
Fourthly, A Rhomboides, whoſe Oppoſite Sides only are Equal, and no Right Angles, as D.

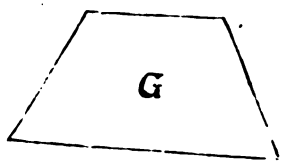
All other four Sided Figures are called Trapezia, as E.



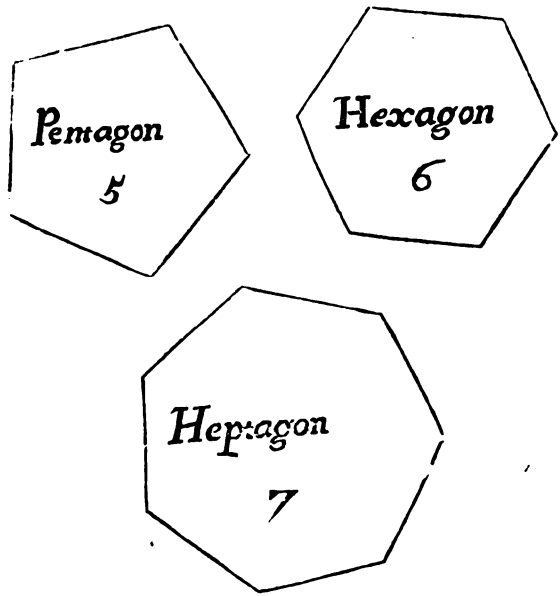
Other

Other Figures that are contained under 5, 6, 7, or more Sides, I call Irregular, as F G, *&c.* Except

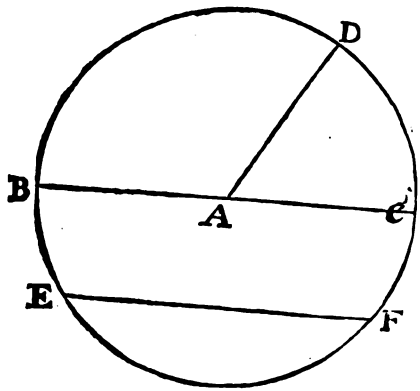




ſuch as are made by dividing the Circumference of a Circle into any number of Parts; for then they are Regular Figures, having all their Sides and Angles Equal; and are called according to the number of Right Lines the Circle is divided into, or more properly according to the Number of Angles they contain, as a Pentagon, Hexagon, Heptagon, Octogon, *&c.* Which in plain Engliſh is no more than a Figure of Five, Six, Seven or Eight Angles; which Angles are all equal one to another, and their Sides conſequently all of the ſame length. And thus (though I mention no more than 8,) the Circumference of the Circle may be divided into as many Parts as you pleaſe; and the Regular Figures ariſing out of ſuch diviſions, are called according to the number of Parts the Circle is divided into; ſee for your better underſtanding theſe two or three following.



A Circle is a Figure determined with one Endleſs Line, as A. Which Line is called the Circumference of the Circle, in the Middle whereof is a Prick or Point, by which the Circle is deſcribed, which is called the Center, from which Point or Center all Streight Lines drawn to the Circumference are Equal, or of the ſame Length, as AB, AC, AD.



The

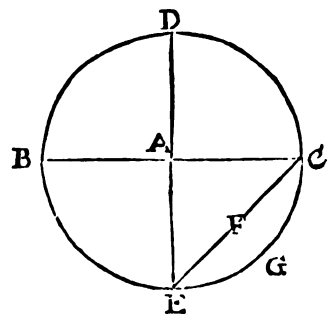
The Diameter of a Circle, is a Line which paſſing through the Center, cuts the Circle into two Equal Parts, or the longeſt Streight Line that can be made in any Circle; as B C.

The Semi-Diameter, is the half of the above-mentioned Line, as A B, A C, or A D, either of which is called a Semi-Diameter.

A Chord, is any Line ſhorter than the Diameter, which paſſeth from one part of the Circumference to another, as E F.

A Semicircle is the half of a Circle, as B D C, or B E C.

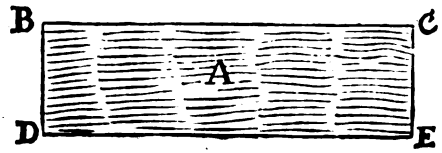
A Quadrant is the fourth part of a Circle, made by two Diameters perpendicularly interſecting each other, as A B D, A D C, A B E, A E C, either of which is a Quadrant, or the fourth part of a Circle.



A Section, Segment, or part of a Circle is a piece of the Circle cut off by a Chord Line, and is greater or leſs than a Semicircle, as E C F G is a Segment of the Circle E B D C G, likewiſe E B D C F is the greater Segment of the ſame Circle.

A Superficies is that which hath both length and breadth, but no thickneſs: whoſe Bounds are Lines, as A is a Superficies or Plain contained in theſe Lines B C, D E, B D, C E, which hath length from B to C, and Breadth from B to D, but no Thickneſs.

When



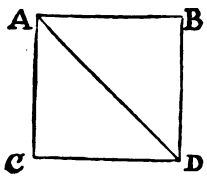
When these bounding Lines are measured, and the Content of the Superficies cast up, the result is called the Area, or Superficial Content of that Figure.

EXAMPLE.

Suppose the Line B C to be twelve foot in Length, and the Line B D, to be four Foot long, they multiplyed together make 48; therefore I say 48 Square Feet is the Area or Superficial Content of that Figure.

When two Lines are in every Part equidistant from each other, they are called Parallel Lines, as the Lines A B and C D, which tho produced to never so great a Length, would come no nearer to each other, much less meet.

A——————B
C——————D



A Diagonal Line is a Line running through a Square Figure, dividing it into two Triangles, beginning at one Angle of the Square, and proceeding to the Opposite Angle. In the Square A B C D, A D is the Diagonal Line.

CHAP.

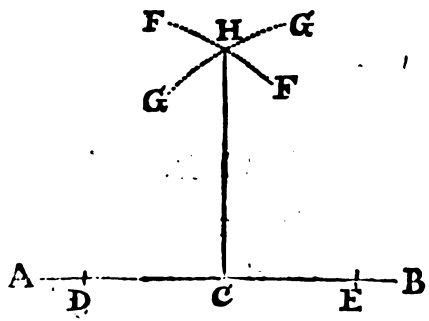
CHAP. III.

Geometrical Problems.

PROB. I.

How to make a Line Perpendicular to a Line Given.

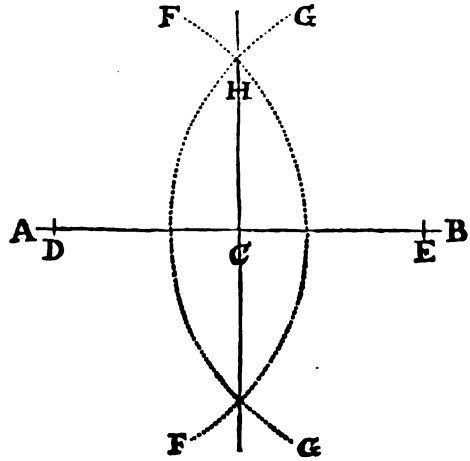
THE Line given is AB, and at the Point C it is required to erect a Line which ſhall be Perpendicular to AB.



Open your Compaſſes to any convenient wideneſs, and ſetting one Foot of them in the Point C, with the other make a Mark upon the Line at E, and alſo at D; then taking off your Compaſſes, open them a little wider than before, and ſetting one Foot in the Point D, with the other deſcribe the Arch F F, then without altering your Compaſſes, ſet one Foot in the Point E, and with the other deſcribe the Arch G G.

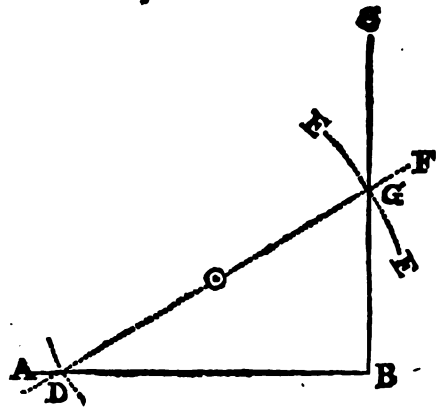
Laſtly, Lay your Ruler to the Point C, and the Interſection of the two Arches G G and F F, which is at H, and drawing the Line H C, you have your deſire, H C being Perpendicular to A B.

See it here done again after the very ſame manner, but may perhaps be plainer for your Underſtanding.



PROB. ii.

How to raiſe a Perpendicular upon the End of a Line.



A B

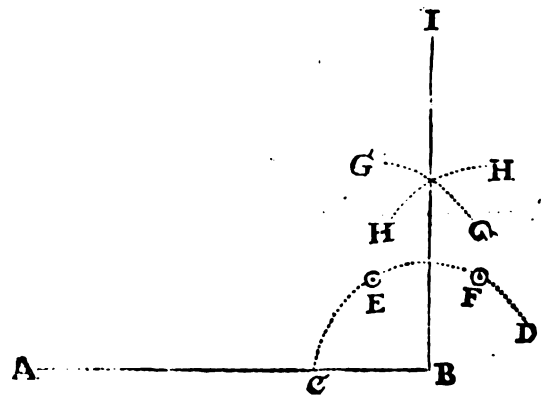
A B is the Line given, and at B it is required to erect the Perpendicular B C.

If you have room you may extend the Line A B to what length you pleaſe, and work as above; but if not, then thus you may do it:

Open your Compaſſes to an ordinary extent, and ſetting one Foot in the Point B, let the other fall at adventure, no matter where in Reaſon, as at the Point ⊙, then without altering the extent of the Compaſſes, ſet one Foot in the Point ⊙, and with the other croſs the Line A B as at D: Alſo on the other ſide deſcribe the Arch E; then laying your Ruler to D and ⊙ draw the prickt Line D ⊙ F. Laſtly, from the Point B, you began at, through the Interjection at *g* draw the Line B *g* C, which is perpendicular to A B.

Another way to do the ſame, I think more eaſie, though indeed almoſt the ſame.

Let A B be the given Line, B I the Perpendicular required.

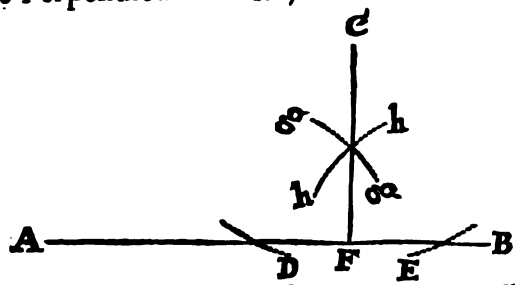


Set one Foot of your Compaſſes in B, and with the other at any ordinary extent deſcribe the Arch C E F D, then keeping your Compaſſes at the ſame extent, ſet one Foot in C, and make a Mark upon the Arch at E; alſo ſetting one Foot in E, make another Mark at F, then opening your Compaſſes, or elſe with the ſame Extent, which you pleaſe, ſet one Foot in E, and with the other deſcribe the Arch G G, alſo ſetting one Point in F, make the Arch H H, then drawing a Line through the interſection of the Arches G and H, to the Point firſt propoſed B, you have the Perpendicular Line I B.

PROB. iii.

How from a Point aſſigned, to let fall a Perpendicular upon a Line given.

The Line given is A B, the Point is at C, from which it is deſired to draw a Line down to A B, that may be Perpendicular to it;



Firſt, ſetting one Foot of your Compaſſes in the Point C, with the other make a Mark upon the Line A B, as at D, and alſo at E, then opening your Compaſſes wider, or ſhutting them cloſer, either will do; ſet

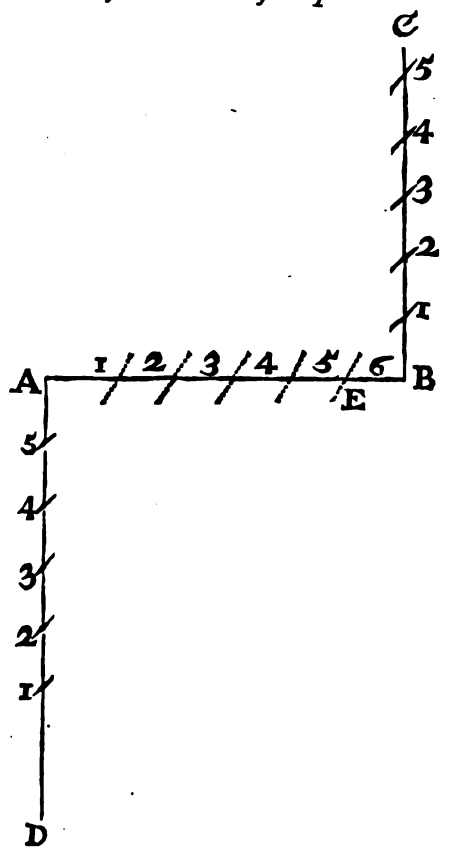
ſet one Foot in the Point of Interſection at D, and with the other deſcribe the Arch *g g*, the like do at E, for the Arch *h h*: Laſtly, from the Point aſſigned, through the Point of Interſection of the two Arches *g g*, and *h h*, draw the Perpendicular Line C F. This is no more but the Firſt Problem reverſed: The ſame you may do by the ſecond Problem, *viz.* let fall a Perpendicular nigh the end of a given Line.

PROB. iv.

How to divide a Line into any Number of Equal Parts.

A B is a Line given, and it is required to divide it into 6 equal Parts.

Make at the Point B a Line Perpendicular to A B, as B C; do the ſame at A the contrary way, as you ſee here; open your Compaſſes to any convenient Wideneſs, and upon the Lines B C, and A D, mark out five Equal Parts; for it muſt be always one leſs than the Number you intend to divide the Line into: which parts you may number, as



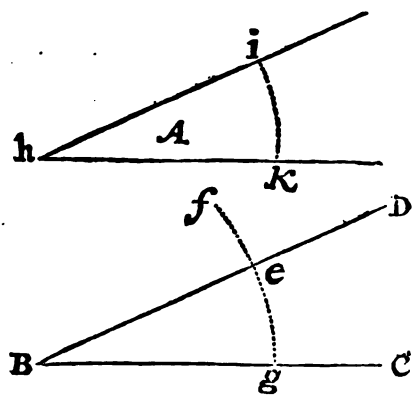
you

you ſee here, thoſe upon one Line one way, and the other the contrary way; then laying your Ruler from No. 1. on the Line B C, to No. 1. on the Line A D, it will interſect the Line A B at E, which you may mark with your Pen, and the Diſtance between B and E, is one ſixth part of the Line; ſo proceed on 'till you come to No. 5. and then you will find that you have divided the given Line into ſix Equal Parts, as required.

PROB. V.

How to make an Angle Equal to any other Angle given.

The Angle given is A, and you are deſired to make one Equal to it.



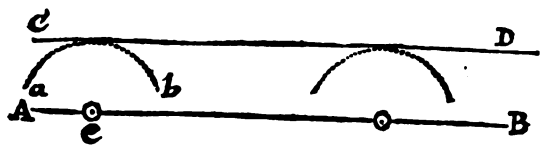
Draw the Right Line B C, then going to the Angle A, ſet one Foot of your Compaſſes in the Point *h*, and with the other at what Diſtance you pleaſe deſcribe

ſcribe the Arch I K, then without altering the extent of the Compaſſes, ſet one Foot in B, and draw the like Arch, as *f g*; after that meaſure with your Compaſſes how far it is from K to I, and the ſame diſtance ſet down upon the Arch from *g* towards *f*, which will fall at E, after draw the Line B E D, and you have done.

PROB. vi.

How to make Lines Parallel to each other.

A B is a Line given, and it is required to make a Line parallel unto it.



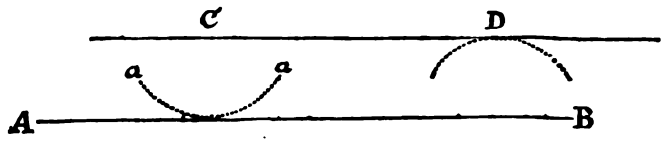
Set one foot of your Compaſſes at or near the end of the given line as at C, and with the other deſcribe the Arch *a b*; do the ſame near the other end of the ſame line, and through the utmoſt convex of thoſe two Arches draw the Parallel line C. D.

PROB.

PROB. vii.

How to make a Line Parallel to another Line, which muſt alſo paſs through a Point aſſigned.

Let A B be the given line, C the point through which the required Parallel line muſt paſs.



Set one foot of your Compaſſes in C, and cloſing them ſo that they will juſt touch, (and no more) the Line AB: deſcribe the Arch *a a*; with the ſame extent in any part of the given Line ſet one Foot, and deſcribe another Arch as at D: then through the aſſigned Point, and the utmoſt Convex of the laſt Arch, draw the required Line CD, which is Parallel to AB, and paſſeth through the Point C.

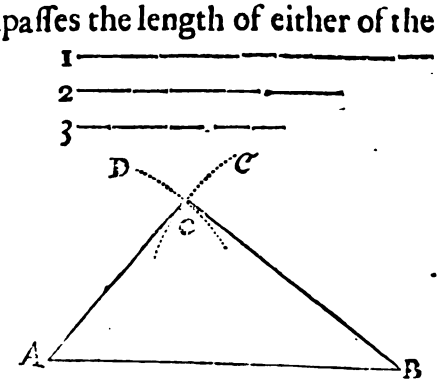
PROB. viii.

How to make a Triangle, three Lines being given you.

Let the three lines given be 1, 2, 3, The Queſtion is how to make a Triangle of them.

Take

Take with your Compaſſes the length of either of the three, in this Example; let it be that No. 1. *viz.* the longeſt, and lay it down as hereunder from A to B; then taking with your Compaſſes the Length of the Line 2, ſet one Foot in B, and make the Arch C; alſo taking the length of the laſt Line 3. place your Compaſſes at A, and make the Arch D, which will interſect the Arch C at the Point E; from which Point of Interſection draw Lines to A B, which ſhall conſtitute the Triangle A E B; The Line A B being equal to the line No. 1, B E to No. 2, A E to No. 3.

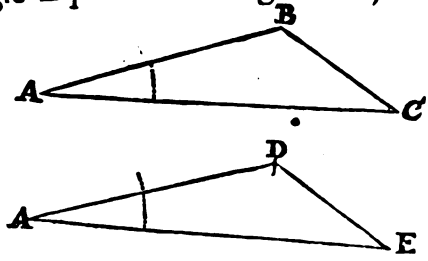


PROB. ix.

How to make a Triangle equal to a Triangle given, and every way in the ſame Proportion.

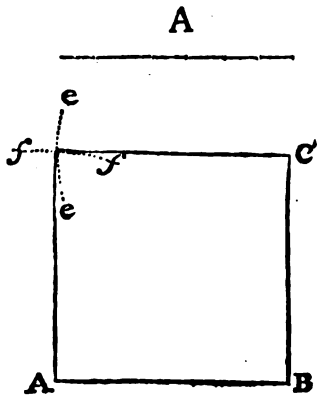
Firſt make an Angle Equal to the Angle at A, as you were taught in PROB. v. Then making the Lines A D and A E equal to A B and A C, draw the Line D E.

Or otherwiſe you may do it as you were taught in PROB. viii.



PROB. x.

How to make a Square Figure.



Let A be a Line given, and it is required to make a ſquare Figure, each ſide of which ſhall juſt be the length of the Line A.

Firſt lay down the length of your Line A, as A B.

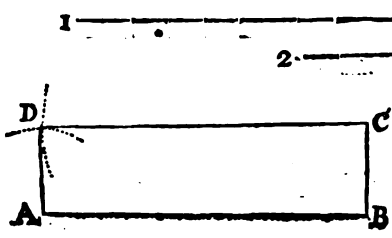
Secondly, raiſe a Perpendicular of the ſame length at B.

Thirdly, take the length of either of the aforementioned Lines with your Compaſſes, and ſetting one Foot in C deſcribe the Arch *e e*; do the like at A, and deſcribe the Arch *f f*.

Fourthly, draw Lines from A and C into the Point of Interſection, and the Square is finiſhed.

PROB. xi.

How to make a Parallelogram, or long Square.



This is much like the former. Admit two Lines be given you, as 1, 2, and it is required to make a Parallelogram of them: What a Parallelogram

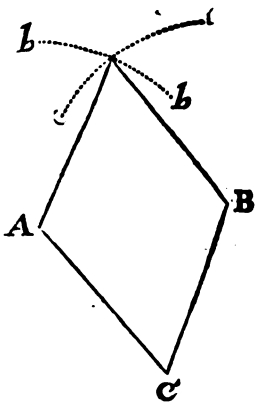
logram is, you may ſee in the Second Chapter of *Definitions.*

Firſt, lay down your longeſt Line, as A B, upon the End of which erect a Perpendicular Line, equal in Length to your ſhorteſt Line, and ſo proceed, as you were taught in the foregoing Problem.

PROB. xii.

How to make a Rhombus.

Firſt make an Angle, ſuppoſe A C B, no matter how great or ſmall; but be ſure let the two Lines be of equal length; then taking with your Compaſſes the length of one of thoſe two Lines, ſet one Foot in A, and deſcribe the Arch *b b*; alſo ſet one Foot in B, and deſcribe the Arch *c c.* Laſtly, draw Lines, and it is finiſhed. Two Equilateral Triangles is a Rhombus.

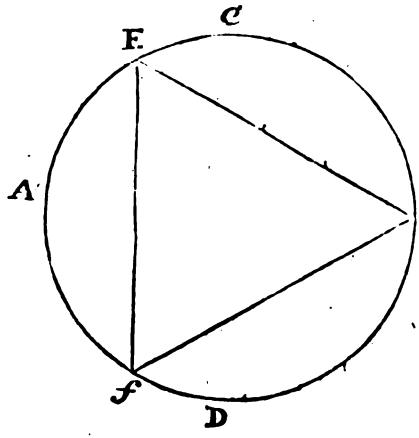


A Rhomboides differs juſt ſo much, and no more from a Rhombus, as a Parallelogram does from a true Square; it is needleſs therefore, I preſume, to ſhew you how to make it.

PROB. xiii.

How to divide a Circle into any number of Equal Parts, not exceeding ten, or otherwise how to make the Figures called, Pentagon, Hexagon, Haptagon, Octogon, *&c.*

Let A B C D be a Circle, in which is required to be made a Triangle, the greateſt that can be made in that Circle.



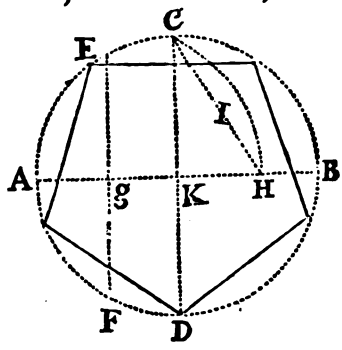
Keeping your Compaſſes at the ſame extent they were at when you made the Circle, ſet one Point of them in any part of the Circle, as at A, and with the other make a Mark at E and *f*, and draw a Line between E and *f*, which will be one Side of the Triangle.

I need not tell you how to make the other two Sides, for it is an Equilateral Triangle, all three Sides being of Equal Length.

To

To make a Pentagon or Five-ſided Figure.

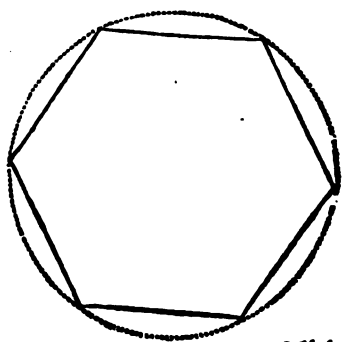
Draw firſt an obſcure Circle, as A B C D; then draw a Diameter from A to B; make another Diameter Perpendicular to the firſt, as C D; then taking with your Compaſſes the Length of the Semi-Diameter, ſet one Point in A, and make the Marks E F, drawing a Line between them, as you did to make the Triangle.



Next, ſet one Point of your Compaſſes in the Interſection at *g*, and extend the other to C, draw the Arch C H: The neareſt Diſtance between C and H, *viz.* the Line C I H, is the Side of a Pentagon, and the greateſt that can be made within that Circle: Which with the ſame extent of your Compaſſes you may mark out round the Circle, and drawing Lines, the Figure will be finiſhed.

To make a Hexagon or Six-ſided Figure.

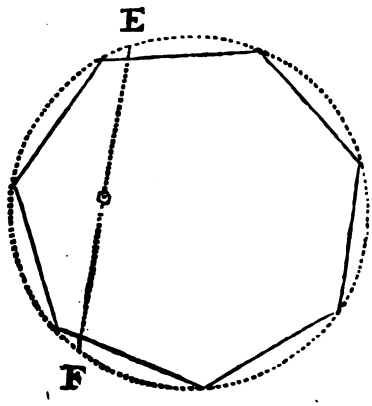
Draw an obſcure Circle, as you ſee here, and then without altering the extent of the Compaſſes, mark out the Hexagon required round the Circle; for the Semidiameter of any Circle is the ſide of the greateſt Hexagon that can be made within the ſame Circle.



This

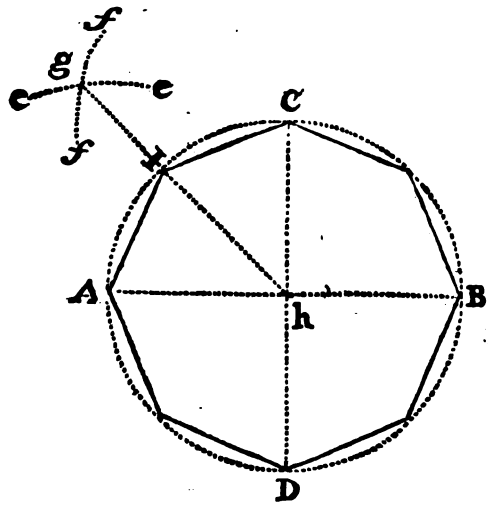
This is the way Coopers uſe, to make Heads for their Casks.

To make a Heptagon, or Figure of Seven, equal Sides and Angles.



You muſt begin and proceed as if you were going to inſcribe a Triangle in a Circle, till you have drawn the Line E F; then taking with your Compaſſes the half of that Line, *viz.* from ⊙ to E, or from ⊙ to F, mark out round the Circle your Heptagon, for the half of the Line E F is one ſide of it.

To make an Octogon, commonly called an Eight-ſquare Figure.



Firſt

Firſt make a Circle.

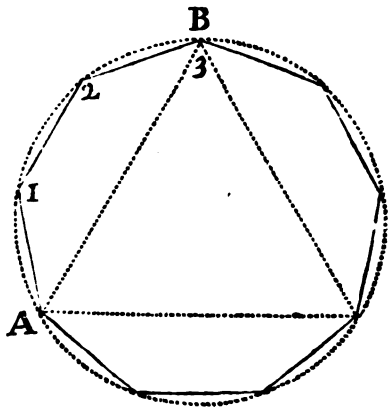
Secondly, divide it into four equal Parts by two Diameters, the one perpendicular to the other, as A B and C D.

Thirdly, Set one Foot of the Compaſſes in A, and make the Arch E E; alſo with the ſame extent ſet one foot in C, and make the Arch *f f*; then through the Interſection of the two Arches draw a Line to the Center, *viz. g h.*

Laſtly, Draw the Line I C or I A, either of which is the ſide of an Octagon.

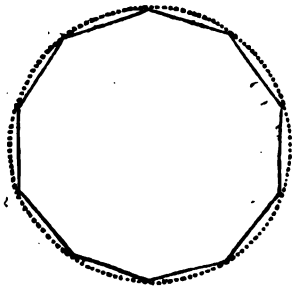
To make a Nonagon.

Firſt make a Circle, and a Triangle in it, as you were taught at the beginning of this Problem. Then divide one third part of the Circle. As for Example, that A, 1,2,3,B, into three equal Parts. Laſtly, draw the lines A1,1,2,2B, *&c.* each of theſe Lines is the ſide of a *Nonagon.*



To

To make a Decagon.

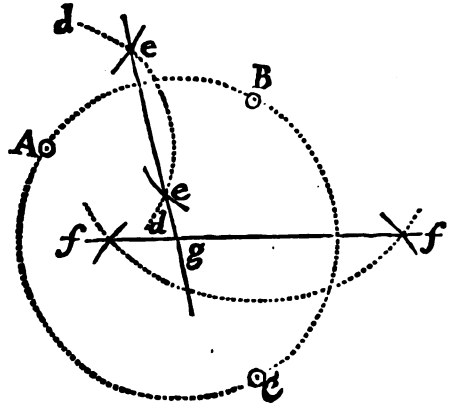


You muſt work altogether as you did in making a *Pentagon*: See the *Pentagon* above, where the diſtance from the Centre K to the Point at H is the ſide of a *Decagon* or Ten-ſided Figure.

PROB. xiv.

Three Points being given: How to make a Circle, whoſe Circumference ſhall paſs through the three given Points, provided the three Points are not in a ſtreight Line.

Let A, B, C, be the three Points given; firſt ſetting one foot of your Compaſſes in A, open them to any convenient wideneſs, more than half the di-



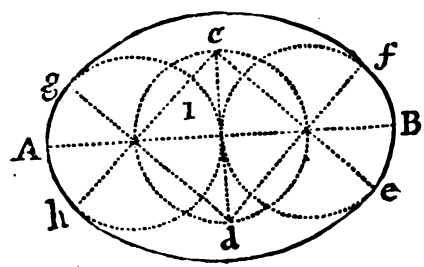
ſtance

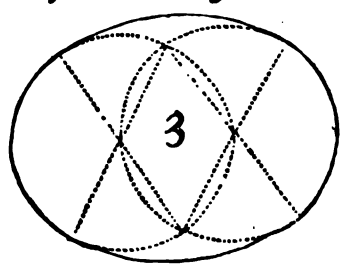
ſtance between A and B, and deſcribe the Arch *d d*; then without altering the extent, ſet one point in B, and croſs the firſt Arch at E and E, through thoſe two Interſections draw the Line E E.

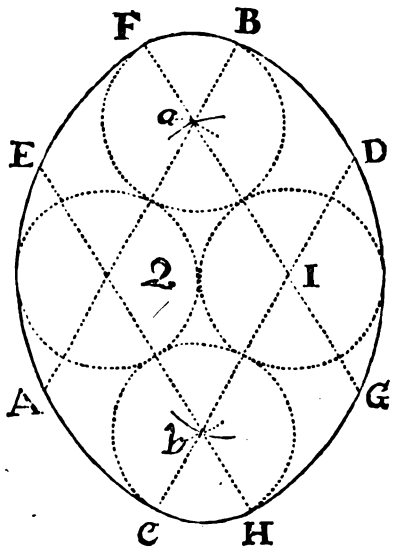
The very ſame you muſt do between B and C, and draw the Line *f f*; where theſe two Lines interſect each other, as at *g*, there is the Centre of the Circle required; therefore ſetting one foot of your Compaſſes in *g*, extend the other to either of the Points given, and deſcribe the Circle A B C. Note the Centre of a Triangle is found the ſame way.

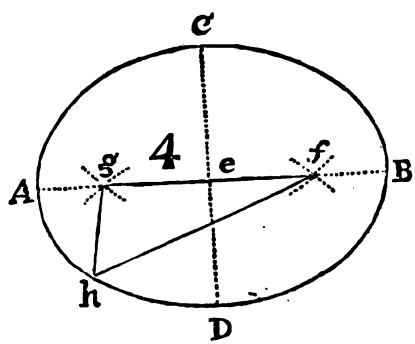
PROB. XV.

How to make an Ellipſis, or Oval ſeveral ways.









F *Fig.* 1.

Fig. 1. Make three Circles whoſe Diameters may be in a ſtreight Line, as A B: Croſs that Line with another Perpendicular to it, at the Centre of the middle Circle, as *c d*: draw the Lines *c e*, *c h*, *d g*, *d f*. Set one foot of the Compaſſes in D, and extend the other to *g*, deſcribing the part of the Ellepſis *g f*; with the ſame extent, ſetting foot one in *c*, deſcribe the other part *h e*: The two Ends are made by parts of the two outermoſt ſmall Circles, as you ſee *f e*, *g h*.

Fig. 2. Draw two ſmall Circles, whoſe circumference may only touch each other: Then taking the diſtance between their Centers, or either of their Diameters, ſet one foot of your Compaſſes in either of their Centres, as that marked 2, and with the other make an Arch at *a*, alſo at *b*; then moving your Compaſſes to the Centre of the other Circle, croſs the ſaid Arches at *a* and *b*, which Croſſes let be the Centres of two other Circles of equal bigneſs with the firſt. Then through the Centres of all the Circles draw the Lines A B, C D, E H, F G; which done, place one foot of the Compaſſes in the Centre of the Circle I, and extend the other to C, deſcribing the Arch of the Ellipſis C E: The ſame you muſt do at 2, to deſcribe the part B H, and then is your Ellipſis finiſhed.

Fig. 3. This needs no Deſcription, it being ſo like the two former Figures, and eaſier than either of them.

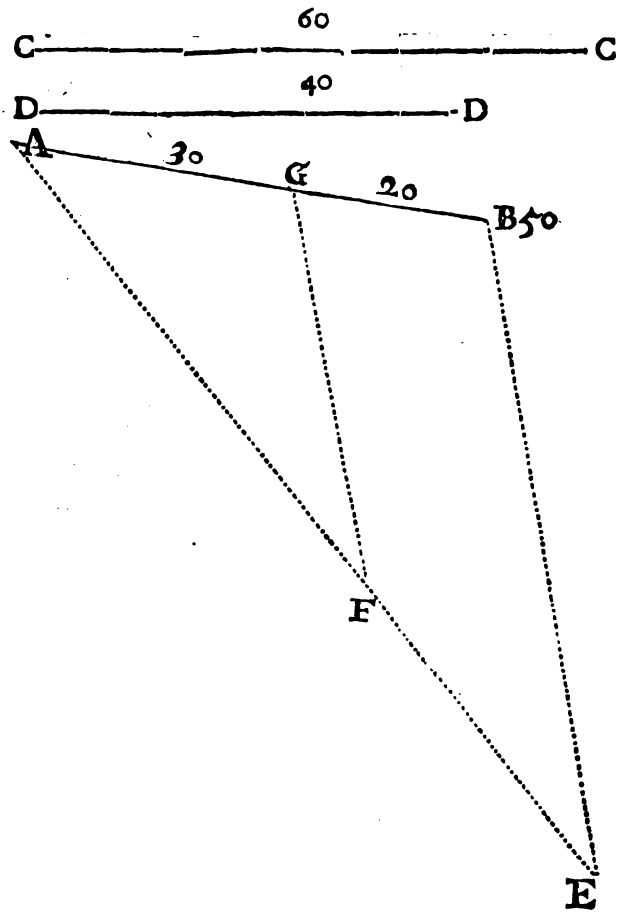
Here Note, that you may make the Ovals 1 and 3 of any determined length: for in the length of the firſt, there is four Semi-diameters, of the ſmall Circles; and in the laſt but three: If therefore any Line was given you, of which length an Oval was required, you muſt take in with your Compaſſes the fourth

fourth part of the Line, to make the the Oval *Fig.* 1. and the third part to make the Oval *Fig.* 3; and with that extent you muſt deſcribe the ſmall Circles: The Breadth will be always proportional to the Length. But if the Breadth be given you, take in alſo the fourth part thereof, and make the Oval *Fig.* 2.

Fig. 4. This Ellipſis is to be made, having Length and Breadth both given. Let A B be the Length, C D the Breadth of a required Oval. Firſt lay down the Line A B equal to the given length, and croſs it in the middle with the Perpendicular C D, equal to the given Breadth. Secondly, take in half the Line A B with your Compaſſes, *viz.* A E, or B E; ſet one foot in C, and make two marks upon the Line A B, *viz.* *f* and *g*; alſo with the ſame extent ſet one foot in D, and croſs the former marks at *f* and *g*. Thirdly, at the Points *f* and *g*, fix two Pins; or if it be a Garden-plat, or the like, two ſtrong Sticks. Then putting a Line about them, make faſt the two ends at ſuch an exact length, that ſtretching by the two Pins, the bent of the Line may exactly touch A or B, or C or D, or *h*, as in this Diagram it does at *h*; ſo moving the Line ſtill round, it will deſcribe an exact Oval.

PROB. xvi.

How to divide a given Line into two Equal Parts, which may be in such Proportion to each other, as two given Lines.



Let

Let A B be the given Line to be divided in ſuch Proportion as the line C is to the line D.

Firſt from A draw a Line at pleaſure, as A E; then taking with your Compaſſes the line C, ſet it off from A towards E, which will fall at F: Alſo take the line D, and ſet off from F to E.

Secondly, draw the line E B; and from F make a line parallel to e b, as F G, which ſhall interſect the given line A B in the Proportional Point required, *viz* at G; making A G and G B in like proportion to each other, as C C and D D.

Example by Arithmetick.

The line C C is 60 Feet, Perches, or any thing elſe; the line D D is 40; the line A B is 50; which is required to be divided in ſuch proportion as 60 to 40. Firſt add the two lines C and D together, and they make 100: Then ſay, if 100 the whole give 60 for its greateſt part, what ſhall 50, the whole line A B, give for its greateſt Proportional part? Multiply 50 by 60, it makes 3000; which divided by 100, produces 30 for the longeſt part; which 30 taken from 50, leaves 20 for the ſhorteſt part; as therefore 60 is to 40, ſo is 30 to 20.

PROB. xvii.

Three Lines being given, to find a Fourth in Proportion to them.

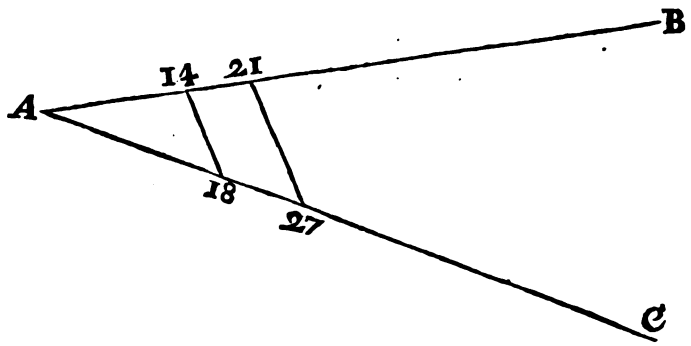
Let A B C be the three Lines given, and it is required to find a fourth Line which may be in ſuch proportion to C, as B is to A;

A——14
B——18
C——21

which

which is no more but performing the *Rule of Three* in Lines. As if we ſhould ſay, if A 14 give B 18, what ſhall C 21 give? Anſwer 27. But to perform the ſame Geometrically, work thus.

Firſt make any Angle, as B A C. Then take with with your Compaſſes the firſt line A, and ſet it from A to 14. Alſo take the ſecond Line B, and ſet it from A to 18; draw the line 14, 18. Then take



the third line C with your Compaſſes, and ſet it from A to 21. From 21 draw a line parallel to 14, 18, which will be 21, 27. Then from A to 27 is the length of your Fourth Line required.

And here for a while I ſhall leave theſe *Problems*, till I come to ſhew you how to divide any piece of Land; and to lay out any piece of a given quantity of Acres into any Form or Figure required: And in the mean time I ſhall ſhew you what is neceſſary to be known.

CHAP.

CHAP. IV.

Of Measures.

AND first of Long Measures; which are either Inches, Feet, Yards, Perches, Chains, *&c.* Note that twelve Inches make one Foot, three Feet one Yard, five Yards and a half one Pole or Perch, four Perches one Chain of *Gunter*'s, eighty Chains one Mile. But if you would bring one sort of Measure into another, you must work by *Multiplication* or *Division.* As for example, Suppose you would know how many Inches are contained in twenty Yards: First reduce the Yards into Feet, by multiplying them by 3, because 3 Feet make one Yard, the Product is 60, which multiplyed by 12, the number of Inches in one Foot, gives 720, and so many Inches are contained in 20 Yards Length.

On the contrary, if you would have known how many Yards there are in 720 Inches, you must first divide 720 by 12, the Quotient is 60 Feet; that again divided by 3, the Quotient is 20 Yards. The like you must do with any other Measure, as Perches, Chains, *&c.* of which more by and by.

Long	Link	Foot	Yard	Perch	Chain	Mile
Inches	7.92	12	36	198	792	63360
	Links	1.515	4.56	25	100	8000
		Feet	3	16.5	66	5280
			Yards	5.5	22	1760
				Perch	4	320
					Chain	80

See

See this Table of Long Measure annexed, the use whereof is very easie: If you would know how many Feet in Length go to make one Chain; look for Chain at Top, and at the Left-hand for Feet, against which, in the common Angle of meeting, is *66*, so many Feet are contained in one Chain.

But because Mr. *Gunters* Chain is most in use among Surveyors for measuring of Lines, I shall chiefly insist on that measure, it being the best in use for Lands.

This Chain contains in Length 4 Pole or *66* Feet, and is divided into 100 Links, each Link is therefore in length $7\frac{92}{100}$ Inches: If you would turn any number of Chains into Feet, you must multiply them by *66*, as 100 Chains multiplyed by *66*, makes *6600* Feet; but if you have Links to your Chains to be turned into Feet and Parts of Feet, you must set down the Chains and Links, as if they were one whole Number, and after having multiplyed that Number by *66*, cut off from the Product the two last Figures to the Right-hand, which will be the Hundreth Parts of a Foot, and those on the Left-hand the Feet required.

EXAMPLE.

Let it be required to know how many Feet there are in 15 Inches, 25 Links.

I set down thus the *Multiplicand*	1525
The num. of Feet in 1 Chain, *Multiplicat.*	66
	9150
	9150
Product	1006|50 Feet.

The

The *Product* is 100650. This is so plain, it needs no other Example.

But now on the other hand, if One thousand and six Feet and an half was given you to reduce into Chains and Links; you must divide 100650 by 66, the Quotient will be 1525, *viz.* 15 Chains, 25 Links. But for those that do not well understand *Decimal Arithmetick*, and may perhaps meet with harder Questions of this nature, I have here inserted

A Table, shewing how many Feet and Parts of a Foot; also how many Perches and Parts of a Perch, are contained in any number of Chains and Links, from One Link to One hundred Chains.

Links	Feet	Parts of a Foot	Perches	Part of a Perch	Chains.	Feet	Perches
1	00.	66	0.	04	1	66	4
2	01.	32	0.	08	2	132	8
3	01.	98	0.	12	3	198	12
4	02.	64	0.	16	4	264	16
5	03.	30	0.	20	5	330	20
6	03.	96	0.	24	6	396	24
7	04.	62	0.	28	7	462	28
8	05.	28	0.	32	8	528	32
9	05.	94	0.	36	9	594	36
10	06.	60	0.	40	10	660	40
20	13.	20	0.	80	20	1320	80
30	19.	80	1.	20	30	1980	120
40	26.	40	1.	60	40	2640	160
50	33.	00	2.	00	50	3300	200
60	39.	60	2.	40	60	3960	240
70	46.	20	2.	80	70	4620	280
80	52.	80	3.	20	80	5280	320
90	59.	40	3.	60	90	5940	360
100	66.	00	4.	00	100	6600	400

The Explanation of the Table.

If you would know how many Feet are contained in Twenty of Mr. *Gunters* Chains.

First, under Title *Chains*, seek for 20; and right against it, under Title *Feet*, stands 1320, the number of Feet contained in Twenty Chains. Also under Title *Perches*, stands 80, the number of Perches contained in Twenty Chains.

Again, If you would know how many Feet are contained in Eight Links only of the Chain, ſeek 8 under Title *Links*, and right againſt it ſtands 05. 28, which is five Feet $\frac{28}{100}$ of a Foot, ſomething more than five Feet and a quarter. Alſo under Title *Perches* and Parts of a Perch, ſtands 0. 32, which ſignifies that 8 Links contain 0 Perch $\frac{32}{100}$ of a Perch. But to know how many Feet are contained in any number of Chains and Links together. Firſt ſeek the Feet anſwering to the whole Chains, and write them down next the firſt anſwering to the Links; and adding them to the other, you will have your deſire. *Example*, In 15 Chains, 25 Links, how many Feet? Firſt, by the Table I find 10 Chains to contain 660 Feet, which I write down thus And when you have added them together, you find the Sum to be 1006 Feet, and $\frac{50}{100}$ of a Foot, that is contained in 15 Chains, 25 Links.

	Chains,	*Feet,*	*Parts,*
	10	660	
	5	330	
Links	20	13	20
	5	3	30
Added		1006	50

In like manner, if it had been asked, how many Perches had been contained in 15 Chains, 25 Links?

In

	Perch,	*Parts,*
In the Table againſt 10 Chains ſtands	40	
5	20	
20 *Links*	00	80
5 *Links*	00	20
Anſwer, 61 *Perches*	61	00

Mark, that the foregoing Table is as big again as it need to be; for you ſee both the Columns are alike in Figures, and only differenced by Points. I made it ſo for your clearer underſtanding of it; which when you well do, you need uſe no more but one Column; and that if you pleaſe, you may have placed on a Scale, or any other Inſtrument. But now to bring a Leſſer Meaſure into a Greater, is ſo much harder than to bring a Greater into a Leſs, as *Diviſion* is harder than *Multiplication*. I have therefore, for your eaſe, hereto annexed a large Table, with which by Inſpection only, or at moſt by a little eaſie Addition, as in the former, you may change any number of Feet into Chains, Links, and Parts of a Link (remembring all this while I mean Mr. *Gunter*'s Chain); alſo into Perches and Parts of a Perch.

A Table, shewing how many Chains, Links, and Parts of a Link; also how many Perches and Parts of a Perch, are contained in any number of Feet, from 1 to 10000.

Feet	Chain	Link	P. of L.	Perch	P. of Per.
1	0	1	515	0	060
2	0	3	030	0	121
3	0	4	545	0	181
4	0	6	060	0	242
5	0	7	575	0	303
6	0	9	090	0	363
7	0	10	606	0	424
8	0	12	121	0	484
9	0	13	636	0	545
10	0	15	151	0	606
20	0	30	303	1	212
30	0	45	454	1	818
40	0	60	606	2	424
50	0	75	757	3	030
60	0	90	909	3	636
70	1	06	060	4	242
80	1	21	212	4	848
90	1	36	363	5	454
100	1	51	515	6	060
200	3	03	030	12	121
300	4	54	545	18	181
400	6	06	060	24	242
500	7	57	575	30	303
600	9	09	090	36	363
700	10	60	606	42	424
800	12	12	121	48	484
900	13	63	636	54	545
1000	15	15	151	60	606
2000	30	30	303	121	212
3000	45	45	454	181	818
4000	60	60	606	242	424
5000	75	75	757	303	030
6000	90	90	909	363	636
7000	106	06	060	424	242
8000	121	21	212	484	848
9000	136	36	363	545	454
10000	151	51	515	606	060

This Table is like the former, and needs not much Explanation. However I will give you an Example or two.

Admit I would know how many Chains in length are contained in 500 Feet. First, in the left-hand Column, under Title *Feet*, I look out 500, and right against it I find 7 Chains, 57 Links, 575 Parts of 1000 of a Link, or 7 Chains, 57$\frac{575}{1000}$. So likewise under Title *Perches*, I find 30$\frac{303}{1000}$ Perches. But if you would know how many odd Feet that $\frac{303}{1000}$ is, you must seek for 303 in the Column titled *Parts of a Perch*, and right against it you will find 5 Feet. So I say that 500 Feet is 30 Perches, 5 Feet.

Again, I would know how many Chains and Links there are in 15045 Feet? First seek for 10000, and write down the Chains, Links, and Parts of a Link contained therein. Do the like by 5000; also by 40 and 5. Lastly, adding them together, you have your desire.

	Feet,	*Chain,*	*Link,*	*Parts*
10000	——	151	51	515
5000	——	75	75	757
40	——	0	60	606
5	——	0	7	575
Added, make	——	227	95	453

Answer, 227 Chains, 95 Links, are contained in 15045 Feet.

One *Example* more, and I have done with this Table.

How many Perches do 10573 Feet make?

Feet,

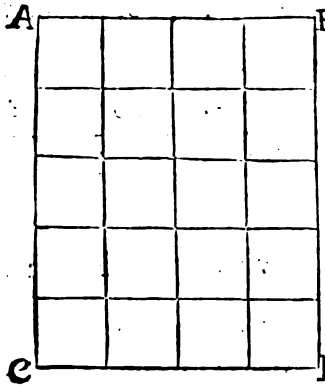
Feet,	Perches,	Parts,
10000	606	060
500	30	303
70	4	242
3	0	181
Add	640	786

The Anſwer is, 640 Perches, and $\frac{786}{1000}$ of a Perch, or 13 Feet. I had forgot to tell you what a Furlong is; it is 40 Perches in length; 8 Furlongs make 1 Mile. And ſo much of *Long Meaſure*: I ſhall now proceed to

Square Meaſure.

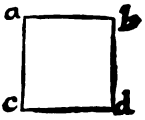
Planometry, or the meaſuring the Superficies or Planes of things (as Sir *Jonas Moore* ſays) is done with the Squares of ſuch Meaſures, as a Square Foot, a Square Perch, or Chain, that is to ſay, by Squares whoſe Sides are a Foot, a Perch, or Chain; and the Content of any Superficies is ſaid to be found, when we know how many ſuch Squares it containeth.

As for Example: Suppoſe A B C D was a Piece of Land, and the Length of the Line AB or CD was 4 Perches; alſo the Length of the Line A C or B D was 5 Perches; I ſay that Piece of Land contains 20 Square Perches, as you may ſee it here divided; every little Square being a Perch, having a Perch in Length for its ſide. If you lay down a Square Figure, whoſe ſide is 1 Foot, and



and at the end of every Inch you draw Lines croſſing one another, as theſe here, you will divide that Square Foot into 144 little Squares, or Square Inches.

Or thus, The Line *a b* is a Perch long or 16 Feet ½, ſo is the Line *b d*, and the other 2 Lines: The whole Figure *a b c d* is called a Square Perch.



But before we go any farther, take this Table following of Square Meaſure.

A TABLE of SQUARE MEASURE.

Inch	Links	Feet	Yards	Pace	Perch	Chain	Acre	Mile
1	62.726	144	1296	3600	39204	627264	6272640	4014489600
	1	2.295	20.755	57.381	625	10000	100000	6400000
		1	9	25	272.25	4356	43560	2787840
			1	2.778	30.25	484	4840	309760
				1	10.89	174.24	1742.4	111513
					1	16	160	10240
						1	10	6400
							1	640
								1

Inch
Links
Feet
Yards
Pace
Perch
Chain
Acre
Mile

This Table is like the former of Long Measure, and the use of it is the same.

Example, If you would know how many Square Feet are contained in one Chain, look for Feet at Top, and Chain on the Side, and in the common Angle of meeting stands 4356, so many Square Feet are contained in one Square Chain.

The common Measure for Land is the Acre, which by Statute is appointed to contain 160 Square Perches, and it matters not in what form the Acre lye in, so it contains just 160 Square Perches: as in a Parallelogram 10 Perches one way, and 16 another contain an Acre: So does 8 one way and 20 another, and 4 one way and 40 the other. If then, having one Side given in Perches, you would know how far you must go on the Perpendicular to cut off an Acre? you must divide 160 (the number of Square Perches in an Acre) by the given Side, the Quotient is your desire. As for Example, the given Side is 20 Perches, divide 160 by 20 the Quotient is 8: By that I know, That 20 Perches one way, and 8 another, including a Right Angle will be the two Sides of an Acre; the other two Sides must be parallel to these.

And here I think it convenient to insert this necessary Table, shewing the Length, and Bredth of an Acre in Perches, Feet and Parts of a Foot: But if your given Side had been in any other sort of Measure; As for Instance in Yards, You must then have seen how many Square Yards had been in an Acre, and that Summ you must have divided by the number of your given Yards, the Quotient would have answered the Question.

EXAMPLE.

EXAMPLE.

If 44 Yards be given for the Bredth, how many Yards shall there be in Length of the Acre?

First, I find that an Acre contains 4840 Square Yards, which I divide by 44, the Quotient is 110 for the Length of the Acre. And thus knowing well how to take the Length and Bredth of one Acre, you may also by the same way know how to lay down any number of Acres together; of which more anon.

Bredth	Length of an Acre	
Perches	Perches	Feet
10	16	0
11	14	9
12	13	5½
13	12	5 5/13
14	11	7 1/14
15	10	11
16	10	0
17	9	6 9/17
18	8	14 8/18
19	8	6 11/19
20	8	0
21	7	10 2/21
22	7	4½
23	6	15 3/23
24	6	11
25	6	6 7/25
26	6	2 1/13
27	5	15½

Bredth	Length of an Acre.	
Perches	Perches	Feet
28	5	11 3/4
29	5	8 13/29
30	5	5½
31	5	2 7/31
32	5	0
33	4	14
34	4	11 2/17
35	4	9 5/7
36	4	7 1/9
37	4	5 1/37
38	4	3 1/19
39	4	1 1/13
40	4	0
41	3	14 21/41
42	3	13 1/2
43	3	11 7/43
44	3	10 1/11
45	3	9 1/2

Reducing of one sort of Square Measure to another, is done, as before taught in Long Measure, by Multiplication and Division. And because Mr. *Gunter*'s Chain is chiefly used by Surveyors, I shall only instance in that, and shew you how to turn any number of Chains and Links into Acres Roods and Perches: Note that a Rood is the fourth part of an Acre.

And first mark well that 10 Square Chains make one Acre, that is to say, 1 Chain in Bredth, and 10 in

Length; or 2 in Bredth and 5 in Length, is an Acre; as you may ſee by this ſmall Table.

Length of an Acre Chains	Breadth of an Acre Chains	Links	Parts of a Link
1	10	00	
2	5	00	
3	3	33	333
4	2	50	
5	2	00	
6	1	66	666
7	1	42	285
8	1	25	
9	1	11	111

And thus well weighing that 10 Chains make one Acre, if any number of Chains be given you to turn into Acres, you muſt divide them by 10, and the Quotient will be the number of Acres contained in ſo many Chains. But this Diviſion is abbreviated by only cutting off the laſt Figure, as if 1590 Chains were given to turn into Acres, by cutting off the laſt Figure 159|0, there is left 159 acres, which is all one as if you had divided 1590 by 10. But if Chains and Links be given you together to turn into Acres, Roods and Perches, firſt from the given Summ cut off three Figures, which is two Figures for the Links and one for the Chains, what's left ſhall be Acres. And to know how many Roods and Perches are contained in the Figures cut off, multiply them by 4, from the Product cutting off the three laſt Figures, you will have the Roods: And then to know the Perches, multiply the Figures cut off from the Roods, by 40, from which Product cutting off again three Figures, you have the Perches, and the Figures cut off are thouſandth Parts of a Perch.

EXAMPLE.

EXAMPLE.

1599 Square Chains, and 55 Square Links, how many Acres, Roods and Perches?

Anſwer, 159 Acres, 3 Rood 32 Perches.

Acres	159	955
		4
Roods	3	620
		40
Perches	24	800

On the contrary, if to any number of Acres given, you add a Cypher, they will be turned into Chains, thus 99 Acres are 990 Chains, 100 Acres 1000 Chains, *&c.* The ſame as if you had multiplyed the Acres by 10. And if you would turn Square Chains into Square Links, add four Cyphers to the end of the Chains, ſo will 990 Chains be 9900000 Links, 1000 Chains 10000000 Links, all one as if you had multiplyed 990 by 10000, the number of Square Links contained in one Chain.

And now, whereas in caſting up the content of a piece of Land meaſured by Mr. *Gunter*'s Chain, (*viz.* multiplying Chains and Links by Chains and Links) the Product will be Square Links; you muſt therefore from that Product cut off five Figures to find the Acres; which is the ſame as if you divided the Product by 100000 (the number of Square Links contained in one Acre) then multiply the five Figures cut off by 4; and from that Product cutting off five Figures you will have the Roods. Laſtly multiply by

40, and take away (as before) 5 Figures, the reſt are Perches.

EXAMPLE.

Admit a Parallelogram, or Long Square, to be one way 5 Chains, 55 Links; and the other way 4 Chains, 35 Links: I demand the content in Acres, Roods and Perches?

Multiplicand 555
Multiplicator 435

2775
1665
2220

Acres 2,41425
4

Roods 1,65700
40

Perches 26,28000

Anſwer, 2 *Acres* 1 *Rood* 26 *Perches* And $\frac{28}{100}$ *Parts* of a *Perch*

Laſtly, Becauſe ſome Men chuſe rather to caſt up the Content of Land in Perches, I will here briefly ſhew you how it is done; which is only by dividing by 160 (the number of Square Perches contained in One Acre) the number of Perches given.

EXAMPLE.

Admit a Parallelogram to be in length 55 Perches, and in breadth 45 Perches; theſe two multiplied together, make 2475 Perches; which to turn into Acres, divide by 160, the Quotient is 15 Acres, and 75 Perches remaining; which to turn into Roods, divide by 40, the Quotient is 1 Rood, and 35 Perches remaining. So much is the Content of ſuch a piece of Land, *viz.* 15 Acres, 1 Rood, and 35 Perches.

Here

Here follows a Table to turn Perches into Acres, Roods and Perches.

Perches	Acres	Roods	Perch
40	0	1	00
50	0	1	10
60	0	1	20
70	0	1	30
80	0	2	00
90	0	2	10
100	0	2	20
200	1	1	00
300	1	3	20
400	2	2	00
500	3	0	20
600	3	3	00
700	4	1	20
800	5	0	00
900	5	2	20
1000	6	1	00
2000	12	2	00
3000	18	3	00
4000	25	0	00
5000	31	1	00
6000	37	2	00
7000	43	3	00
8000	50	0	00
9000	56	1	00
10000	62	2	00
20000	125	0	00
30000	187	2	00
40000	250	0	00
50000	312	2	00
60000	375	0	00
70000	437	2	00
80000	500	0	00
90000	562	2	00
100000	625	0	00

The Use of this Table.

In 2475 Perches, how many Acres, Roods and Perches.

Perch	*Acres*	*Rood*	*Perch*
2000	12	2	00
400	2	2	00
70	0	1	30
To which add the odd 5 Perches	0	0	05
Answer	15	1	35

CHAP.

CHAP. V.

Of Inſtruments and their Uſe.

And firſt of the Chain.

THere are ſeveral ſorts of Chains, as Mr. *Rathborne*'s of two Perch long: Others, of one Perch long, ſome have had them 100 Feet in length: But that which is moſt in uſe among Surveyors (as being indeed the beſt) is Mr. *Gunter*'s, which is 4 Pole long, containing 100 Links, each Link being 7,92 Inches: The Deſcription of which Chain, and how to reduce it into any other Meaſure, you have at large in the foregoing Chapter of Meaſures. In this place I ſhall only give you ſome few Directions for the uſe of it in Meaſuring Lines.

Take care that they which carry the Chain, deviate not from a ſtreight Line; which you may do by ſtanding at your Inſtrument, and looking through the Sights: If you ſee them between you and the Mark obſerved, they are in a ſtreight Line, otherwiſe not. But without all this trouble, they may carry the Chain true enough, if he that follows the Chain always cauſeth him that goeth before to be in a direct line between himſelf, and the place they are going to, ſo as that the Foreman may always cover the Mark from him that goes behind. If they ſwerve from the Line, they will make it longer than really it

it is; a ſtreight Line being the neareſt diſtance that can be between any two places.

Beſure that they which carry the Chain, miſtake not a Chain either over or under in their Account, for if they ſhould, the Error would be very conſiderable; as ſuppoſe you was to meaſure a Field that you knew to be exactly Square, 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 ſuch a great Error may ariſe, what may be in a greater, you may eaſily imagine. But the uſual way to prevent ſuch Miſtakes is, to be provided with 10 ſmall Sticks ſharp at one End, to ſtick into the Ground; and let him that goes before take all into his Hand at ſetting out, and at the End of every Chain ſtick down one, which let him th at follows take up; when the 10 Sticks are done, be ſure they have gone 10 Chains; then if the Line be longer, let them change the Sticks, and proceed as before, keeping in Memory how often they change: They may either Change at the end of 10 Chains, then the hindmoſt Man muſt give the foremoſt all his Sticks; or which is better, at the end of 11 Chains, and then the laſt Man muſt give the firſt but 9 Sticks, keeping one to himſelf. At every Change count the Sticks, for fear leſt you have dropt one, which ſometimes happens.

If you find the Chain too long for your uſe, as for ſome Lands it is, eſpecially in *America*, you may then take the half of the Chain, and meaſure as before, remembring ſtill when you put down the Lines in your Field Book, that you ſet down but the half of the

the Chains, and the odd Links, as if a Line meaſured by the little Chain be 11 Chains 25 Links, you muſt ſet down 5 Chains 75 Links, and then in plotting and caſting up it will be the ſame as if you had meaſured by the whole Chain.

At the end of every 10 Links, you may, if you find it convenient, have a Ring, a piece of Braſs, or a Ragg, for your more ready reckoning the odd Links.

When you put down in your Field-Book the length of any Line, you may ſet it thus, if you pleaſe, with a Stop between the Chains and Links, as 15 Chains 15 Links 15.15. or without, as thus 1515, it will be all one in the caſting up.

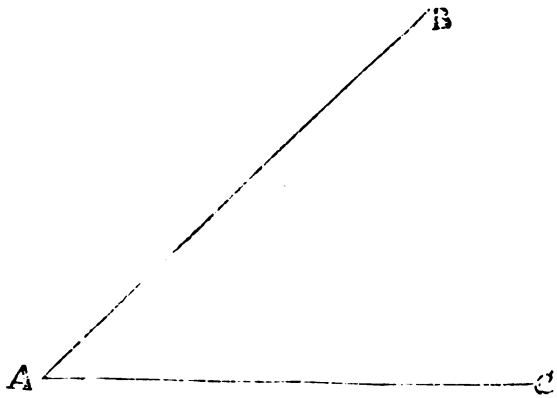
Of Inſtruments for the taking of an Angle in the Field.

There are but two material things (towards the meaſuring of a piece of Land) to be done in the Field; the one is to meaſure the Lines (which I have ſhewed you how to do by the Chain) and the other to take the quantity of an Angle included by theſe Lines; for which there are almoſt as many Inſtruments as there are Surveyors. Such among the reſt as have got the greateſt eſteem in the World, are, the Plain Table for ſmall Incloſures, the Semicircle for Champaign Grounds, The Circumferentor, the Theodolite, *&c.* To deſcribe theſe to you, their Parts, how to put them together, take them aſunder, *&c.* is like teaching the Art of Fencing by Book, one Hours uſe of them, or but looking on them in the Inſtrument-maker's Shop, will better deſcribe them to you than the reading one hundred Sheets of Paper

Paper concerning them. Let it ſuffice that the only uſe of them all is no more (or chiefly at moſt) but this; *viz.*

To take the Quantity of an Angle.

As ſuppoſe A B and A C are two Hedges or other Fences of a Field, the Chain ſerves to meaſure the



length of the Sides A B or A C, and theſe Inſtruments we are ſpeaking of are to take the Angle A. And firſt by the

Plain Table.

Place the Table (already fitted for the Work, with a Sheet of Paper upon it) as nigh to the Angle A as you can, the North End of the Needle hanging directly over the *Flower de Luce*; then make a Mark upon the Sheet of Paper at any convenient place for the Angle A, and lay the Edge of the Index to the Mark, turning it about, till through the Sights you

eſpy B, then draw the Line A B by the Edge of the Index. Do the ſame for the Line A C, keeping the Index ſtill upon the firſt Mark, then will you have upon your Table an Angle equal to the Angle in the Field.

To take the Quantity of the ſame Angle by the Semicircle.

Place your Semicircle in the Angle A, as near the very Angle as poſſibly you can, and cauſe Marks to be ſet up near B and C, ſo far off the Hedges, as your Inſtrument at A ſtands, then turn the Inſtrument about 'till through the fixed Sights you ſee the Mark at B, there ſcrew it faſt; next turn the moveable Index, 'till through the Sights thereof you ſee the Mark at C, then ſee what Degrees upon the Limb are cut by the Index; which let be 45, ſo much is the Angle B A C.

How to take the ſame Angle by the Circumferentor.

Place your Inſtrument, as before, at A, with the *Flower de Luce* towards you, direct your Sights to the Mark at B, and ſee what Degrees are then cut by the South End of the Needle, which let be 55; do the ſame to the Mark at C, and let the South End of the Needle there cut 100, ſubſtract the leſſer out of the greater, the remainder is 45, the Angle required. If the remainder had been more than 180 degrees, you muſt then have ſubſtracted it out of 360, the laſt remainder would have been the Angle deſired.

This

This laſt Inſtrument depends wholly upon the Needle for taking of Angles, which often proves erroneous; the Needle yearly of it ſelf varying from the true North, if there be no Iron Mines in the Earth, or other Accidents to draw it aſide, which in Mountainous Lands are often found: It is therefore the beſt way for the Surveyor, where he poſſibly can, to take his Angles without the help of the Needle, as is before ſhewed by the Semicircle: But in all Lands it cannot be done, but we muſt ſometimes make uſe of the Needle, without exceeding great trouble, as in the thick Woods of *Jamaica*, *Carolina*, &c. It is good therefore to have ſuch an Inſtrument, with which an Angle in the Field may be taken either with or without the Needle, as is the Semicircle, than which I know no better Inſtrument for the Surveyors uſe yet made publick; therefore as I have before ſhewed you, How by the Semicircle to take an Angle without the help of the Needle; I ſhall here direct you

How with the Semicircle to take the Quantity of an Angle in the Field by the Needle.

Screw faſt the Inſtrument, the North End of the Needle hanging directly over the *Flower de Luce* in the Chard, turn the Index about, till through the Sights you eſpy the Mark at B; and note what Degrees the Index cuts, which let be 40; move again the Index to the Mark at C, and note the Degrees cut, *viz.* 85. Subſtract the Leſs from the greater, remains 45, the Quantity of the Angle.

Or thus;

Turn the whole Inſtrument 'till through the Fixed Sights you eſpy the Mark at B, then ſee what Degrees upon the Chard are cut by the Needle; which for Example are 315, turn alſo the Inſtrument till through the ſame Sights you eſpy C, and note the Degrees upon the Chard then cut by the Needle, which let be 270; ſubſtract the Leſs from the Greater, (as before in working by the Circumferentor) remains 45 for the Angle. Mark if you turn the *Flower de Luce* towards the Marks, you muſt look at the Norh End of the Needle for your Degrees.

Beſides the Diviſion of the Chard of the Semicircle into 360 Equal Parts or Degrees: It is alſo divided into four Quadrants, each containing 90 Degres, beginning at the North and South Points, and proceeding both ways 'till they end in 90 Degrees at the Eaſt and Weſt Points; which Points are marked contrary, *viz.* Eaſt with a W. and Weſt with an E, becauſe when you turn your Inſtrument to the Eaſtward, the End of the Needle will hang upon the Weſt Side, *&c.*

If by this way of diviſion of the Chard, you would take the aforeſaid Angle, direct the Inſtrument ſo (the *Flower de Luce* from you) 'till through the fixed Sights you eſpy the Mark at B; then ſee what Degrees are cut by the North End of the Needle, which let be N E 44; next direct the Inſtrument to C, and the North End of the Needle will cut N E 89; ſubſtract the one from the other, and there will remain 45 for the Angle.

But if at the firſt ſight the Needle had hung over NE 55, and at the ſecond S E 80, then take 55 from

from 90, remains 35, take 80 from 90, remains 10, which added to 35, makes 45, the Quantity of the Angle: Moreover, if at the firſt Sight, the North End of the Needle had pointed to N W 22, and at the ſecond N E 23, theſe two muſt have been added together, and they would have made 45 the Angle as before.

Mark, if you had turned the South part of your Inſtrument to the Marks, then you muſt have had reſpect to the South End of your Needle.

Although I have been ſo long ſhewing you how to take an Angle by the Needle, yet when we come to Survey Land by the Needle, as you ſhall ſee by and by, we need take but half the Pains; for we take not the Quantity of the Angle included by two Lines, but the Quantity of the Angle each Line makes with the Meridian; then drawing Meridian Lines upon Paper, which repreſent the Needle of the Inſtrument, by the help of a Protractor, which repreſents the Inſtrument, we readily lay down the Lines and Angles in ſuch proportion as they are in the Field.

This way of dividing the Chard into four 90s, is in my Opinion, for any Work the beſt; but there is a greater uſe yet to be made of it, which ſhall hereafter be ſhewed in its proper place.

Of the Field-Book.

You muſt always have in readineſs in the Field, a little Book, in which fairly to inſert your Angles and Lines; which Book you may divide by Lines into Columns, as you ſhall think convenient in your Practiſe; leaving always a large Column to the right hand, to put down what remarkable things you meet with in your way, as Ponds, Brooks, Mills, Trees, or the

the like. Thus for Example, if you had taken the Angle A, and found it to contain 45 Degrees; and measured the Line A B, and found it to be 12 Chains, 55 Links, set it down in your Field-Book thus,

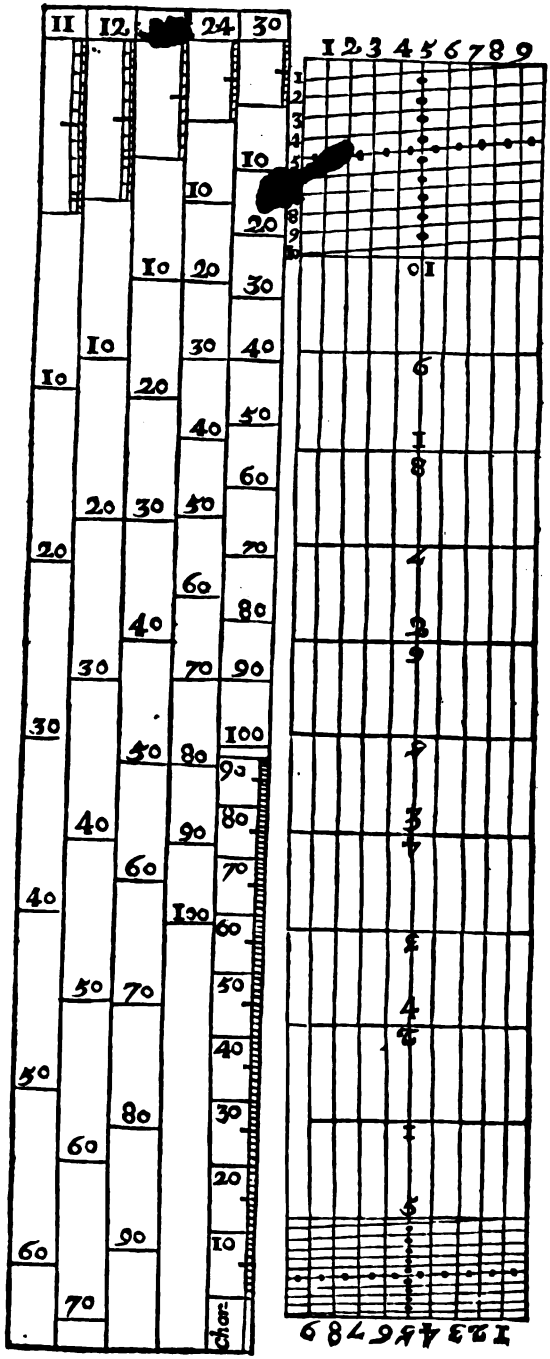
	degrees	Min.	Chain	Link	
A	45	00	12	55	

Or if at A you had only turned your fixed Sights to B, and the Needle had then cut 315; in the place of 45 you must have put down 315. If you Survey by Mr. *Norwood*'s way, then there must be four Columns more for E. W. N. and Southing. You may also make two Columns more, if you please, for Off-sets, to the right and left.

Lastly, You may chuse whether you will have any Lines or not, if you can write streight, and in good order, the Figures directly one under another. For this I leave you chiefly to your own fancy; for I believe there are not two Surveyors in *England*, that have exactly the same Method for their Field-Notes.

Of the Scale.

Having by the Instruments before spoken of, measured the Angles and Lines in the Field; the next thing to be done, is to lay down the same upon Paper; for which Use the Scale serves. There are several sorts of Scales, some large, some small, according as Men have occasion to use them; but all do principally consist of no more but two sorts of Lines; the first, of Equal Parts, for the laying down Chains and Links; the second, of Chords, for laying down or measuring Angles. I cannot better explain the Scale to you, than by shewing the Figure of such a one as are commonly sold in Shops, and teaching how to use it. Those



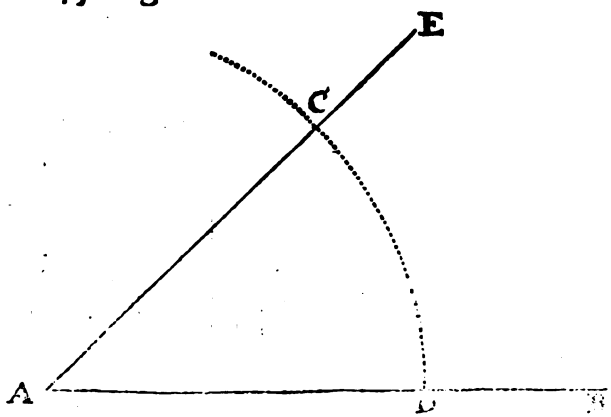
Thoſe Lines that are numbred at top with 11, 12, 16, *&c.* are Lines of Equal Parts, containing 11, 12, or 16 Equal Parts in an Inch. If now by the Line of 11 in an Inch, you would lay down 10 Chains, 50 Links; look down the Line under 11, and ſetting one foot of your Compaſſes in 10; cloſe the other till it juſt touch 50 Links, or half a Chain, in the ſmall Diviſions. Then laying your Ruler upon the Paper; by the ſide thereof make two ſmall Pricks, with the ſame extent of the Compaſſes, and draw the Line A B, which ſhall contain in length 10 Chains, 50 Links, by the Scale of 11 in an Inch.

A——B

The back-ſide of the Scale, is only a Scale of 10 in an Inch; but divided with Diagonal Lines, more nicely than the other Scales of Equal Parts.

How to lay down an Angle by the Line of Chords.

If it were required to make an Angle that ſhould contain 45 Degres.



Draw

Draw a Line at pleaſure, as A B; then ſetting one Foot of your Compaſſes at the beginning of the Line of Chords, ſee that the other fall juſt upon 60 Degrees: With that extent ſet one foot in A, and deſcribe the Arch C D. Then take from your Line of Chords 45 Degrees, and ſetting one foot in D, make a mark upon the Arch, as at C, through which draw the Line A E: So ſhall the Angle E A B be 45 Degrees. If by the Line of Chords you would erect a Perpendicular Line, it is no more but to make an Angle that ſhall contain 90 Degrees.

The reaſon why I bid you take 60 from the Line of Chords to make your Arch by, is becauſe 60 is the Semi-diameter of a Circle whoſe circumference is 360.

How to make a Regular Polygon, or a Figure of 5, 6, 7, 8, or more Sides, by the Line of Chords.

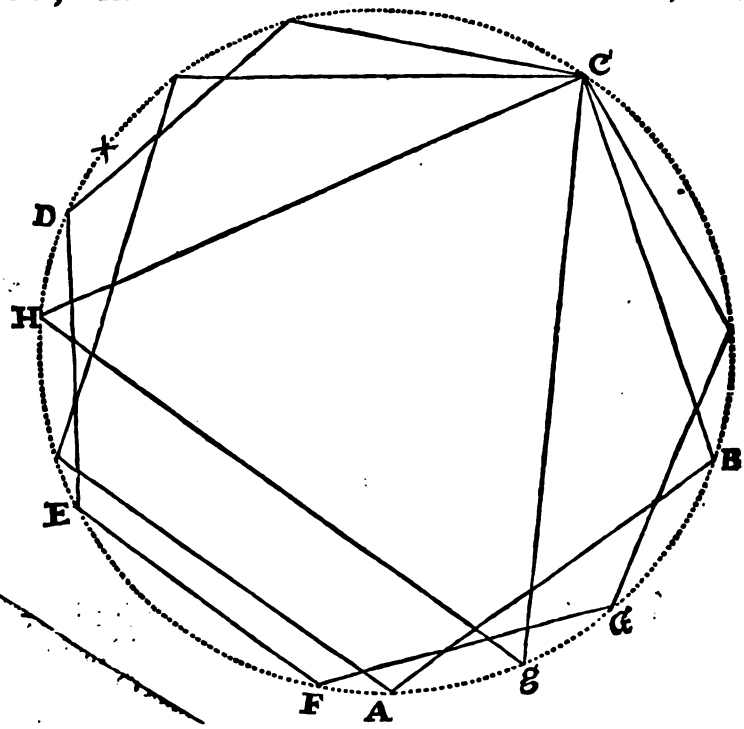
Divide 360, the number of Degrees contained in a Circle, by 5, 6, or 7, the number of Sides you would have your Figure to contain; the Quotient taken from the Line of Chords ſhall be one Side of ſuch a Figure.

EXAMPLE.

For to make a Pentagon, or Figure of five Sides: Divide 360 by 5, the Quotient is 72, one Side of a Pentagon.

Take 60 Degrees from your Line of Chords, and deſcribe an obſcure Arch; which done, take 72 from

your Line of Chords, and deſcribe an obſcure Arch; which done, take 72 from your Line of Chords, and beginning at any part of the Circle, ſet off that extent round the Circle, as



from A to B, from B to C, and ſo round till you come to A again. Then having drawn Lines between thoſe Marks, the Pentagon is compleated. The like of any other Polygon, though it contain never ſo many Sides.

As for Example in a Heptagon: Divide 360 by 7, the Quotient will be 51 Deg. 25 Min. which if you take from the Line of Chords, and ſet off round the Circle, you will make a Heptagon, as D E, E F, F G, *&c.* are the Sides thereof. *To*

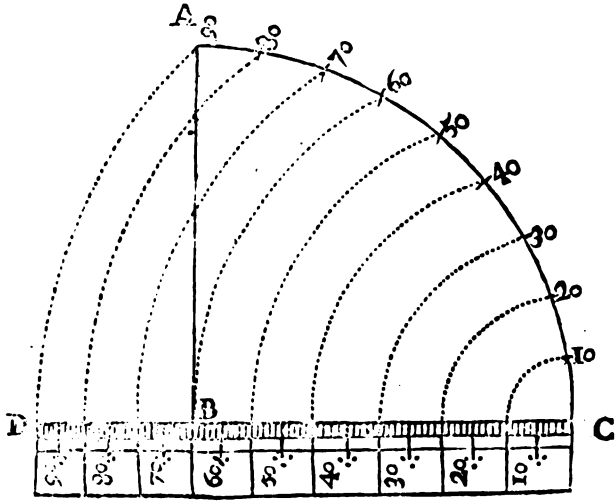
To make a Triangle in a Circle by the Line of Chords.

Firſt, Take the whole length of your Line of Chords, or the Chord of 90 Degrees, with your Compaſſes; which diſtance upon the Circle, ſet off from C to *. Then take 30 Degrees from the Line of Chords, and ſet that from * to H. Draw the Line C H, which is one ſide of the greateſt Triangle that can be made in that Circle.

Or you may make it, by ſetting off twice the Semidiameter of the Circle for 60, and 60, is 120, as well as 90, and 30.

How to make a Line of Chords.

Firſt, make a Quadrant, or the fourth part of a



K 2 Circle,

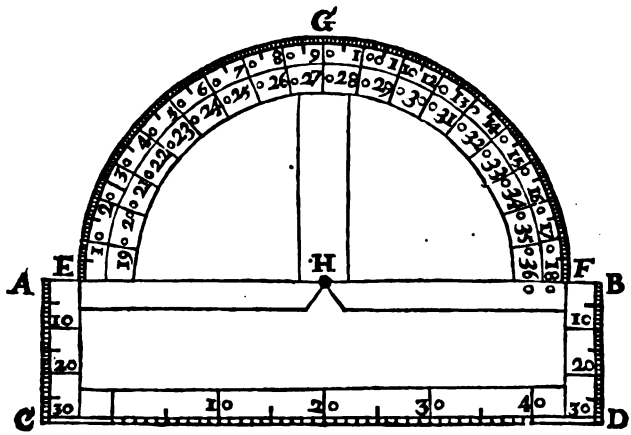
Circle, as A B C; divide the Arch thereof, *viz.* A C, into 90 Equal Parts; which you may do, by dividing it firſt into three Equal Parts, and every of thoſe Diviſions into three Equal Parts more, and every of the laſt Diviſions into ten Equal Parts.

Secondly, Continue the Semi-diameter B C to any convenient length, as to D. Then ſetting one foot of your Compaſſes in C, let the other fall on 90, and deſcribe the Arch 90. So likewiſe 80,80; 70,70; and the reſt. C D is the Line of Chords, and theſe Arches cutting of it into Unequal Parts, conſtitute the true Diviſions thereof, as you may ſee by the Figure: You may, if you pleaſe draw Lines Parallel to D C, as I have done here, for the better diſtinguiſhing every Tenth and Fifth Figure.

Of the Protractor.

The Protractor is an Inſtrument with which, with more eaſe and expedition you may lay down an Angle, than you can by the Line of Chords: alſo when you have Surveyed by the Needle, by placing the Diameter of the Protractor upon a Meridian Line made upon your Paper, you readily with a Needle upon the Arch of the Protractor prick off the true ſituation of any Line from the Meridian, without ſcratching the Paper, as you muſt do in the uſe of the Line of Chords. It is made almoſt like, and graduated altogether like the Braſs Limb of a Semicircle, performing the ſame upon Paper, as your Inſtrument did in the Field: See here the Figure of it.

For

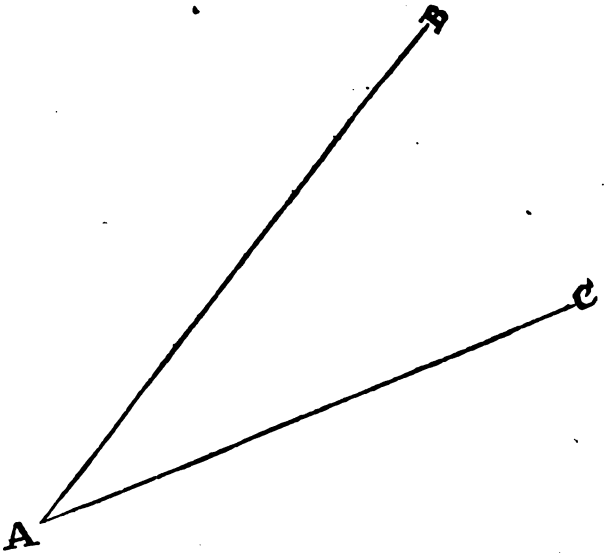


For the uſe of the Protractor, you muſt have a fine Needle, ſuch as Women ſew withal, put into a ſmall Handle of Wood, Ivory, or the like, which is to put through the Centre of the Protractor to any Point aſſigned upon the Paper, that the Protractor may turn round upon it.

How to lay down an Angle with the Protractor.

If it were required by the Protractor to lay down an Angle of 30 Degrees. Draw the Line A B, then take the Protractor, and putting a Needle through the Centre Point thereof, place the Needle in A, ſo that the Centre of the Protractor may lye juſt upon

the



the end of the Line at A, move the Protractor about 'till you find the Diameter thereof lye upon the Line A B; then at 30 Degrees upon the Arch, with your Protracting Needle make a Mark upon the Paper, as at C, draw the Line C A, which ſhall make an Angle of 30 Degrees *viz.* B A C.

If you Survey according to Mr. *Norwood*'s way before ſpoken of, it will be good to have the Arch of your Protractor divided accordingly, *viz.* into two Quadrants, or twice 90 Degrees.

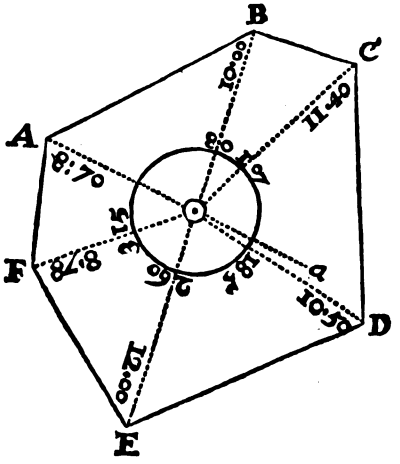
I need ſay no more of a Protractor, any ingenuous Man may eaſily find the ſeveral uſes thereof, it being as it were, but only an Epitome of Inſtruments.

CHAP.

CHAP. VI.

How to take the Plot of a Field at one Station in any place thereof, from whence you may ſee all the Angles by the Semicircle.

ADmit ABCDEF to be a Field, of which you are to take the Plot: Firſt ſet your Semicircle upon the Staff in any convenient place thereof, as at ⊙, and cauſe Marks to be ſet up in every Angle: Direct your Inſtrument, the *Flower de Luce* from you to any one Angle: As for Example, to A, and eſpying the Mark at A through the fixed Sights, there ſcrew faſt the Inſtrument; then turn the move-



able

able Index about (the Semicircle remaining immoveable) 'till through the Sights thereof you eſpy the Mark at B. See what Degrees on the Braſs Limb are cut by the Index, which let be 80, write that down in your Field-Book, ſo turn the Index round to every one of the other Angles, putting down in your Field-Book what Degrees the Index points to, as for Example, at C 107 Degrees, at D 185, mark that at D, the End of the Index will go off the Braſs Limb, and the other End will come on; you muſt therefore look for what Degrees the Index cuts in the innermoſt Circle of the Limb at E 260, at F 315 Degrees.

All which you may note down in your Field-Book thus.

Angles	Degrees	Minutes	Chains	Links	
⊙ A .	00 .	00 .	8 .	70	
⊙ B .	080 .	00 .	10 .	00	
⊙ C .	107 .	00 .	11 .	40	
⊙ D .	185 .	00 .	10 .	50	
⊙ E .	260 .	00 .	12 .	00	
⊙ F .	315 .	00 .	8 .	78	

Secondly, cauſe the Diſtance between your Inſtrument, and every Angle to be meaſured, thus from ⊙ to A will be found to be 8 Chains 70 Links; from ⊙ to B 10 Chains 00. all which ſet down in order in your Field-Book, as you ſee here above; and then have you done what is neceſſary to be done in that Field towards meaſuring of it. Your next work is to Protract or lay it down upon Paper.

How

How to Protract the Former Observations taken.

First draw a Line at adventure as A *a*, then take from your Scale, with your Compasses, the first Distance measured, *viz.* from ⊙ to A 8 Chain 70 Links, and setting one Foot in any convenient place of the Line, which may represent the place where the Instrument stood, with the other make a Mark upon the Line as at A; so shall A be the first Angle, and ⊙ the place where the Instrument stood.

Secondly, Take a Protractor, and having laid the Centre thereof exactly upon ⊙, and the Diameter or Meridian upon the Line A *a*, the Semi circle of the Protracture lying upwards. There hold it first, and with your Protracting Pin, make a mark upon the Paper against 80 *deg.* 107 *deg. &c.* as you find them out of your Field-Book. Then for those Degrees that exceed 180, you must turn the Protractor downward, keeping still the Centre upon ⊙, and placing again the Diameter upon *a* A. Mark out by the Innermost Circle of Divisions the rest of your Observations 185, 260, 315. Then applying a Scale to ⊙, and every one of the Marks, draw the prick'd Lines ⊙ B, ⊙ C, ⊙ D, ⊙ E, ⊙ F.

Thirdly, Take in with your Compasses the length of the Line ⊙ B, which you find by the Field Book to be 10 Chains, which from ⊙ set off to B. The like do for ⊙ C, ⊙ D, and the rest.

Lastly, Draw the Lines A B, B C, C D, *&c.* which will include a Figure exactly proportionable to the Field before Surveyed.

How to take the Plot of the ſame Field at one Station by the Plain Table.

Place your Table with a ſheet of Paper upon it at ⊙, and making a mark upon the Paper, that ſhall ſignifie where the Inſtrument ſtands, lay your Index to the mark, turning it about till you ſee through the Sights the mark at A ; there holding it faſt, draw the Line A ⊙. Turn the Index to B, keeping it ſtill upon the firſt mark at ⊙ ; and when you ſee through the Sights the mark at B, draw the Line B ⊙. Do the ſame by all the reſt of the Angles, and having meaſured the diſtance between the Inſtrument, and each Angle, ſet it off with your Scale and Compaſſes, from ⊙ to A, from ⊙ to B, *&c.* making marks where, upon the ſeveral Lines, the diſtances fall.

Laſtly, Between thoſe Marks draw Lines, as A B, B C, C D, *&c.* and then have you the true Plot of the Field ready protracted to your hand. This Inſtrument is ſo plain and eaſie to be underſtood, I ſhall give no more Examples of the Uſe of it. The greateſt Inconveniency that attends it, is, that when never ſo little Rain or Dew falls, the Paper will be wet, and the Inſtrument uſeleſs.

How to take the Plot of the ſame Field at one Station by the Semi-circle, either with the help of the Needle and Limb both together, or by the help of the Needle only.

In the beginning of this Chapter, I ſhewed you how to take the Plot of a Field at one Station, by the

the Simi-circle, without reſpect to the Needle, which is the beſt way: But that I may not leave you ignorant of any thing belonging to your Inſtrument, I ſhall here ſhew how to perform the ſame with the help of the Needle two ways. And firſt with the *Needle* and *Limb* together.

Fix the Inſtrument, as before, in ⊙, making the North-Point of the Needle hang directly over the *Flower-de-Luce* of the Card; there ſcrew faſt the Inſtrument. Then turn the Index to all the Angles, noting down what Degrees are cut thereby at every Angle, as at A let be 25, at B 105, at C 132, and ſo of the reſt round the Field. And when you have meaſured the Diſtances, and are come to Protraction, you muſt firſt draw a Line croſs your Paper, calling it a North and South-Line, which repreſents the Meridian-Line of the Inſtrument. Then applying the Protractor to that Line, mark round the Degrees as they were obſerved, *viz.* 25, 105, 132, *&c.* and having ſet off the Diſtances, and drawn the outward Lines altogether, like what you were taught at the beginning of this Chapter, you will find the Figure to be the very ſame as there.

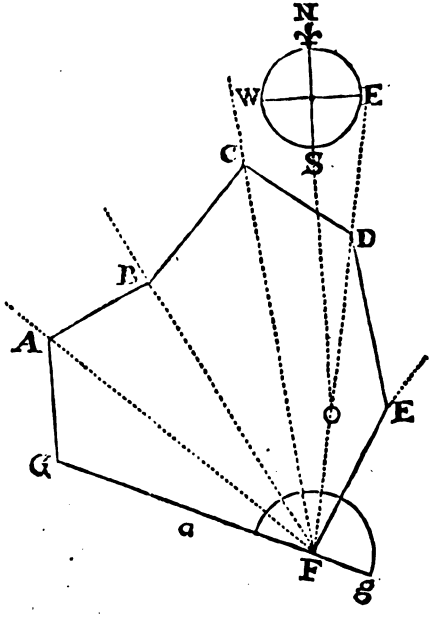
Now to perform this by the Needle only, is in a manner the ſame as the former: For inſtead of turning the Index about the Limb, and ſeeing what Degrees are cut thereby, here you muſt turn the whole Inſtrument about, and obſerve at every Angle what Degrees upon the Card the Needle hangs over; which ſet down, and Protract as before. But here mind ſome Cards are numbred from the North Eaſtwards 10, 20, 30, *&c.* to 360 *deg.* Some from the North Weſtard, which are beſt for this uſe, Protractors being made accordingly: For when you

turn your Inſtrument to the Eaſtward, the Needle will hang over the Weſtward Diviſion, and the contrary.

As for the Uſe of the Diviſion of the Card into four Quadrants, I ſhall ſpeak largely of by and by, therefore for the preſent beg your patience.

How by the Semi-circle to take the Plot of a Field, at one Station, in any Angle thereof, from whence the other Angles may be ſeen.

Let A B C D E F G be the Field, and F the Angle.



at which you would take your Obſervations. Having placed your Semi-circle at F, turn it about the North-

North-Point of the Card from you, till through the Fixed-Sights, (Note that I call them the Fixed-Sights which are on the Fixed-Diameter) you eſpy the mark at G. Then ſcrew faſt the Inſtrument; which done, move the Index, till through the Sights thereof you ſee the mark at A; and the Degrees on the Limb there cut by it, will be 20. Move again the Index to the mark at B, where you will find it to cut 40 *deg.* Do the ſame at C, and it cuts 60 *deg.* likewiſe at D 77, and at E 100 *deg.* Note down all theſe Angles in your Field-Book; next meaſure all the Lines, as from F to G 14 Chain, 60 Links; from F to A 18 Chain, 20 Links; from F to B 16 Chain, 80 Links; from F to C 21 Chain, 20 Links; from F to D 16 Chain, 95 Links; from F to E 8 Chain, 50 Links; and then will your Field-Book ſtand thus:

Angles	*Degrees*	*Minutes*	*Chains*	*Links*
G	00	00	14	60
A	20	00	18	20
B	40	00	16	80
C	60	00	21	20
D	77	00	16	95
E	10	00	8	50

To Protract the former Obſervations.

Draw a Line at adventure as G, *g*, upon any convenient place, on which lay the Centre of your Protractor, as at F, keeping the Diameter thereof right upon the Line G, *g*. Then make marks round the Protractor at every Angle, as you find them in the Field-Book, *viz.* againſt 20, 40, 60, 77, and 100; which

which done, take away the Protractor, and applying the Scale or Ruler to F, and each of the marks, draw the Lines F A, F B, F C, F D, and F E. Then ſetting off upon theſe Lines the true diſtances as you find them in the Field-Book; as for the firſt Line F G 14 Chain, 60 Links; for the ſecond F A 18 Chain, 20 Links, *&c.* make marks where the ends of theſe diſtances fall, which let be at G, A, B, C, *&c.*

Laſtly, Between theſe Marks, drawing the Lines G A, A B, B C, C D, D E, E F, F G, you will have compleated the Work.

When you Survey thus without the help of the Needle, you muſt remember before you come out of the Field to take a Meridian-Line, that you may be able to make a Compaſs ſhewing the true Situation of the Land, in reſpect of the four Quarters of the Heavens, I mean Eaſt, Weſt, North and South; which thus you may do:

The Inſtrument ſtill ſtanding at F, turn it about till the Needle lies directly over the *Flower-de-Luce* of the Card, there ſcrew it faſt. Then turn the moveable Index, till through the Sights you eſpy any one Angle.

As for Example. Let be D: Note then what Degrees upon the Limb are cut by the Index, which let be 10 *deg.* Mark this down in your Field-Book, and when you have Protracted as before directed, lay the Centre of your Protractor upon any place of the Line F D, as at ⊙, turning the Protractor about till 10 *deg.* thereof lye directly upon the Line F D. Then againſt the end of the Diameter of the Protractor, make a mark, as at N, and draw the Line N ⊙, which is a Meridian, or North and South Line, by which you may make a Compaſs.

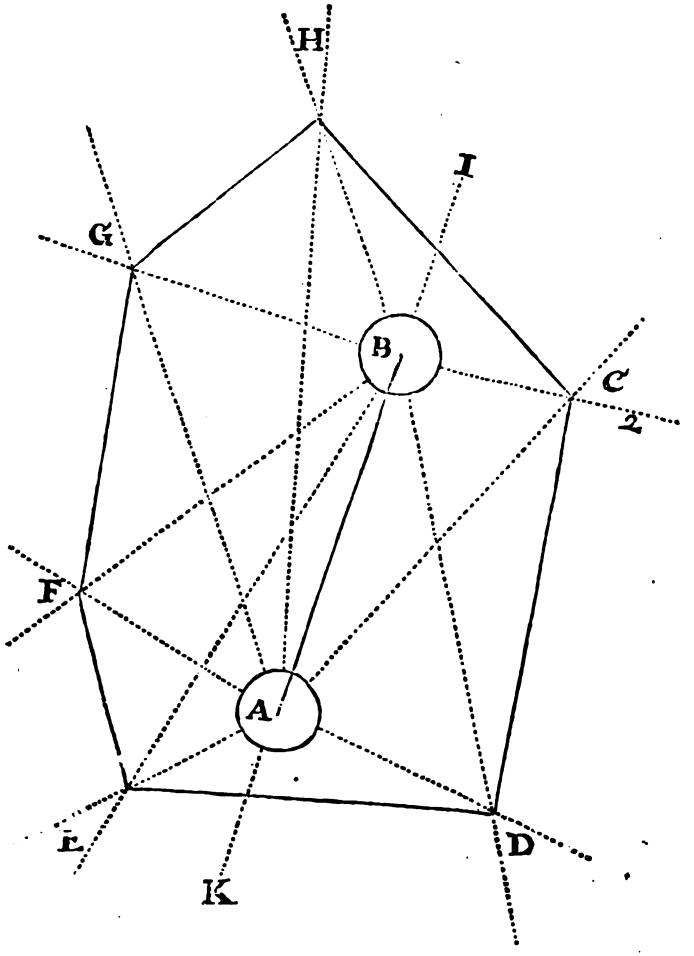
Note,

Note that you may as well take the Plot of a Field at one Station, ſtanding in any Side thereof, as in an Angle: For if you had ſet your Inſtrument in *a*, the Work would be the ſame. I ſhall forbear therefore (as much as I may) Tautologies.

How to take the Plot of a Field at two Stations, provided from either Station you may ſee every Angle, and meaſuring only the Stationary Diſtance.

Let CDEFGH, be ſuppoſed a Field, to be meaſured at two Stations; firſt when you come into the Field, make choice of two Places for your Stations, which let be as far aſunder as the Field will conveniently admit of; alſo take care that if the Stationary Diſtance were continued, it would not touch an Angle of the Field; then ſetting the Semicircle at A, the firſt Station, turn it about, the North Point from you, till through the Fixed Sights you eſpy the Mark at your ſecond Station, which admit to be at B, there ſcrew faſt the Inſtrument; then turn the Moveable Index, to every ſeveral Angle round the whole Field,

and



and ſee what Degrees are cut thereby at every Angle, which note down in your Field-Book as followeth:

Angles

Angles	Degrees	Minutes	
C	24	30	
D	97	00	
E	225	00	Firſt Station.
F	283	30	
G	325	00	
H	346	00	

Secondly, meaſure the Diſtance between the two Stations, which let be 20 Chains, and ſet it down in the Field-Book.

Stationary Diſtance 20 *Chains,* 00 *Links.*

Thirdly, placing the Inſtrument at B, the Second Station, look backwards through the fixed Sights to the Firſt Station at A, (I mean by looking backward, that the South Part of the Inſtrument be towards A) and having eſpyed the Mark at A, make faſt the Inſtrument, and moving the Index, as you did at the Firſt Station to each Angle, ſee what Degrees are cut by the Index, and note them down as followeth ; and then have you done, unleſs you will take a Meridian Line before you move the Inſtrument ; which you were taught to do a little before.

Angles	Degrees	Minutes	
C	84	00	
D	149	00	
E	194	00	The Second Station.
F	215	00	
G	270	00	
H	322	00	

How to Protract or lay down upon Paper these foregoing Observations.

First, draw a Line cross your Paper at pleasure, as the Line I K, then take from off the Scale the Stationary Distance 20 Chains, and set it upon that Line, as from A to B, so will A represent the First Station, B the Second.

Secondly, apply your Protractor, the Centre thereof to the Point A, and the Diameter lying streight upon the Line B K; mark out round it the Angles, as you find them in the Field-Book, and through those Marks from A, draw Lines of a convenient Length.

Thirdly, move your Protractor to the Second Station B; and there mark out your Angles, and draw Lines, as before at the First Station.

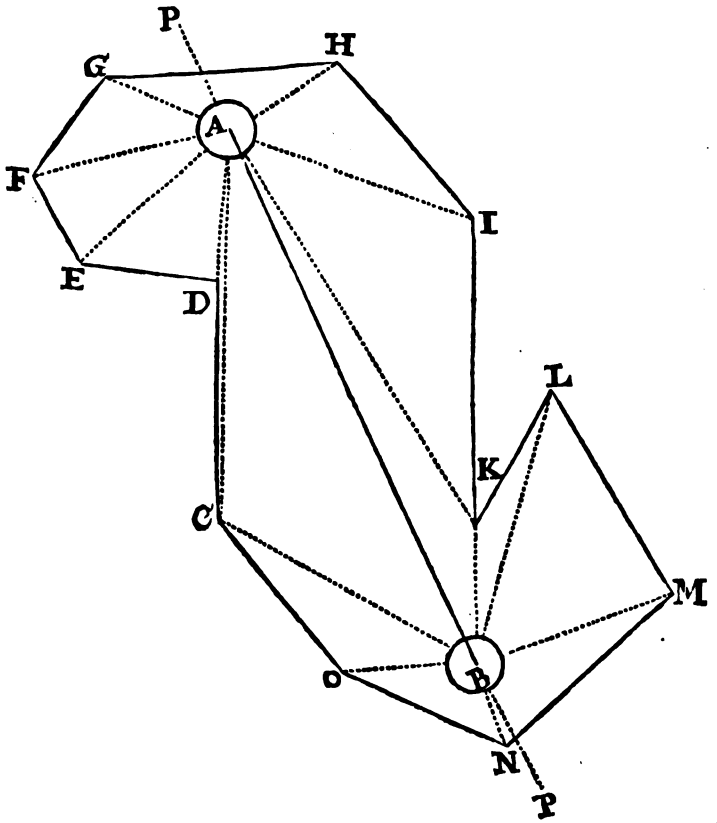
Lastly, the places where the Lines of the First Station, and the Lines of the Second intersect each other, are the Angles of the Field: As for Example;

At the First Station the Angle C was 24 Degrees 30 Minutes, through those Degrees I drew the Line A 1. At the Second Station C was 84 Degrees: Accordingly from the Second Station I drew the Line B 2; now, I say, where these two Lines cut each other, as they do at C, there is one Angle of the Field. So likewise of D E, and the rest of the Angles; if therefore between these Intersections you draw streight Lines, as C D, D E, E F, *&c.* you will have a true Figure of the Field.

This may as well be done by taking two Angles for your Stations, and measuring the Line between them, as

as C and D, from whence you might as well have ſeen all the Angles, and conſequently as well have performed the Work.

How to take the Plot of a Field at two Stations, when the Field is ſo Irregular, that from one Station you cannot ſee all the Angles.



Let C D E F G H I K L M N O be a Field in which from no one Place thereof all the Angles may be ſeen; chuſe therefore two Places for your Stations, as A and B, and ſetting the Semicircle in A, direct the Diameter to the Second Station B; there making the Inſtrument faſt, with the Index take all the Angles at that end of the Field, as C D E F G H I K, and meaſure the Diſtance between your Inſtrument and each Angle; meaſure alſo the Diſtance between the two Stations A and B.

Secondly, remove your Inſtrument to the Second Station at B; and having made it faſt ſo, as that throug the Back Sights you may ſee the Firſt Station A; take the Angles at that End of the Field, as N O C K L M, and meaſure their Diſtances alſo as before; all which done, your Field-Book will ſtand thus.

Firſt Station.

Angles	Degrees	Minutes	Chains	Links
C	25	00	20	75
D	31	00	8	10
E	67	00	9	85
F	101	00	10	80
G	137	00	7	00
H	262	00	6	70
I	316	00	13	70
K	354	00	24	50

The Diſtance between the two Stations 31 Ch. 60 L.

Second

Second Station.

Angles	Deg.	Min.	Chain.	Link.
N	3	30	4	20
O	111	00	7	00
C	145	00	15	60
K	205	00	7	48
L	220	00	15	00
M	274	00	11	20

To lay this down upon Paper, draw at adventure the Line P B A P; then taking in with the Compaſſes the Diſtance between the two Stations, *viz.* 31 Ch. 60 Links; ſet it upon the Line, making Marks with the Compaſſes as A and B, A being the Firſt Station, B the Second, lay the Protractor to A the North End of the Diameter towards B, and mark out the ſeveral Angles obſerved at your Firſt Station, drawing Lines, and ſetting off the Diſtances as you were taught in the beginning of this Chapter, Fig. I.

Do the ſame at B, the Second Station; and when you have marked out all the Diſtances, between thoſe Marks draw the Bound-Lines.

I am the briefer in this, becauſe it is the ſame as was taught concerning Fig I; for if you conceive a Line to be drawn from C to K; then would there be two diſtinct Fields to be meaſured, at one Station a-piece.

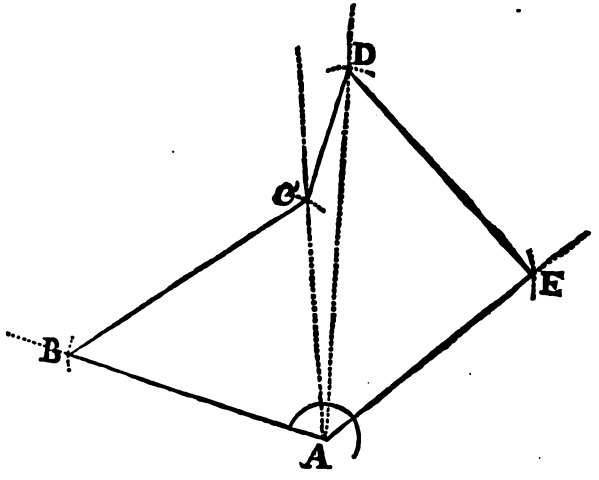
If a Field be very irregular, you may after the ſame manner make three, four or five Stations, if you pleaſe; but I think it better to go round ſuch a Field and meaſure the bounding Lines thereof: Which by and by, I ſhall ſhew you how to do.

Note,

Note, in the foregoing Figure you might as well have had your Stations in two convenient Angles, as D and K, and have wrought as you were taught concerning Fig. 2. the Work would have been the ſame.

How to take the Plot of a Field at one Station in an Angle (ſo that from that Angle you may ſee all the other Angles) by meaſuring round about the ſaid Field.

A B C D E is the Field, and A the Angle appointed for the Station; place your Semicircle in A, and direct the Diameter thereof 'till through the fixed Sights you ſee the Mark at B, then ſcrew it faſt, and turn the Index to C, obſerving what Degrees are there cut upon the Limb; which let be 68 Degrees; turn it further, 'till you eſpy D, and note



down

down the Degrees there cut, *viz.* 76 Degrees; do the like at E, and the Index will cut 124 Degrees: This done, measure round the Field, noting down the length of the Side Lines between Angle and Angle, as from A to B 14 Chains 00 Links, from B to C 15 Chains, 00 Links, from C to D 7 Chains 00 Links, from D to E 14 Chains 40 Links, and from E to A 14 Chains 05 Links:

Then will your Field-Book be as hereunder.

Angles	Degrees	Minutes
C	68	00
D	76	00
E	124	00

Lines	Chains	Links
A B	14	00
B C	15	00
C D	07	00
D E	14	40
E A	14	05

To protract which draw the Line A B at adventure, and applying the Centre of the Protractor to A, (the Diameter lying upon the Line A B, and the Semicircle of it upwards) prick off the Angles, as against 68 : 76: and 124: make Marks, through which Marks draw the Lines A C, A D, A E, long enough be sure; then taking in with your Compasses, from off the Scale, the length of the Line A B, *viz.* 14 Chains, and setting one Foot of the Compasses in A, with the other cross the Line, as at B; also for B C take in 15 Chains, and setting one Foot in B, with the other cross the Line A C, which will fall to be at C; for the Line C D take in 7 Chains, and setting one Foot in C, cross the Line A D, *viz.* at D; then for D E, take in 14 Chains 40 Links, and setting

ting one Foot of the Compaſſes in D E, with the other croſs the Line A E, which will fall at E: Laſtly for E A take 14 Chains 5 Links with your Compaſſes, and ſetting one Point in E, ſee if the other fall exactly upon A, if it does, you have done the Work true, if not, you have erred; between the Croſſes or interſections, draw ſtreight Lines, which ſhall be the bounds of the Field, *viz.* A B, B C, C D, D E, E A.

How to take the Plot of the foregoing Field, by meaſuring one Line only, and taking Obſervations at every Angle.

Begin as you have been juſt before taught, 'till you have taken the Angles C, D, E, *viz.* 68, 76, and 124 Degrees; then leaving a good Mark at A, which may be ſeen all round the Field, go to B, meaſuring as you go the Diſtance from A to B, which is all the Lines you need to meaſure; and planting your Semicircle at B, direct the South Part thereof toward A, until through the back fixed Sights you ſee the Mark at A, there making it faſt, turn the Index about 'till you eſpy C, and note down the Degrees there cut, which let be 129 Degrees; move your Inſtrument to C, and ſtill keeping the South Part of the Diameter to A, turn the Index to D, where it will cut 20 Degrees; then remove to D, and eſpying A through the Back Sights, turn the Index to E, where it will cut 135 Degrees. Note all this in your Field-Book.

Angles

Angles taken at the First Station.		*Angles round the Field.*	
C= 68		B . 129	
D= 76	Degrees	C . 20	Degrees
E=124		D . 135	

Line A B: 14 Chains.

To protract this you must work as you were taught concerning the foregoing Figure, untill you have drawn the Lines A B, A C, A D, A E, and set off the Line A B 14 Chains; then laying the Centre of your Protractor to B, and the South End of the Diameter, (or that marked with 180 Degrees) towards A, make a Mark against 129 Degrees, and through that mark from B, draw the Line B C, 'till it interfect the Line A C, which it will do at C: Lay also the Centre of the Protractor upon C, the Diameter thereof upon A C, and against 20 Degrees make a Mark, through which from C, draw the Line C D 'till it interfect the Line A D, which it will do at D; lastly place your Protractor at D, the Diameter thereof upon the Line D A, and make a Mark against 135 Degrees, through which Mark draw the Line D E, until it interfect the Line A E at E, also drawing the Line E A you have done.

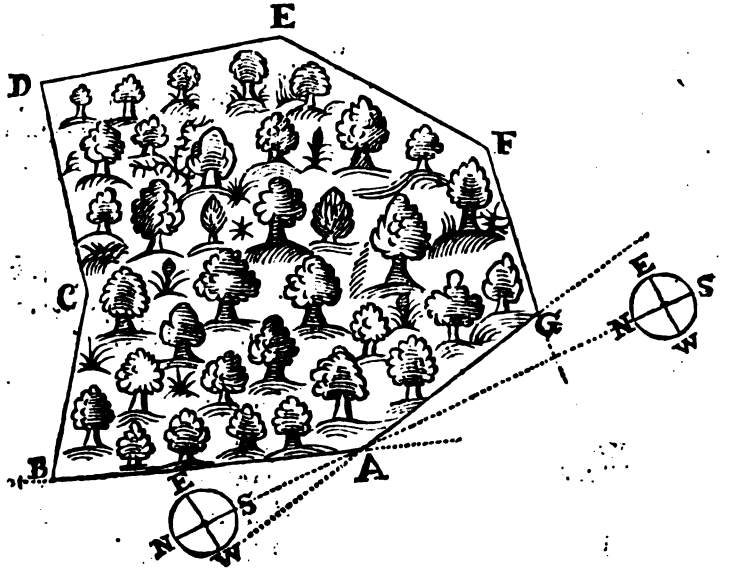
This may be done otherwise thus, after you have, standing at A, taken the several Angles, and measured the Distance A B, you may only take the quantity of the bounding Angles, without respect to A: As the Angle at B is 51 Degrees, at C (an outward Angle, which in your Field Book you should distinguish with a Mark >) 138; and so of the rest. And when you come to plot, having found the

place for B, there make an Angle of 51 Degrees, drawing the Line 'till it interſect A C, *&c.*

You may alſo ſurvey a Field after this manner, by ſetting up a Mark in the middle thereof, and meaſuring from that to any one Angle, alſo in the Obſervations round the Field, having reſpect to that Mark, as you had here to the Angle A.

It is too tedious to give Examples of all the Varieties; beſides it would rather puzzle than inſtruct a Neophyte.

How to take the Plot of a Large Field or Wood, by meaſuring round the ſame, and taking Obſervations at every Angle thereof, by the Semicircle.



Suppoſe

Suppoſe A B C D E F G to be a Wood, through which you cannot ſee to take the Angles, as before directed, but muſt be forced to go round the ſame; firſt plant the Semicircle at *A*, and turn the North End of the Diameter about, 'till through the fixed Sights you ſee the Mark at B, then move round the Index, till through the Sights thereof you eſpy G, the Index there cutting upon the Limb 146 Degrees.

2. Remove to B, and as you go meaſure the Diſtance A B, *viz.* 23 Chains 40 Links, and planting the Inſtrument at B, direct the North End of the Diameter to C, and turn the Index round to A, it then pointing to 76 Degrees.

3. Remove to C, meaſuring the Line as you go, and ſetting your Inſtrument at C, direct the North End of the fixed Diameter to D, and turn the Index till you eſpy B, and the Index then cutting 205 Degrees; which, becauſe it is an outward Angle, you may mark thus > in your Field-Book.

4. Remove to D, and meaſure as you go; then placing the Inſtrument at D, turn the North End of the Diameter to E, and the Index to C, the Quantity of that Angle will be 84 Degrees.

And thus you muſt do at every Angle round the Field as at E, you will find the quantity of that Angle to be 142 Degrees, F 137, G 110, but there is no need for your taking the laſt Angle, nor yet meaſuring the two laſt Sides, unleſs it be to prove the Truth of your Work; which is indeed convenient: When you have thus gone round the Field; you will find your Field-Book to be as followeth.

Angles	Deg.	Min.	Lines	Ch.	Lin.
A	146	00	A B	23	40
B	76	00	B C	15	20
C	205	00	C D	17	90
D	84	00	D E	20	60
E	142	00	E F	18	85
F	137	00	F G	13	60
G	110	00	G A	19	28

To protract this, draw a dark Line at adventure, as A B; upon which set off the Distance, as you see it in your Field-Book, 23 Chains 40 Links, from A to B; then laying the Centre of your Protractor upon A, and the Diameter upon the Line A B, the North End, or that of 00 Degrees towards B; on the outside of the Limb make a Mark against 146 Degrees, through which Mark from A draw the Line A G, so have you the first Angle and first Distance.

2. Place the Centre of the Protractor upon B, and turn it about until 76 Degrees lyes upon the Line A B; there hold it fast, and against the North End of the Diameter make a Mark, through which draw a Line, and set off the Distance B C 15 Chains 20 Links.

3. Apply the Centre of the Protractor to C, (the Semicircle thereof outward, because you see by the Field-Book it is an outward Angle) and turn it about 'till 205 Degrees, lye upon the Line C B; then against the Upper or South End of the Diameter make a Mark, through which draw a Line, and set off 17 Chains 90 Links from C to D.

4. Pu

4. Put the Centre of the Protractor to D, and make 84 *deg.* thereof lye upon the line C D; then making a mark at the end of the Diameter or 0 *deg.* Through that mark draw a line, and ſet off 20 Chains, 60 Links, *viz.* D E.

5. Move the Protractor to E, and make 142 *deg.* to lye upon the line E D. Then at the end of the Protractor, make a mark as before, and ſetting off the diſtance 18 Chains, 85 Links, draw the line E F.

6. Lay the Centre of the Protractor upon F, and making 137 *deg.* lye upon the line E F; againſt the end of the Diameter make a mark, through which draw the line F G, which will interſect the line A G at G: So have you a true Copy of the Field or Wood: But you may, if you think fit to prove your Work, ſet off the diſtance from F to G; and at G apply your Protractor, making 110 *deg.* thereof to lye upon the line F G. Then if the end of the Diameter point directly to A, and the diſtance be 90 Chain, 28 Links, you may be ſure you have done your Work true.

Whereas I bid you put the North end of the Inſtrument and of the Protractor towards B, it was chiefly to ſhew you the variety of Work by one Inſtrument; for in the Figure before this, I directed you to do it the contrary way; and in this Figure, if you had turned the South-ſide of the Inſtrument to G, and with the Index had taken B, and ſo of the reſt, the work would have been the ſame, remembring ſtill to uſe the Protractor the ſame way as you did your Inſtrument in the Field.

Alſo, if you had been to have Surveyed this Field or Wood by the help of the Needle; after you had planted the Semi-circle at A. and poſited it, ſo that the

the Needle might hang directly over the *Flower-de-Luce* in the Card, you should have turned the Index to B, and put down in your Field-Book what Degrees upon the Brass Limb had then been cut thereby, which let be 20. Then moving your Instrument to B, make the Needle hang over the *Flower-de-Luce*, and turn the Index to C, and note down what Degrees are there cut. So do by all the rest of the Angles. And when you come to Protract, you must draw Lines Parallel to one another cross the Paper, not farther distant asunder than the breadth of the Parallelogram of your Protractor; which shall be Meridian-lines, marking one of them at one end N, for North; and at the other S, for South. This done, chuse any place which you shall think most convenient upon one of the Meridian lines for your first Angle at A; and laying the Diameter of your Protractor upon that Line, against 20 *deg.* make a mark; through which draw a line, and upon it set off the distance from A to B.

In like manner proceed with the other Angles and Lines, at every Angle laying your Protractor Parallel to a North and South Line, which you may do by the Figures gratuated thereon, at either end alike.

When you have Surveyed after this manner, how to know before you go out of the Field whether you have wrought true or not.

Add the Sum of all your Angles together, as in the Example of the precedent Wood, and they make 900. Multiply 180 by a number less by 2 than the number

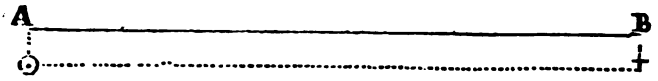
number of Angles; and if the Product be equal to the Sum of the quantity of all the Angles, then have you wrought true. There were seven Angles in that Wood, therefore I multiply 180 by 5, and the Product is 900.

If you Survey, by taking the quantity of every Angle, and if all be inward Angles, you must work as before. But if one or more be outward Angles, you must substract them out of 180 *deg.* and add the Remainder only to the rest of the Angles. And when you multiply 180 by a Sum less by 2 than the number of your Angles, you are not to account the outward Angles into the number. Thus in the precedent Example I find one outward Angle, *viz.* C 205; the quantity of which, if it had been taken, would have been but 155 *deg.* That taken from 180 *deg.* there remains 25; which I add to the other Angles, and they make then in all 720. Now because C was an outward Angle, I take no notice of it, but see how many other Angles I have, and I find 6; a number less by 2 than 6, is 4; by which I multiply 180, and the Product is 720, as before.

Directions how to Measure Parallel to a Hedge (when you cannot go in the Hedge it self,) and also in such case, how to take your Angles.

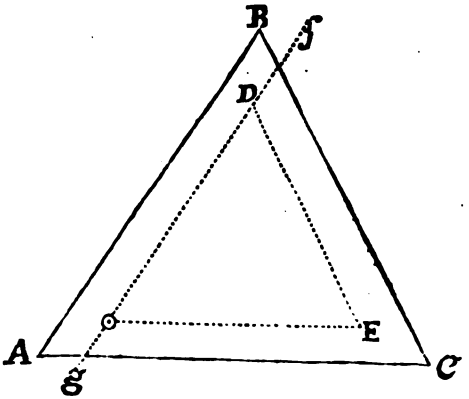
It is impossible for you when you have a Hedge to measure, to go at top of the Hedge itself; but if you go Parallel thereto, either within side or without, and make your Parallel-line of the same length as

as the Line of your Hedg, your work will be the ſame. Thus if A B was a buſhy Hedge, to which



you could not conveniently come nigher to plant your Inſtrument than ⊙; let him that goes to ſet up your mark at B, take before he goes the Diſtance A ⊙, which he may do readily with a Wand or Rod; and at B let him ſet off the ſame diſtance again, as to +, where let the mark be placed for your Obſervation; and when the Chain bears meaſure the diſtance ⊙ +, be ſure they have reſpect to the Hedge A B, ſo as that they make ⊙ + equal to A B, or of the ſame length.

But to make this more plain. Suppoſe A B C to be a Field; and for the Buſhes, you cannot come nigher than ⊙ to plant your Inſtrument. Let him that ſets

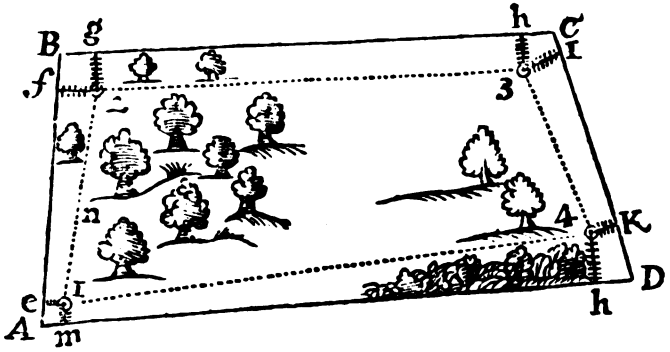


up the Marks, take the diſtance between the Inſtrument ⊙ and the Hedge A B; which diſtance let him ſet off again nigh B, and ſet up his Mark at D; likewiſe

wiſe let him take the diſtance between ⊙ and the Hedge A C, and accordingly ſet up his Mark at E. Then taking the Angle *d* ⊙ E, it will be the ſame as the Angle B A C: So do for the reſt of the Angles. But when the Lines are meaſured, they muſt be meaſured of the ſame length as the outſide Lines, as the Line ⊙ *d*, meaſured from G to F, *&c.* the beſt way therefore is for them that meaſure the Lines, to go round the Field on the outſide thereof, although the Angles be taken within.

How to take the Plot of a Field or Wood, by obſerving near every Angle, and meaſuring the Diſtance between the Marks of Obſervation, by taking, in every Line, two Off-ſets to the Hedge.

Let A, B, C, D, be a Wood or Field, to be thus meaſured. Cauſe your Aſſiſtants to ſet up Marks in



every Angle thereof, not regarding the diſtance from the Hedges, ſo much as the convenience for planting

the Inſtrument, ſo as you may ſee from one Mark to another. Then beginning at ⊙ 1, take the quantity of that Angle, and meaſure the diſtance 1, 2. But before you begin to meaſure the Line, take the Off-ſet to the Hedge, *viz.* the diſtance ⊙ *e*; and in taking of it, you muſt make that little Line ⊙ *e* perpendicular to 1, 2; which is eaſily done, when your Inſtrument ſtands with the Fixed Sights towards 2, by turning the Moveable Index till it lye upon 90 *deg.* which then will direct to what place of the Hedge to meaſure to, as *e*, that little Line ⊙ *e*: Set down in your Field-Book under title *Off-ſet*. So likewiſe when you come to 2, meaſure there the Off-ſet again, *viz.* ⊙ *f*. Then taking the Angle at 2, meaſure the Line 2, 3, and the Off-ſets 2 *g*, 3 *h*. The like do by all the reſt of the Lines and Angles in the Field, how many ſoever they be. And when you come to lay this down upon Paper; firſt, as you have been taught before, Protract the Figure 1, 2, 3, 4. That done, ſet off your Off-ſets as you find them in the Field-Book, *viz.* ⊙ *e*, and ⊙ *f*, perpendicular to the Line 1, 2; alſo ⊙ *g*, ⊙ *h*, perpendicular to the Line 2, 3, making Marks at *e*, *f*, *g*, *h*, and the reſt; through which draw Lines, which ſhall interſect each other at the true Angles, and deſcribe the true Bound-Lines of the Field or Wood.

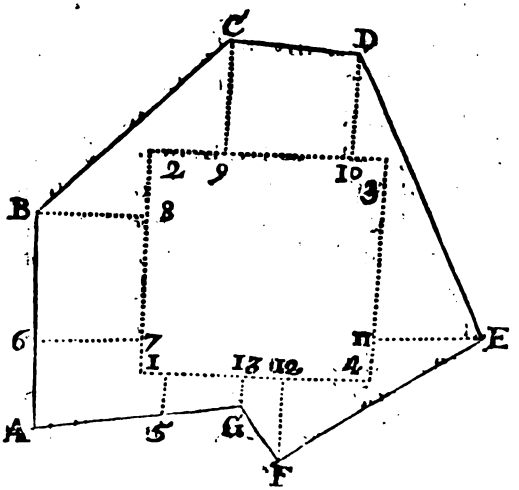
In working after this manner, obſerve theſe two things. Firſt, if the Wood be ſo thick, that you cannot go within-ſide thereof, you may after the ſame manner as well perform the Work, by going on the out-ſide round the Wood.

Secondly, if the Lines are ſo long, that you cannot ſee from Angle to Angle, cauſe your Aſſiſtant to ſet up a Mark ſo far from you as you can conveniently ſee

ſee it, as at N: Meaſure the diſtance ⊙ 1 N, and take the Off-ſet from N to the Hedge. Then at N turn the Fixed-Sights of the Inſtrument to ⊙ 1, and and by that Direction, proceed on the Line till you come to an Angle.

This way of Surveying is much eaſier done (though I cannot ſay truer) by taking only a great Square in the Field; from the Sides of which, the Off-ſets are taken.

I have drawn this following Figure ſo, that at once you may ſee all the variety of this way of Working. The beſt way, indeed, is to contrive your Square



ſo, that, if poſſible, you may from the Sides thereof go upon a Perpendicular-line to any of the Angles. But if that cannot be, then Perpendicular-lines to the Sides may do as well, as you ſee here 1, 5, 7, 6,

to be. To begin therefore, plant your Semi-circle in any convenient place of the Field, for taking a large Square, as at 1; and laying the Moveable Index upon 90 *deg.* look through the Sights, and cauſe a Mark to be ſet up in that Line, as at 4: Looking alſo through the Fixed-Sights, cauſe another Mark to be ſet up, as at 2. Meaſure out from your Inſtrument, towards either of theſe Marks, any number of Chains, as 1, 2, 12 Chains; 1, 4, 12 Chains. But as you meaſure, remember to take the Off-ſets in a Perpendicular-line to every Angle or Side, if there be occaſion, as here at 7, which is 1 Chain, 50 Links from my Station I take an Off-ſet to a ſide of the Hedge, and put it down accordingly 5 Chains, 40 Links. So at 8 I take an Off-ſet to an Angle, *viz.* 8 B, 6 Chains; which Off ſet is at the end of 8 Chains, 30 Links in my firſt Line. Then ſeeing in that Line there is no more occaſion of Off-ſets, I meaſure on to 2, making the Line 1, 2, 12 Chains. Then planting my Inſtrument at 2, I direct the Fixed-Sights to my firſt Station, and laying the Index upon 90 *deg.* I cauſe a Mark to be ſet up, ſo as that I may ſee it through the Sights; and upon that Line, as I meaſure out 12 Chains, I take the Off-ſets C 9, D 10. In like manner you muſt do for the other Angle, Lines and Off-ſets.

And when you have thus laid out your Square, and taken all your Off-ſets, you will find in your Field-Book ſuch *Memorandums* as theſe, to help you Protract.

The

The Angles 4 *Right-Angles.*
The Sides 12 *Chains,* 00 *Links each.*

I went round *cum Sole*, or the Hedges being on my Lefth and.

	C.	L.		C.	L.
In the firſt Line, at	1	50	Off-ſet to a Side-Line	5	40
	8	30	Off-ſet to an Angle	6	00

	C.	L.		C.	L.
In the ſecond Line, at	3	50	Off-ſet to an Angle	6	00
	10	70	Off-ſet to an Angle	5	50

	C.	L.		C.	L.
In the third Line, at	10	00	Off-ſet to an Angle	5	30

	C.	L.		C.	L.
In the fourth Line, at	4	30	Off-ſet to an Angle	4	40
	6	70	Off-ſet to an Angle	1	50
	10	80	Off-ſet to a Side	2	20

Now to lay down upon Paper the foregoing Work, make firſt a Square Figure, whoſe Side may be 12 Chains, as 1, 2, 3, 4. Then conſidering you went with the Sun, take 1, 2, for the firſt Line; and taking from your Scale 1 Chain, 50 Links, ſet it upon the Line from 1 to 7: at 7 raiſe a Perpendicular, as 7, 6, making it according to your Field-Book 5 Chains, 40 Links long. Alſo for the ſecond Off-ſet upon the ſame

ſame Line, take from your Scale of Equal Parts 8 Chains, 30 Links, which ſet upon the line from 1 to 8, and upon 8 make the Perpendicular-line 8 B, 6 Chains in length.

For the Off-ſets of the ſecond Line, take 3 Chains, 50 Links, from the Scale, and ſet it from 2 to 9; at 9 make a Perpendicular-line 6 Chains long, *viz.* 9 C: Alſo for the ſecond Off-ſet of the ſame Line, take 10 Chains, 70 Links, and ſet it from 2 to 10; at 10 make the Perpendicular 10 D, 5 Chains, 50 Links in length.

For the Off-ſets of the third Line, take from your Scale 10 Chains, and ſet it from 3 to 11; and at 11 make the Perpendicular 11 E, 5 Chains, 30 Links long.

For the Off-ſets of the fourth Line, take from your Scale 4 Chains, 30 Links, and ſet it from 4 to 12; and at 12 make the Perpendicular 12 F, 4 Chains, 40 Links long. Alſo take 6 Chains, 70 Links, and ſet it from 4 to 13; and at 13 make the Perpendicular 13 G, 1 Chain, 50 Links long.

Laſtly, take 10 Chains, 80 Links, and ſet it from 4 to 1; and at 1 make the Perpendicular 1, 5, 2 Chains, 20 Links long.

Then have you no more to do, but through the ends of theſe Perpendiculars to draw the Bounding-lines, remembring to make Angles where the Field-Book mentions Angles; and where it mentions Side-lines, there to continue ſuch Side-lines till they meet in an Angle.

Although I mention a Square, yet you are not bound to that Figure; for you may with the ſame ſucceſs uſe a Parallelogram, Triangle, or any other Figure. Nor are you bound to take the Off-ſets in Perpen-

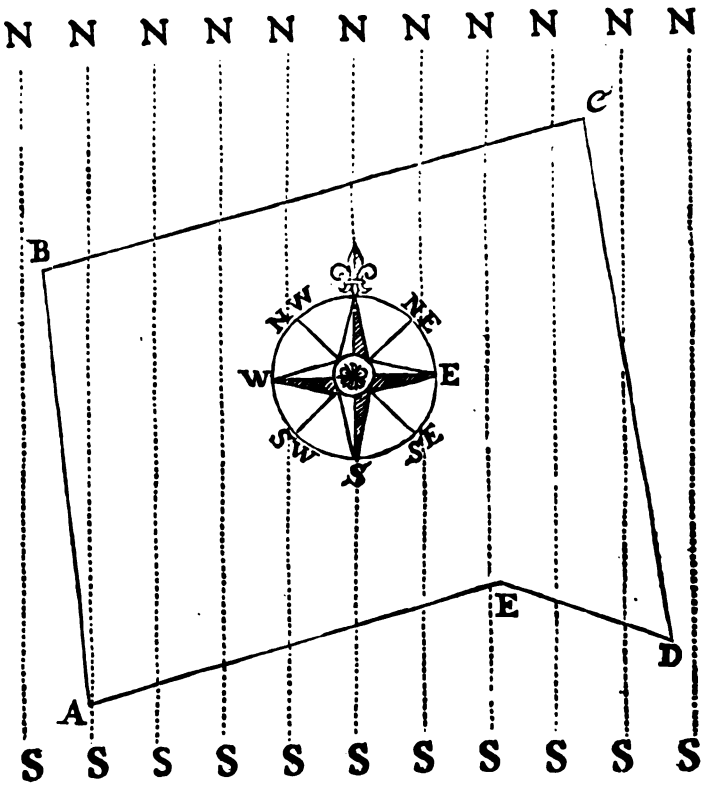
Perpendicular-lines, although it be the beſt way; for you may take the Angles with the Index, from any part of the Line.

This way was chiefly intended for ſuch as were not provided with Inſtruments; for inſtead of the Semi-circle with a plain Croſs only, you may lay out a Square, the reſt of the Work being done with a Chain.

How by the help of the Needle to take the Plot of a large Wood by going round the ſame, and making uſe of that Diviſion of the Card that is numbred with four 90s or Quadrants.

Let A B C D E repreſent a Wood; ſet your Inſtrument at A. and turn it about till through the Fixed Sights you eſpy B, then ſee what Degrees in the Diviſion before ſpoken of, the Needle cuts, which let be N. W. 7, meaſure A B 27 Chains 70 Links; then ſetting the Inſtrument at B, direct the Sights to C, and ſee what then the Needle cuts, which let be N. E. 74; meaſure B C 39 Chains 50 Links; in like manner meaſure every Line, and take every Angle, and then your Field-Book will ſtand thus; as followeth hereunder.

Lines



Lines	Degrees	Minutes	Chains	Links
A B : N. W.	7	80	28	20
B C : N. E.	74	80	39	50
C D : S. E.	9	80	38	00
D E : N. W.	63	20	14	55
E A : S. W.	74	80	28	60

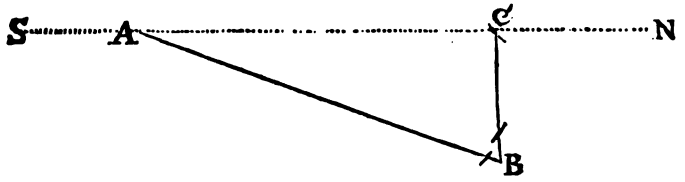
To

To lay down which upon Paper, draw Parallel Lines through your Paper, which ſhall repreſent Meridian, or North and South Lines, as the Lines N S, N S; then applying the Protractor (which ſhould be gratuated accordingly with twice 90 Degrees, beginning at each End of the Diameter, and meeting in the middle of the Arch) to any convenient place of one of the Lines as to A, lay the Meridian Line of the Protractor to the Meridian Line on the Paper; and againſt 7 Degrees make a Mark, through which draw a Line, and ſet off thereon the Diſtance A B 28 Chains 20 Links. Secondly, apply the Centre of the Protractor to B, and (turning the Semicircle thereof the other way, becauſe you ſee the Courſe tends to the Eaſtward) make the Diameter thereof lye parallel to the Meridian Lines on the Paper, (which you may do by the Figures at the Ends of the Parallelogram) and againſt 74 Degrees make a Mark, and ſet off 39 Chains 50 Links, and draw the Line B C; the like do by the other Lines and Angles, until you come round to the place where you began.

This is the moſt uſual way of plotting Obſervations taken after this manner, and uſed by moſt Surveyors in *America*, where they lay out very large Tracts of Land: but there is another way, though more tedious, yet ſurer; (I think firſt made Publick by Mr. *Norwood*) whereby you may know before you come out of the Field, Whether you have taken your Angles, and meaſured the Lines truly or not, and is as followeth.

When you have Surveyed the Ground as above directed, and find your Field-Book to ſtand as before; caſt up what Northing, Southing, Eaſting or Weſt-

ing every Line makes; that is to ſay, How far at the End of every Line you have altered your Meridian, and what Diſtance upon a Meridian-Line you have made: As for Example, ſuppoſe A B was the Side of a Field meaſured to be 20 Chains, N S a Meridian-



Line, the Angle C A B N E 20 Degrees. The buſineſs is to find the Length of the Line A C, which is called the Northing, or the difference of Latitude; alſo the length of the Line C B, which is called the Eaſting, or Difference of Longitude, which you may do indifferently truly by laying them down thus upon Paper: But paſſing this and the *Gunter*'s Scale, the only way is by the Tables of Sines and Logarithms, where the Proportion is this.

As Radius or Sine of 90 Degrees, *viz.* the Right Angle C is to the Logarithm of the Line A B 20 Chains;

So is the Sine of the Angle C A B 20 Degrees to the Difference of Longitude C B 6 Chains 80 Links.

Secondly, to find the difference of Latitudes, or the Line A C, ſay,

As Radius is to the Logarithm Line A B 20 Chain, ſo is the Sine Complement of the Angle at A to the Logarithm of the Line A C 18 Chains 80 odd Links.

Example

Example of the foregoing Figure.

In the precedent Figure, I find in my Field-Book, the firſt Line to run N W 7 Degrees 28 Chain, 20 Links; now to find what Northing, and what Weſting is here made, I ſay thus,

As Radius	10,000000
Is to the Logarithm of the Line 28 Chains 20 Links,	1,450249
So is the Sine of the Angle from the Meridian, *viz.* 7 Degrees	9,085894
To the Logarithm of the Weſting 3 Chains 43 Links	0,536143

Again,

As Radius	10,000000
Is to the Logarithm 28 Chains 20 Links	1,450249
So is the Sine Complement of 7 Degrees	9,996751
To the Log. of the Northing 27 Ch. 99 Lin.	1,447000

And having thus found the Northing and Weſting of that Line: I put it down in the Field-Book againſt the Line under the proper Titles N W, in like manner I find the Latitude and Longitude of all the reſt, and having ſet them down, the Field-Book will appear thus.

Lines	Degrees	Minutes	Chains	Links	N	S	E	W
A B. NW	7 : 00		28 : 20		27 : 99	.. : ..	.. : ..	03 : 43
B C. N E	74 : 00		39 : 50		10 : 89	.. : ..	37 : 97	.. : ..
C D. S E	9 : 00		38 : 00		.. : ..	37 : 53	05 : 95	.. : ..
D E. NW	63 : 20		14 : 55		06 : 53	.. : ..	.. : ..	13 : 00
E A. S W	74 : 00		28 : 60		.. : ..	07 : 88	.. : ..	27 : 49
					45 : 41	45 : 41	43 : 92	43 : 92

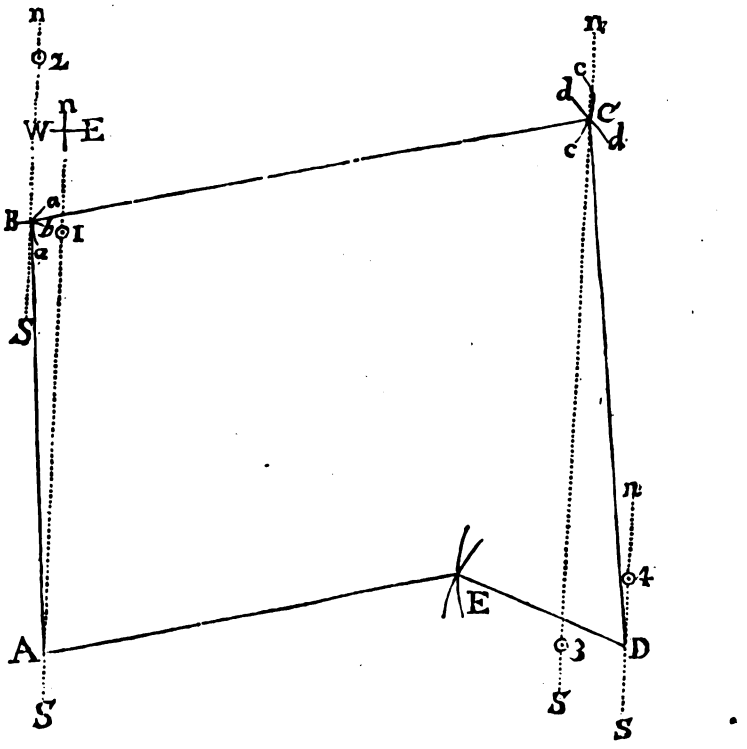
This done, add all the Northings together, alſo all the Southings, and ſee if they agree; alſo all the Eaſtings and Weſtings; and if they agree likewiſe, then you may be ſure you have wrought truly, otherwiſe not. Thus in this Example the ſumm of the Northings is 45 Chains 41 Links; ſo likewiſe is the ſumm of the Southings; alſo the ſumm of the Eaſtings is 43 Chains 92 Links, ſo is the ſumm of the Weſtings: Therefore I ſay I have ſurveyed that Piece of Land true.

But becauſe this way of caſting up the Northing, Southing, Eaſting or Weſting, of every Line may ſeem tedious and troubleſome to you; I have at the End of this Book, made a Table, wherein by Inſpection only, you may find the Longitude and Latitude of every Line, what quantity of Degrees ſoever it is ſituated from the Meridian.

Moreover, I am alſo obliged to ſhew you another way of plotting the foregoing Piece of Ground according to the Table in the Field-Book of N S, E W, as hereunder.

Draw

Draw a Line at adventure, as the Line N ⊙ A S for a Meridian Line; then beginning in any place of that



Line, as at A, ſet off the Northing of the Firſt Line as from A, to ⊙ 1, *viz.* 27 Chain 99 Links; then taking with your Compaſſes the Weſting of the ſame Line, *viz.* 3 Chains 43 Links; ſet one Foot in ⊙ 1, and with the other make the Arch *a a*; next take the Length of your firſt Line, as you find it in the Field-Book, *viz.* 28 Chains 20 Links; and ſetting one Foot of the Compaſſes in A, with the other croſs

croſs the former Arch *a a* with another, *viz.* B *b*, and in the Interſection of thoſe Arches, *viz.* at B, is your ſecond Angle.

Then through B draw another North and South Line parallel to the firſt, as N B S is parallel to N A S; and taking with your Compaſſes the Northing of the ſecond Line, *viz.* 10 Chains 89 Links, ſet it upon the Line from B to ⊙ 2, take alſo the Eaſting of the ſame Line *viz.* 37 Chains 97 Links, and ſetting one Foot of the Compaſſes in ⊙ 2, with the other ſweep the Arch *c c*; alſo take with your Compaſſes the length of the ſecond Line, *viz.* 39 Chains 50 Links, and ſetting one Foot in B croſs the former Arch with another *d d*; and that interſection is your third Angle, *viz.* C.

It would be but tautologie in me to go round thus with all the Lines; for by theſe two firſt you may eaſily conceive how all the reſt are done: But let me put you in mind when you ſweep the Arches for the Eaſting and Weſting, to turn your Compaſſes the right way, and not take Eaſt for Weſt, and Weſt for Eaſt.

Nor can I commend to you this way of plotting, the former being as true, and far eaſier; yet when you plot by the former way, it is very good for you to prove your Work by the Table of difference of Latitude and Longitude before you begin to protract; and when you find your Field-Work true, you may lay it down upon Paper, which way you think the eaſieſt.

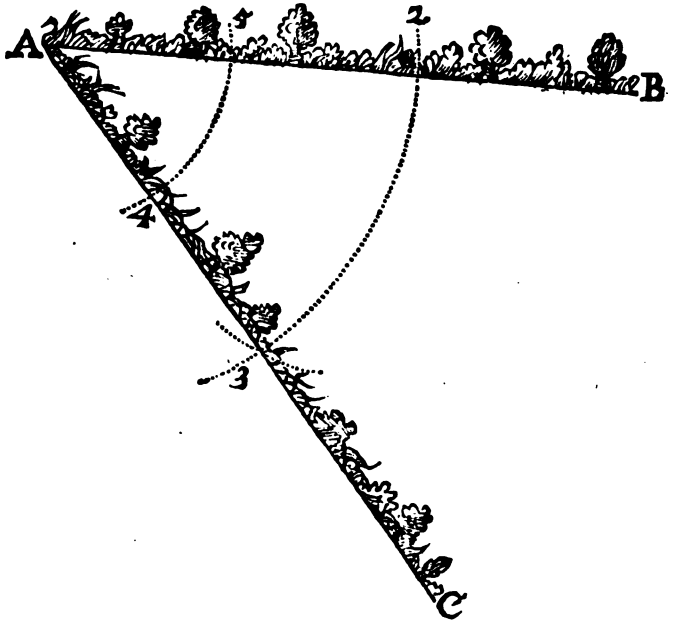
To conclude this Chapter or Section, I ſhall in the next place ſhew you, How to take the Plot of a Field by the Chain only, uſing no other Inſtrument in the Field; and that after a better manner than hitherto has been taught.

Firſt

Firſt therefore, I ſhall ſhew you how to take the quantity of an Angle by the Chain; (which well underſtood) there need be no more required: For the Buſineſs of a Surveyor in the Field, is no more but to meaſure Lines and take Angles: I mean for telling the quantity of any Field or Piece of Land, as how many Acres it contains, or the like.

How by the Chain only, to take an Angle in the Field.

Firſt meaſure along the Hedge A B, any ſmall diſtance, as A 2 two Chains; alſo meaſure along the



Hedge

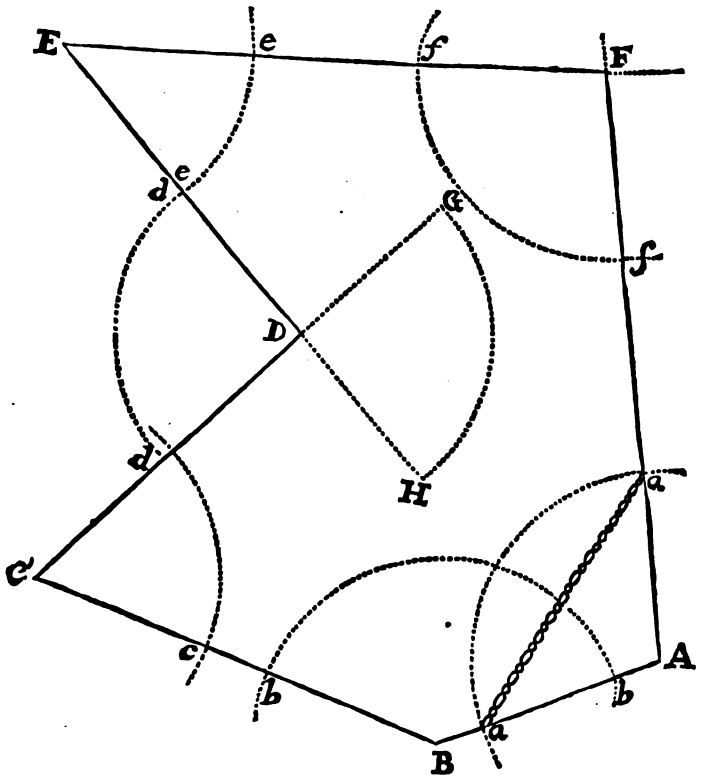
Hedg A C what number of Chains you pleaſe, no matter whether they be equal to the former or not; as A 3 two Chains; next meaſure the diſtance 2, 3, *viz.* 1 Chain 68 Links; and then have you done in the Field. To plot which, draw the Line A B at adventure, and ſet off 2 Chains from A to 2; then take with your Compaſſes the diſtance A 3, 2 Chains, and ſetting one Foot in A, deſcribe the Arch 2, 3; take alſo with your Compaſſes the diſtance 2, 3, *viz.* 1 Chain 68 Links; and ſetting one Foot in 2, with the other croſs the former Arch; through which Croſs draw the Line A C; which with A B will make an Angle equal to the Angle in the Field.

But the more eaſie and ſpeedy way is to take but one Chain only along the Hedges; as in the foregoing Figure, I ſet a ſtrong Stick in the very Angle A, and putting the Ring at one End of the Chain over it, I take the other End in my Hand, and ſtretch out the Chain along the Firſt Hedge A B, and where it ends, as at 5, I ſtick down a Stick, then I ſtretch the Chain alſo along the Hedge A C, and at the end thereof ſet another Stick as at 4, then looſing my Chain from A, I meaſure the diſtance 4, 5, which is 74 Links, which is all I need note down in my Field-Book for that Angle; and now coming to plot that Angle, I take firſt from my Scale the diſtance of one Chain, and placing one Foot of the Compaſſes in any part of the Paper, as at A, I deſcribe the Arch 4, 5; then I take from the ſame Scale 74 Links, and ſet it off upon that Arch, making Marks where the Ends of the Compaſſes fall, as at 4, 5. Laſtly, from A, through theſe Marks I draw the Lines A B, and A C, which conſtitute the former Angle: Remember to plot

plot your Angles with a very large Scale; and you may ſet off your Lines with a ſmaller.

I will give you two Examples of this way of meaſuring, and then leave you to your own practice. Firſt,

How by the Chain only to Survey a Field by going round the ſame.



Let A B C D E F be the Field; and beginning at A in the very Angle, ſtick down a Staff through the great

great Ring at one of the Ends of your Chain, and taking the other End in your Hand, ſtretch out the Chain in length, and ſee in what part of the Hedge A F the other End falls: as ſuppoſe at *a*, there ſet up a Stick; and do the like by the Hedge A B, and ſay, there the Chain ends at (*a*) alſo; meaſure the neareſt diſtance between *a* and *a*, which let be 1 Chain 60 Links, this note down in your Field-Book; meaſure next the length of the Hedge A B, which is 12 Chains 50 Links; note this down alſo in your Field-Book. Nextly, coming to B, take that Angle in like manner as you did the Angle A, and meaſure the diſtance B C: after this manner you muſt take all the Angles, and meaſure all the Sides round the Field. But leſt you be at a Nonplus at D, becauſe that is an outward Angle, thus you muſt do; ſtick a Staff down with the ring of the Chain round it in the very Angle D, then taking the other end of the Chain in your Hand, and ſtretching it at length, move your ſelf to and Fro 'till you perceive your ſelf in a direct Line with the Hedge D C, which will be at G, where ſtick down an Arrow, or one of your Surveying-Sticks; then move round 'till you find your ſelf in a direct Line with the Hedge D C, and there the Chain ſtretched out at length, plant another Stick, as at H, then meaſure the neareſt Diſtance H G, which let be 1 Chain 43 Links; which note down in your Field-Book, and proceed on to meaſure the Line D E; but in your Field Book make ſome ſome Mark againſt D, to ſignifie it is an outward Angle, as >, or the like: And when you come to plot this, you muſt plot the ſame Angle outward that you took inward; for the Angle G D H, is the ſame, as the Angle *d* D *d*. I made this outward Angle

Angle here on purpose to shew you how you must Survey a Wood, by going round it on the Outside, where you must take most of the Angles, as here you do D.

Having thus taken all the Angles, and measured all the Sides; the next thing to be done, Is to lay down upon Paper, according to your Field-Book: Which you will find to stand thus.

Angles	Chains	Links	Lines of the Field	Chains	Links
A	1	60	AB	12	50
B	1	84	BC	23	37
C	1	06	CD	19	30
D	1	43	DE	20	00
E	0	80	EF	29	00
F	1	52	FA	31	50

Forasmuch now as it is convenient that the Angles be made by a greater Scale than the Lines are laid down with: I have therefore in this Figure made the Angles by a Scale of one Chain in an Inch, and laid down the Lines by a Scale of ten Chains in one Inch. But to begin to plot, take from your Scale one Chain, and with that Distance, in any convenient place of your Paper, as at A, sweep the Arch *a a*; then from the same large Scale take off 1 Chain 60 Links, and set it upon that Arch, as from *a* to *a*; and from A draw Lines through *a* and *a*, as the Lines A B, A F:

Then repairing to your ſhorter Scale, take from thence the firſt diſtance, *viz.* 12 Chains 50 Links, and ſet it from A to B, drawing the Line A B.

Secondly, repairing to B, take from your large Scale 1 Chain, and ſetting one Foot of the Compaſſes in B, with the other make the Arch *b b*; alſo from the ſame Scale take your Chord Line, *viz.* 1 Chain 84 Links, and ſet it upon the Arch *b b*, one Foot of the Compaſſes ſtanding where the Arch interſects A B, the other will fall at *b*; then through *b* draw the Line B C; and from your ſmaller Scale ſet off the Diſtance B C 23 Chains 37 Links, which will fall at C, where the next Angle muſt be made. After this manner proceed on according to your Field-Book, 'till you have done.

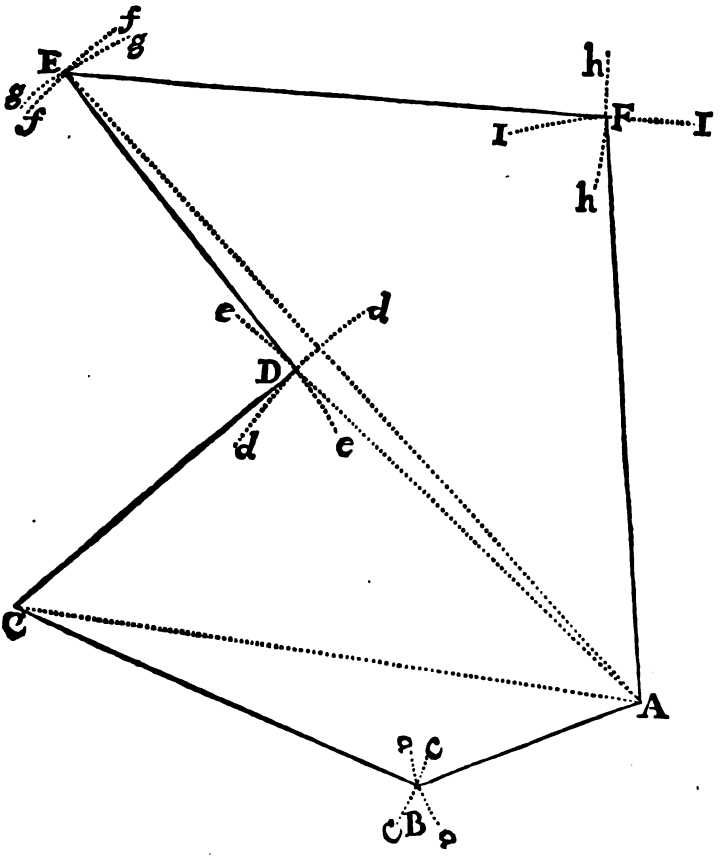
And here mark that you need neither in the Field, nor upon the Paper, take notice of the Angle F, nor yet meaſure the Lines E F and A F, for if you draw thoſe two Lines through, they will interſect each other at the true Angle F: However, for the Proof of your Work, it is good to meaſure them, and alſo to take the Angle in the Field.

I muſt not let ſlip in this place the uſual way taught by Surveyors, for the meaſuring a Field by the Chain only, as true indeed as the former, but more tedious, which take as followeth.

The common way taught by Surveyors, for taking the Plot of the foregoing Field.

Becauſe I will not confound your Underſtanding with many Lines in one Figure, I have here again placed the ſame. Firſt they bid you meaſure round the

the Field, and note down in your Field-Book every Line thereof, as in this Field has been before done.



Secondly, they bid you turn all the Field into Triangles, as beginning at A, to measure the Diagonal A C, A D, A E, and note them down; then is your Field turned into four Triangles, and the Diagonals are,

A C

		Chains		Links
A C	:	33	.	70
A D	:	25	.	70
A E	:	45	.	40

To plot which, they adviſe you firſt to draw a Line at adventure, as the Line A C, and to ſet off thereon 33 Chains 70 Links, according to your Field-Book for the Diagonals; then taking with your Compaſſes the Length of the Line A B, *viz.* 12 Chains 50 Links, ſet one Foot in A, and with the other deſcribe the Arch *a a*; alſo take the Line B C, *viz.* 23 Chains 37 Links, and ſetting one Foot in C, with the other deſcribe the Arch *c c*, cutting the Arch *a a* in the Point B, then draw the Lines A B, C B, which ſhall be two bound Lines of the Field.

Secondly, take with your Compaſſes the Length of the Diagonal A D, *viz.* 25 Chains 70 Links, and ſetting one Foot of the Compaſſes in A, with the other deſcribe the Arch, as *d d*, alſo taking the Line C D, *viz.* 19 Chains 30 Links, ſet one Foot in C, and with the other deſcribe the Arch *e e*, cutting the Arch *d d* in the point D, to which Interſection draw the Line C D.

Thirdly, take with your Compaſſes the Length of of the Diagonal A E, *viz.* 45 Chains 40 Links, and ſetting one Foot in A, with the other deſcribe an Arch, as *f f*, alſo take the Line D E 20 Chains, and therewith croſs the former Arch in the Point E, to which draw the Line D E.

Laſtly,

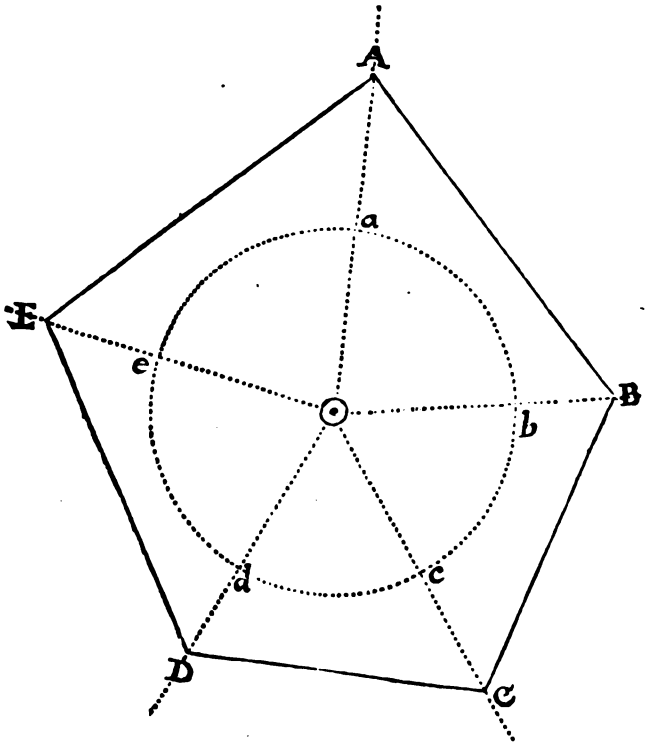
Laſtly, take with your Compaſſes the length of the Line A F, *viz.* 31 Chains, 50 Links; and ſetting one foot in A, deſcribe an Arch, as I I. Alſo take the length of the Line E F, *viz.* 29 Chains, 00 Links, and therewith deſcribe the Arch *h h*, which cuts the Arch I I, in the Point F, to which Point draw the Lines A F and E F, and ſo will you have a true Figure of the Field.

I have ſhewed you both ways, that you may take your choice. And now I proceed to my Second Example promiſed.

How to take the Plot of a Field at one Station, near the Middle thereof, by the Chain only.

Let A B C D E be the Field, ⊙ the appointed place, from whence by the Chain to take the Plot thereof. Stick a Stake up at ⊙ through one ring of the Chain, and make your Aſſiſtant take the other end, and ſtretch it out. Then cauſe him to move up and down, till you eſpy him exactly in a Line between the Stake and the Angle A; there let him ſet down a ſtick, as at *a*, and be ſure that the ſtick *a* be in a direct Line between ⊙ and A; which you may eaſily perceive, by ſtanding at ⊙, and looking to A. This done, cauſe him to move round towards B; and at the Chains end, let him there ſtick down another ſtick exactly in the Line between ⊙ and B, as at *b*. Afterwards let him do the ſame at *c*, at *d*, and at *e*; and if there were more Angles, let him plant a ſtick at the end of the Chain in a right Line between

tween ⊙ and every Angle. In the next place measure the nigheſt diſtance between ſtick and ſtick, as *a b*, 1 Chain 26 Links, *b c* 1 Chain 06 Links,



c d 1 Chain 00 Links, *d e* 1 Chain 20 Links, and put them down in your Field-Book accordingly. Meaſure alſo the Diſtances between ⊙ and every Angle, as ⊙ A 18 Chains 10 Links, ⊙ B 15 Chains 00 Links, *&c.* all which put down, your Field-Bok will appear thus;

Subten-

		Chains	Links
Subtendent or Chord-Lines	*a b*	1	26
	b c	1	06
	c d	1	00
	d e	1	20

		Chains	Links
Diagonal or Centre-Lines	⊙ A	18	10
	⊙ B	15	00
	⊙ C	17	00
	⊙ D	15	00
	⊙ E	16	00

How to plot the former Obſervations.

Take from a large Scale 1 Chain, and ſetting one foot of the Compaſſes in any convenient place of the Paper, as at ⊙, make the Circle *a b c d e*. Then taking for your firſt Subtendent, or Chord-line, 1 Chain, 26 Links; ſet it upon the Circle, as from *a* to *b*. From ⊙ through *a* and *b*, draw Lines, as ⊙ A, ⊙ B, which be ſure let be long enough. Then take your ſecond Subtendent from the ſame large Scale, *viz.* 1 Chain, 6 Links, and ſet it upon the Circle from *b* to *c*, and through *c* draw the Line ⊙ C. When thus you have ſet off all your Subtendents, and drawn Lines through their ſeveral Marks, repair to a ſmaller Scale; and upon the Lines drawn, ſet off your Diagonal or Centre Lines, as you find them in the Field-Book: So upon the Line ⊙ *a* you muſt ſet off 18 Chains, 10 Links, making a Mark where it falls, as at A: Upon the Line ⊙ *b* 15 Chains, 00 Links, which falls at B; and ſo by all the reſt. Laſtly, draw the Lines A B, B C, C D, *&c.* and the Work will be finiſhed.

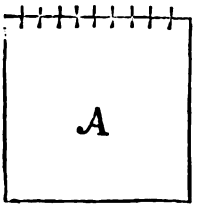
It would be but running things over again, to ſhew you how, after this manner, to Survey a Field at two or three Stations, or in any Angle thereof, *&c.* For if you well underſtand this, you cannot be ignorant of the reſt.

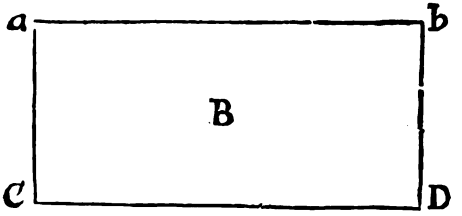
CHAP. VII.

How to caſt up the Contents of a Plot of Land.

HAving by this time ſufficiently ſhewed you how to Survey a Field, and lay down a true Figure thereof upon Paper; I come in the next place to teach you how to caſt up the Contents thereof; that is to ſay, to find out how many Acres, Roods and Perches it containeth. And firſt

Of the Square, and Parallelogram.





To caſt up either of which, multiply one Side by the other, the Product will be the Content.

EXAMPLE.

Let A be a true Square, each ſide being 10 Chains; multiply 10 Chains 00 Links by 10 Chains 00 Links, *facit* 10100000. from which I cut off the five laſt Figures, and there remains juſt 10 Acres for the Square A.

Again,

Again, In the Parallelogram B, let the ſide A *b* or *c* D be 20 Chains, 50 Links; and the ſide *a c* or *b* D 10 Chains, 00 Links: Multiply *a b*, 20 Chains, 50 Links, by *a c* 10 Chains, 00 Links, *facit* 201500000. from which cutting off the laſt five Figures, remains 20 Acres. Then if you multiply the Figures cut off, *viz.* 50000 by 4, *facit* 200000; from which cutting off five Figures, remains 2 Roods; and if any thing but 000 had been left, you muſt have multiplied again by 40; and then cutting off again five Figures, you would have had the odd Perches: See it done hereunder.

I need not have multiplied 00 by 40; for I know 40 times Nothing is Nothing; but only to ſhew you in what order the Figures will ſtand when you have odd Perches, as preſently we ſhall light on. So much is the Content of the long Square B, *viz.* 20 Acres, 2 Roods, 00 Perch.

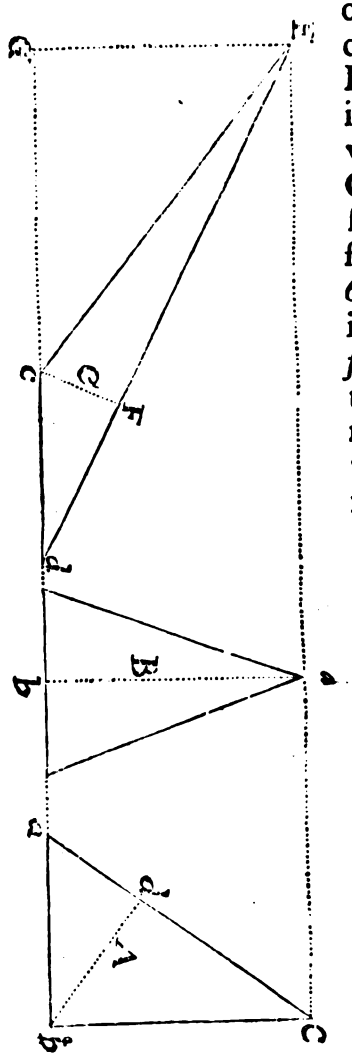
	20.50
	10.00
Acres	201500 00
	4
Roods	21000 00
	40
Perches	01000 00

Of Triangles.

The Content of all Triangles are found, by multiplying half the Baſe by the whole Perpendicular; or the whole Baſe by half the Perpendicular; or otherwiſe, by multiplying the whole Baſe and whole Perpendicular together, and taking half that Product for the Content. Either of theſe three ways will do, take which you pleaſe.

E X A M P L E.

In the Triangle A, the Baſe *a b* is 10 Chains, 00 Links: the Perpendicular *c b* 13 Chains, 70 Links: the half of which is 6 Chains, 85 Links; which multiplied by 10 Ch. 00 Lin. *facit* 685000; from which cutting off five Figures, there is left 6 Acres. Then multiplying the Remainder by 4, *facit* 340000; from which taking five Figures, remains 3 Roods. Again, the five Figures cut off multiplied by 40, makes 1600000; from which taking five Figures, leaves 16 Perches. See the Operation.



	6,85
	10,00
Acres	6185000
	4
Roods	3140000
	40
Perches	16100000

So

So likewise in the Triangle B, the Perpendicular *a f* is 13 Chains, 70 Links; which multiplied by half the Base, will give the same Content.

Also in the Triangle C, if you multiply half the Base E *d*, by the Perpendicular *c* F, the Product will be the Content of that Triangle.

And here Note, that you are not confined to any Angle, but you may let fall your Perpendicular from what Angle you please, taking the Line on which it falls for the Base. Thus in the Triangle A, if from *b* you let fall a Perpendicular, take *b d*, and the half of *a c* for finding the Content. Also in the Triangle C, yon may from E let fall your Perpendicular, although it falls without the Triangle; and the half of E G, and the whole of *c d*, shall be the true Content of the Triangle C; but then you must remember to extend the Base-line *c d*.

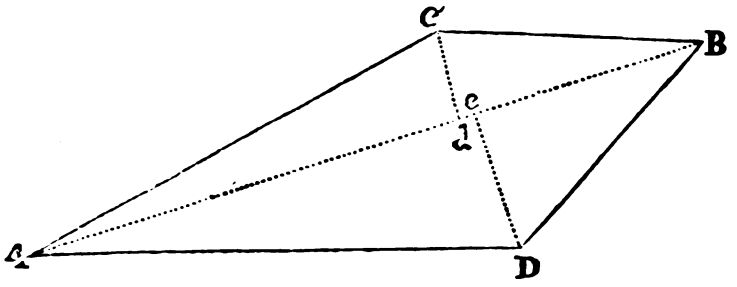
Remember this, all Triangles having the same Base, and lying between Parallel-lines, are of the same Content; so the Triangles A B C have the same Base, and lye between the Lines E *c* and G *b*, and are therefore of the same Content.

To find the Content of a Trapezia.

Draw between two opposite Angles a streight Line, as A B; then is the Trapezia reduced into two Triangles, *viz.* A B C and A B D, which you may measure as before taught, and adding their Products together, you will have the true content of the Trapezia. Or a Little shorter, thus:

Take

Take the length of the Line A B, which let be 37 Chain 00 Links; take alſo the length of the Per-



pendicular D *e*, which let be 7 Chains 40 Links; alſo C *d* 4 Chains 80 Links: add the two Perpendiculars together, and they make 12 Chains 20 Links, which multiply by half the common Baſe A B 18 Chains 50 Links, and the Product is 22 Acres, 2 Rood, 11 Perch, as appears by the Operation hereunder.

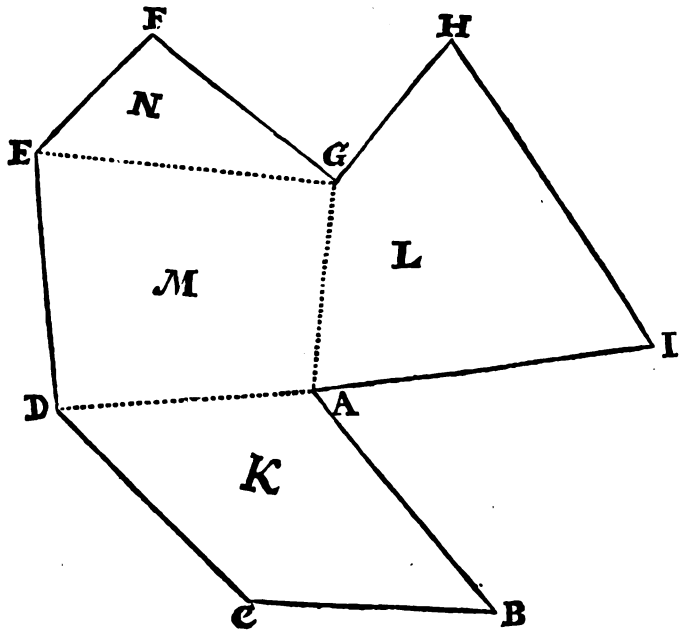
Half the common Baſe A B	18,50
The Sum of the two Perpendiculars	12,20
	37000
	3700
	1850
Acres	22|57000
	4
Roods	2|28000
	40
Perches	11|20000

How

How to find the Content of an Irregular Plot, conſiſting of many Sides and Angles.

To do this, you muſt firſt by drawing Lines from Angle to Angle, reduce the Plot all into Trapeziaes and Triangles; after which meaſure every Trapezia and Triangle ſeverally, and adding their Contents altogether, you will have the true Content of the whole Plot.

EXAMPLE.



In

In the annexed Figure A B C D E F G H I, I draw the Line A D, which cuts off the Trapezia K; alſo the Line A G, which cuts off the Trapezia L: And laſtly the Line G E, which makes the Trapezia M, and the Triangle N, ſo is the whole Plot reduced into the three Trapeziaes K, L, M, and the Triangle N; all which I meaſure as before taught, and put them down as hereunder.

	Acres	Roods	Perches
The Trapezia K contains	21	2	12
The Trapezia L contains	26	3	18
The Trapezia M contains	30	2	16
The Triangle N contains	6	2	24
The Content of the Plot	85	2	30

By which you find the whole Plot to contain 85 Acres, 2 Rood, 30 Perches.

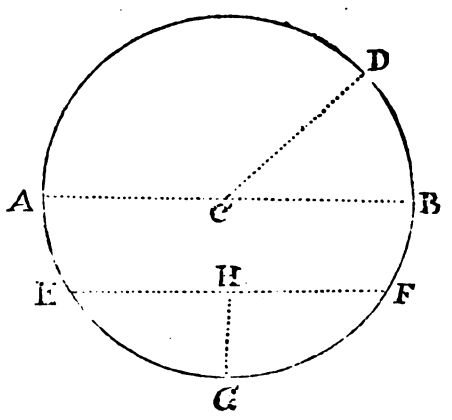
If the Sides of the Plot had been given in Perches, Yards, Feet, or any other Meaſure, you muſt ſtill caſt up the Content after this manner, and then your Product will be Perches, Yards, *&c.* To turn which into Acres, Roods and Perches, I have largely treated of in the beginning of this Book.

How to find the Content of a Circle, or any Portion thereof.

To find the Content of the whole Circle, it is convenient, That firſt you know the Diameter and Circumference thereof; one of which being known, the

the other is eaſily found; for as 7 is to 22, ſo is the the Diameter to the Circumference: And as 22 is to 7, ſo is the Circumference to the Diameter.

In this annexed Figure, the Diameter AB is 2 Chains, or 2000 Links, which multiplyed by 22, and



the Product divided by 7, gives 6 Chains 28 Links, and ſomething more for the Circumference. Now, to know the Superficial Content multiply half the Circumference by half the Diameter, the Product will be the Content: Half the Circumference is 3 Chains 14 Links; half the Diameter 1 Chain 00 Links; which multiplyed together, the Product is 3,1400 Square Links, or 1 Rood 10 Perch, the Content of the Circle. Again,

By the Diameter only to find the Content.

As 14 is to 11, ſo is the Square of the Diameter to the Content. The Square of the Diameter is 40000,

which multiplyed by 11, makes 440000, which divided by 14 gives 31428, or 1 Rood 10 Perch, and ſomething more for the Content.

How to meaſure the Superficial Content of the Section of a Circle.

Multiply half the Compaſs thereof by the Semidiameter of the Circle, the Product will anſwer your deſire.

In the foregoing Circle, I would know the Content of that little piece D C B; the Arch D B is 78 Links $\frac{1}{2}$; the half of it 39 $\frac{1}{2}$, which multiplyed by 1 Chain, 00 Links, the Semidiameter gives 3925 Square Links, or 6 Perches $\frac{1}{4}$.

How to find the Content of a Segment of a Circle without knowing the Diameter.

Let E F G be the Segment, the Chord E F is 1 Chain 70 Links, or 170 Links, the Perpendicular G H 50 Links; now multiply $\frac{2}{3}$ of the one by the whole of the other, the Product will be the Content, the two thirds of 170 is neareſt 113, which multiplyed by 50 produces 5650 Square Links or 9 Perches.

How to find the Superficial Content of an Oval.

The common way is to multiply the long Diameter by the ſhorter, and from that Product extract the Square

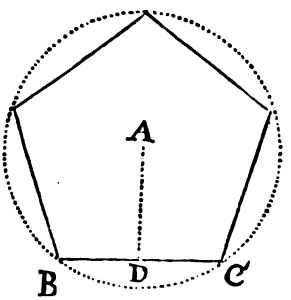
Square Root, which you may call a mean Diameter; then as if you were meaſuring a Circle, ſay,

As 14 to 11, ſo the mean Diameter to the Content of the Oval; but this is not exact: A better way is;

As 1, [illegible] is to the length of the Oval; ſo is the bredth to the Content, or nearer, as 1,27324 to the length; ſo the bredth to the Content.

How to find the Superficial Content of Regular Polygons; as Pentagons, Hexagons, Heptagons, &c.

Multiply half the ſumm of the Sides, by a Perpendicular, let fall from the Centre upon one of the Sides, the Product will be the Area or Superficial Content of the Polygon. In the following Pentagon the Side B C is 84 Links, the whole ſumm of the five Sides, therefore muſt be 420, the half of which is 210, which multiplyed by the Perpendicular A D 56 Links, gives 11760 Square Links for the Content, or 18 Perches $\frac{4}{10}$ of a Perch, almoſt 19 Perches.



I have been ſhorter about theſe three laſt Figures than my uſual Method, becauſe they very rarely fall in the Surveyors way to meaſure them in Land, though indeed in Broad Meaſure, Paving, *&c.* often.

CHAP. VIII.

Of laying out New Lands, very useful for the Surveyors, in his Majesty's Plantations in America.

A certain quantity of Acres being given, how to lay out the same in a Square Figure.

ANnex, to the Number of Acres given, 5 Cyphers, which will turn the Acres into Links; then from the Number thus increased, extract the Root, which shall be the Side of the proposed Square.

EXAMPLE.

Suppose the Number given be 100 Acres, which I am to lay out in a Square Figure; I joyn to the 100 5 Cyphers, and then it is 10000000 Square Links, the Root of which is 3162 nearest, or 31 Chains 62 Links, the length of one Side of the Square.

Again,

If I were to cut out of a Corn-Field one Square Acre: I add to one five Cyphers, and then is it 100000; the Root of which is 3 Chains 16 Links, and something more, for the Side of that Acre.

How

How to lay out any given Quantity of Acres in a Parallelogram; whereof one Side is given.

Turn first the Acres into Links, by adding as before 5 Cyphers, that number thus increased, divide by the given Side, the Quotient will be the other Side.

EXAMPLE.

It is required to lay out 100 Acres in a Parallelogram, one Side of which shall be 20 Chains, 00 Links; first to the 100 Acres I add 5 Cyphers, and it is 100,00000; which I divide by 20 Chains 00 Links, the Quotient is 50 Chains 00 Links, for the other Side of the Parallelogram.

How to lay out a Parallelogram that shall be 4, 5, 6, or 7, &c. times longer than it is broad.

In *Carolina*, all Lands lying by the Sides of Rivers, except Seignories or Baronies, are (or ought, by Order of the Lord's Proprietors to be) thus laid out. To do which, first as above taught, turn the given quantity of Acres into Links, by annexing 5 Cyphers; which summ divide by the number given for the Proportion between the length and bredth, as 4, 5, 6, 7, *&c.* the Root of the Quotient will shew the shortest Side of such a Parallelogram.

EXAMPLE.

EXAMPLE.

Admit it were required of me to lay out 100 Acres in a Parallelogram, that ſhould be five times as long as broad: Firſt to the 100 Acres I add 5 Cyphers, and it makes 100,00000, which ſumm I divide by 5, the Quotient is 2000000, the Root of which is neareſt 14 Chains 14 Links, and that I ſay ſhall be the ſhort Side of ſuch a Parallelogram, and by multiplying that 1414 by 5, ſhews me the longeſt Side thereof to be 70 Chains 70 Links.

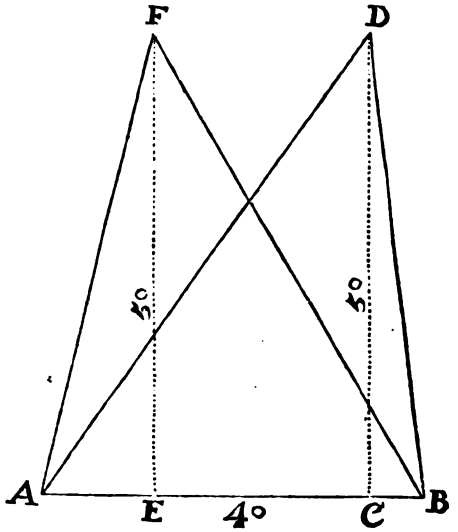
How to make a Triangle that ſhall contain any number of Acres, being confined to a certain Baſe.

Double the given number of Acres, (to which annexing firſt five Ciphers,) divide by the Baſe; the Quotient will be the length of the Perpendicular.

EXAMPLE.

Upon a Baſe given that is in length 40 Chains, 00 Links; I am to make a Triangle that ſhall contain 100 Acres. Firſt I double the 100 Acres, and annexing five Ciphers thereto, it makes 200,00000. which I divide by 40 Chains, 00 Links, the limited Baſe; the Quotient is 50 Chains, 00 Links, for the height of the Perpendicular. As in this Figure, A B is the given Baſe 40; upon any part of which Baſe, I ſet the Perpendicular 50, as at C; then the Perpendicular is C D. Therefore I draw the Lines D A, D B, which

which makes the Triangle D A B to contain juſt 100 Acres, as required. Or if I had ſet the Perpendicular at E, then would E F have been the Perpendi-



cular 50, and by drawing the Lines F A, F B; I ſhould have made the Triangle F A B, containing 100 Acres, the ſame as D A B.

If you conſider this well, when you are laying out a new piece of Land, of any given Content, in *America* or elſewhere, although you meet in your way with 100 Lines and Angles; yet you may, by making a Triangle to the firſt Station you began at, cut off any quantity required.

How

How to find the Length of the Diameter of a Circle which ſhall contain any number of Acres required.

Say as 11 is to 14, ſo will the number of Acres given be to the Square of the Diameter of the Circle required.

EXAMPLE.

What is the Length of the Diameter of a Circle, whoſe Superficial Content ſhall be 100 Acres? Add five Cyphers to the 100, and it makes 100,00000 Links, which multiply by 14, *facit* 140000000; which divided by 11, gives for Quotient 12727272; the Root of which is 35 Chains, 67 Links and better, almoſt 68 Links. And ſo much ſhall be the Diameter of the required Circle.

I might add many more Examples of this nature, as how to make Ovals, Regular Polygons, and the like, that ſhould contain any aſſigned quantity of Land. But becauſe ſuch things are meerly for Speculation, and ſeldom or never come in Practiſe, I at preſent omit them.

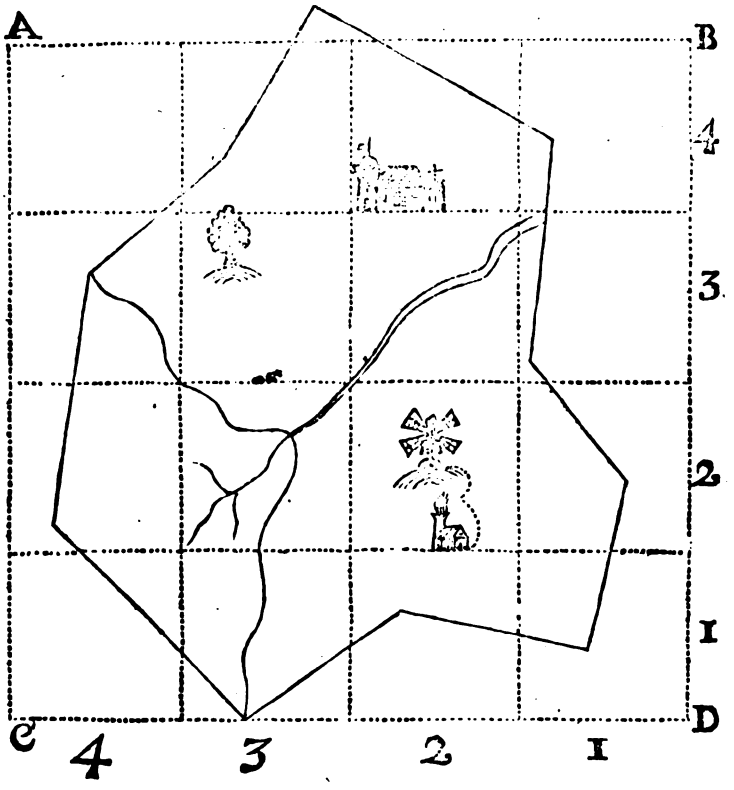
CHAP.

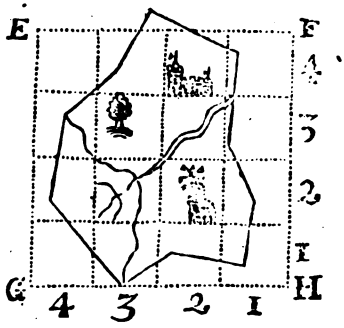
CHAP. IX.

Of Reduction.

How to Reduce a large Plot of Land or Map into a leſſer compaſs, according to any given Proportion; or e contra, *how to Enlarge one.*

THe beſt way to do this, is, if your Plot be not over-large, to plat it over again by a ſmaller Scale: But if it be large, as a Map of a County, or the like, the only way is to compaſs in the Plot firſt with one great Square; and afterwards to 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, by a leſſer Scale, according to the Proportion given. This done, ſee in what Square, and part of the ſame Square, any remarkable accident falls, and accordingly put it down in your leſſer Squares; and that you may not miſtake, it is a good way to number your Squares. I cannot make it plainer, than by giving you the following Example, where the Plot A B C D, made by a Scale of 10 Chains in an Inch, is reduced into the Plot E F G H, of 30 Chains in an Inch.





There are ſeveral other ways taught by Surveyors for reducing Plots or Maps, as Mr. *Rathborn*, and after him Mr. *Holwell*, adviſeth to make uſe of a Scale or Ruler; having a Centre-hole at one end, through which to faſten it down on a Table, ſo that it may play freely round; and numbred from the Centre-end to the other, with Lines of Equal Parts: The Uſe of which is thus. Lay down upon a ſmooth Table, the Map or Plot that you would reduce, and glew it with Mouth-glew faſt to the Table at the four corners thereof. Then taking a fair piece of Paper about the bigneſs that you would have your reduced Plot to be of, and lay that down upon the other; the middle of the laſt about the middle of the firſt. This done, lay the Centre of your Reducing-Scale near the Centre of the white Paper, and there with a Needle through the Centre make it faſt; yet ſo, that it may play eaſily round the Needle. Then moving your Scale to any remarkable thing of the firſt Plot, as an Angle, a Houſe, the bent of a River, or the like: See againſt how many Equal Parts of the Scale it ſtands, as ſuppoſe 100; then taking the ½, the ⅓, the ¼, or any other number thereof, according to the Proportion you would have the reduced Plot to bear; and make a mark upon the white Paper againſt 50, 25, 33, *&c.* of the ſame Scale: And thus turning the Scale about, you may firſt reduce all the outermoſt parts of the Plot. Which done, you muſt double the leſſer Plot, firſt ½ thereof, and then the other; by which you may ſee to reduce the innermoſt part near the Centre.

But I adviſe rather to have a long Scale, made with the Centre-hole, for fixing it to the Table in about one third part of the Scale, ſo that ⅓ of the

Scale may be one way numbred with Equal Parts from the Centre-hole to the end; and ; part thereof numbred the other way to the end with the ſame number of Equal Parts, tho leſſer. Upon this Scale may be ſeveral Lines of Equal Parts, the leſſer to the greater, according to ſeveral Proportions. Being thus provided with a Scale, glew down upon a ſmooth Table your greater Plot to be reduced; and cloſe to it upon the ſame Table, a Paper about the bigneſs whereof you would have your ſmaller Plot. Fix with a ſtrong Needle the Centre of your Scale between both; then turning the longer end of your Scale to any remarkable thing of your to be reduced Plot, ſee what number of Equal Parts it cuts, as ſuppoſe 100; there holding faſt the Scale, againſt 100 upon the ſmaller end of your Scale, make a mark upon the white Paper; ſo do round all the Plot, drawing Lines, and putting down all other accidents as you proceed, for fear of confuſion, through many Marks in the end; and when you have done, although at firſt the reduced Plot will ſeem to be quite contrary to the other; yet when you have unglewed it from the Table, and turned it about, you will find it to be an exact Epitome of the firſt. You may have for this Work divers Centers made in one Scale, with Equal Parts proceeding from them accordingly; or you may have divers Scales, according to ſeveral Proportions, which is better.

What has been hitherto ſaid concerning the Reducing of a Plot from a greater volume to a leſſer, the ſame is to be underſtood *vice verſa*, of Enlarging a Plot, from a leſſer to a greater. But this laſt ſeldom comes in practiſe.

How

How to change Cuſtomary-Meaſure into Statute, and the contrary.

In ſome Parts of *England*, for Wood-Lands; and in moſt Parts of *Ireland*, for all ſorts of Lands; they account 18 Foot to a Perch, and 160 ſuch Perches to make an Acre, which is called *Cuſtomary-Meaſure*: Whereas our true Meaſure for Land, by *Act of Parliament*, is but 160 Perches for one Acre, at 16 Foot ½ to the Perch. Therefore to reduce the one into the other, the Rule is,

As the Square of one ſort of Meaſure,
is to the Sqare of the other;
So is the Content of the one,
to the Content of the other.

Thus if a Field meaſured by a Perch of 18 Feet, accounting 160 Perches to the Acre, contain 100 Acres; How many Acres ſhall the ſame Field contain by a Perch of 16 Feet ½?

Say, if the Square of 16 Feet ½, *viz.* 272. 25. give the Square of 18 Feet, *viz.* 324. What ſhall 100 Acres *Cuſtomary* give? Anſwer 119. ⅔ of an Acre *Statute.*

Knowing the Content of a piece of Land, to find out what Scale it was plotted by.

Firſt, by any Scale meaſure the Content of the Plot; which done, argue thus:

As the Content found, is to the Square of the Scale I tried by;
So is the true Content, to the Square of the true Scale it was plotted by.

Admit

Admit there is a Plot of a piece of Land containing 10 Acres, and I measuring it by the Scale of 11 in an Inch, find it to contain 12 Acres ½ of an Acre. Then I say, If 12½ give for its Scale 11: What shall 100 give? Answer 10. Therefore I conclude that Plot to be made by a Scale of 10 in the Inch. And so much concerning Reducing Lands.

CHAP. X.

Instructions for Surveying a Mannor, County, or whole Country.

To Survey a Mannor observe these following Rules.

1. WAlk or ride over the Mannor once or twice, that you may have as it were a Map of it in your Head, by which means, you may the better know where to begin, and proceed on with your Work.

2. If you can conveniently run round the whole Mannor with your Chain and Instrument, taking all the Angles, and measuring all the Lines thereof; taking notice of Roads, Lanes or Commons as you

cross

croſs them: Alſo minding well the Ends of all dividing Hedges, where they butt upon your bound Hedges in this manner.

3. Take a true Draught of all the Roads and By-Lanes in the Mannor, putting down alſo the true Buttings of all the Field-Fences to the Road. If the Road be broad, or goes through ſome Common or Waſt Ground, the beſt way is to meaſure, and take the Angles on both Sides thereof; but if it be a narrow Lane, you may only meaſure along the midſt thereof, taking the Angles and Off-ſets to the Hedges, and meaſuring your Diſtances truly: Alſo if there be any conſiderable River either bounds or runs through the Mannor, ſurvey that alſo truly, as is hereafter taught.

4. Make a true Plot upon Paper of all the foregoing Work; and then will you have a Reſemblance of the Mannor, though not compleat, which to make ſo, go to all the Buttings of the Hedges, and there Survey every Field diſtinctly, plotting it accordingly every Night, or rather twice a Day, till you have perfected the whole Mannor.

5. When thus you have plotted all the Fields, according to the Buttings of the Hedges found in your firſt Surveys, you will find that you have very nigh, if not quite done the whole Work: But if there be any Fields lye ſo within others, that they are not bounded on either Side by a Road, Lane nor River; then you muſt alſo Survey them, and place them in your Plot, accordingly as they are bounded by other Fields.

6. Draw

6. Draw a fair Draught of the whole, putting down therein the Mannor-Houſe, and every other conſiderable Houſe, Wind-mill, Water-mill, Bridg, Wood, Coppice, Croſs-paths, Rills, Runs of Water, Ponds, and any other Matter Notable therein. Alſo in the fair Draught, let the Arms of the Lord of the Mannor be fairly drawn, and a Compaſs in ſome waſt part of the Paper; alſo a Scale, the ſame by which it was plotted: You muſt alſo beautifie ſuch a Draught with Colours and Cuts according as you ſhall ſee convenient.

Write down alſo in every Field the true Content thereof; and if it be required, the Names of the preſent Poſſeſſors, and their Tenures: by which they hold it of the Lord of the Mannor.

The Quality alſo of the Land, you may take notice of as you paſs over it, if you have Judgment therein, and it be required of you.

How to take the Draught of a County or Country.

1. If the County or Country is in any place thereof bounded with the Sea, Survey firſt the Seacoaſt thereof, meaſuring it all along with the Chain, and taking all the Angles thereof truly.

2. Which done, and plotted by a large Scale, Survey next all the Rocks, Sands or other Obſtacles that lye at the entrance of every River, Harbor, Bay or Road upon the Coaſt of that County or Country; which plot down accordingly, as I ſhall teach you in this Book by and by.

3. Sur-

3. Survey all the Roads, taking notice as you go along of all Towns, Villages, great Houſes, Rivers, Bridges, Mills, Croſs Ways, *&c.* Alſo take the bearing at two Stations of all ſuch Remarks, as you ſee out of the Road, or by the Side thereof.

4. Alſo Survey all the Rivers, taking notice how far they are Navigable, what (and where the) Branches runs into them, what Fords they have, Bridges, *&c.*

5. All this being exactly plotted, will give you a truer Map of the County than any that I know of hath been yet made in *England*: However you may look upon old Maps, and if you find therein any thing worth the Notice that you have not yet put down, you may go and Survey it; and thus by degrees you may ſo finiſh a County, that you need not ſo much as leave out one Gentleman's Houſe; for hardly will it ſcape but every remarkable thing will come into your View, either from the Roads, the Rivers or Sea-Coaſt.

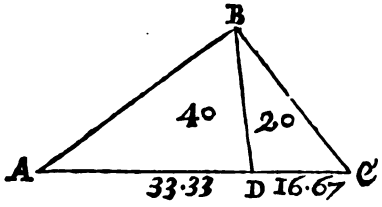
6. Laſtly, with a large Quadrant take the true Latitude of the Place, in three or four Places of the County, which put down upon the Edge of your Map accordingly.

CHAP. XI.

Of dividing Lands.

How to divide a Triangle ſeveral ways.

SUppoſe A B C to be a Triangular Piece of Land, containing 60 Acres, to be divided between two Men, the one to have 40 Acres cut off towards A, and the other 20 Acres towards C; and the Line of Diviſion to proceed from the Angle B. Firſt Meaſure the Baſe A C, *viz.* 50 Chains 00 Links; then ſay by the Rule of Three, If the whole Content 60 Acres give 50 Chain for its Baſe, what ſhall 40 Acres give? Multiply and Divide, the Quotient will be 33 Chains 33 Links; which ſet off upon the Baſe from A to D, and draw the Line B D, which ſhall divide the Triangle as was required. If it had been required to have divided the ſame into 3, 4, 5, or more unequal Parts; you muſt, in the like maner, by the Rule of Three have found the length of each ſeveral Baſe; much after the ſame manner as Merchants part their Gains, By the Rule of Fellowſhip.

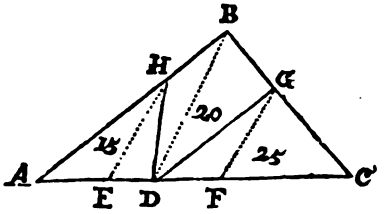


There are ſeveral ways of doing this by Geometry, without the help of Arithmetick, but my Buſineſs is not

not to ſhew you what maybe done, but to ſhew you how to do it, the moſt eaſie and practicable way.

How to divide a Triangular Piece of Land into any Number of Equal or Unequal Parts, by Lines proceeding from any Point aſſigned in any Side thereof.

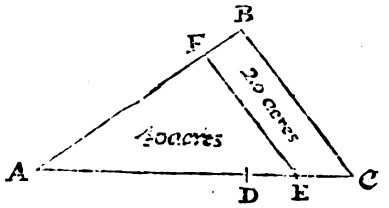
Let A B C be the Triangular Piece of Land, containing 60 Acres to be divided between three Men, the firſt to have 15 Acres, the ſecond 20, and the third 25 Acres, and the Lines of Diviſion to proceed from D: Firſt meaſure the Baſe, which is 50 Chains; then divide the Baſe into three Parts, as you have been before taught, by ſaying, If 60 give 50, what ſhall 15 give? Anſwer, 12 Chains 50 Links for the



firſt Mans Baſe; which ſet off from A to E. Again, Say if 60 give 50, what ſhall 20 give? Anſwer, 16 Chains 66 Links for the ſecond Man's Baſe; which ſet off from E F, then conſequently the third Man's Baſe, *viz.* from F to C muſt be 20 Chains 84 Links: This done, draw an obſcure Line from the Point aſſigned D, to the oppoſite Angle B, and from E and F draw the Lines E H and F G, parallel to B D. Laſtly, from D, draw the Lines D H, DG, which ſhall divide the Triangle into three ſuch Parts as were required.

How to divide a Triangular Piece of Land, according to any Proportion given, by a Line Parallel to one of the Sides.

A B C is the Triangular Piece of Land, containing 60 Acres, the Baſe A C is 50 Chains; this Piece of



Land is to be divided between two Men, by a Line Parallel to B C, in ſuch Proportion that one have 40 Acres, the other 20.

Firſt, divide the Baſe, as has been before taught, and the point of Diviſion will fall in D, A D being 33 Chains 33 Links, and D C 16 Chains 67 Links.

Secondly, find a mean Proportion between A D and A C; by multiplying the whole Baſe 50 by A D 33, 33, the Product is 1666500, of which ſumm extract the Root, which is 40 Chains 82 Links, which ſet off from A to E. Laſtly from E draw a Line parallel to B C, as is the Line E F; which divides the Triangle, as demanded.

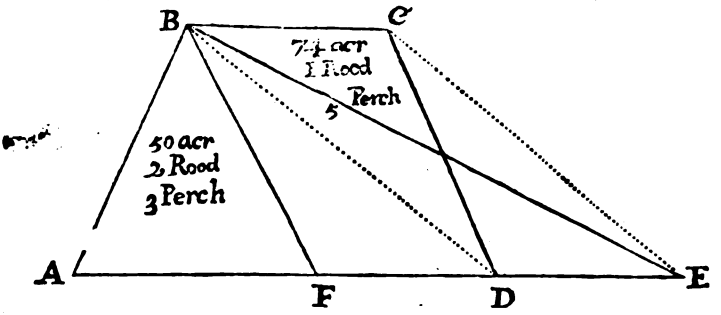
Of dividing Four-Sided Figures or Trapeziaes.

Before I begin to teach you how to divide Pieces of Land of four Sides, it is convenient firſt to ſhew you how to change any Four-Sided Figure into a Triangle; which

which done, the Work will be the ſame as in dividing Triangles.

How to reduce a Trapezia into a Triangle, by Lines drawn from any Angle thereof.

Let A B C D be the Trapezia to be reduced into a Triangle, and B the Angle aſſigned: Draw the



Dark Line B D, and from C make a Line Parallel thereto, as C E; extend alſo the Baſe A D, till it meet C E in E; then draw the Line B E, which ſhall make the Triangle B A E equal to the Trapezia A B C D.

Now to divide this Trapezia according to any aſſigned Proportion is no more but to divide the Triangle A B E; as before taught, which will alſo divide the Trapezia.

E X A M P L E.

Suppoſe the Trapezia A B C D containing 124 Acres 3 Roods and 8 Perches, is to be divided between two Men, the firſt to have 50 Acres, 2 Rood and

and 3 Perches; the other 74 Acres, 1 Rood and 5 Perches, and the Line of Diviſion to proceed from B.

Firſt, Reduce all the Acres and Roods into Perches, then will the Content of the Trapezia be 19968 Perches; the firſt Man's Share 8083 Perches; the ſecond 11885.

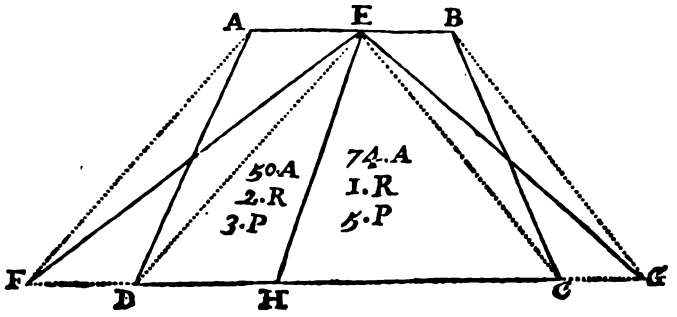
Secondly, Meaſure the Baſe of the Triangle, *viz.* A E 78 Chains 00 Links;

Then ſay, If 19968 the whole Content give for its Baſe } 78 Chains 00 Links,
What ſhall 8083, the firſt Man's part give? Anſwer } 31 Chains 52 Links;

which ſet off from A to F, and drawing the Line F B, you divide the Trapezia as deſired; the Triangle A B F being the Firſt Man's Portion, and the Trapezia B C F D, the ſecond's.

How to reduce a Trapezia into a Triangle, by Lines drawn from a Point aſſigned in any Side thereof.

A B C D is the Trapezia, E the Point aſſigned from whence to reduce it into a Triangle, and run the diviſion Line; the Trapezia is of the ſame Con-

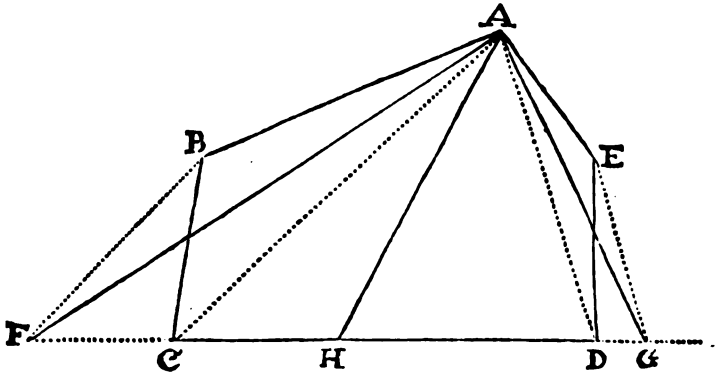


tent

tent as the former, *viz.* 19968 Perches, and it is to be divided as before, *viz.* one Man to have 8083 Perches, and the other 11885. First for to reduce it into a Triangle, draw the Lines E D, E C, and from A and B make Lines parallel to them, as A F, B G; then draw the Lines E G, E F, and the Triangle E F G will be equal to the Trapezia A B C D; which is divided as before; for when you have found by the Rule of Proportion, What the first Man's Base must be, *viz.* 31 Chains 52 Links, set it from F to H, and draw the Line H E, which shall divide the Trapezia according to the former Proportion.

How to reduce an Irregular Five-Sided Figure into a Triangle, and to divide the same.

Let A B C D E be the Five-Sided Figure; to reduce which into a Triangle, draw the Lines A C,

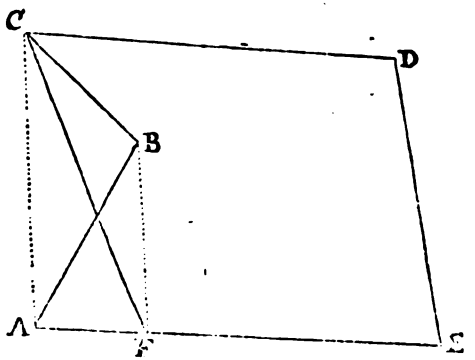


A D; and parallel thereto B F, E G extending the Base from C to F, and from D to G; then draw the Lines A F, A G, which will make the Triangle A F G equal to the Five Sided-Figure. If this was to

to be divided into two equal Parts, take the half of the Baſe of the Triangle, which is F H, and from H draw the Line H A; which divides the Figure A B C D E into two equal Parts. The like you may do for any other Proportion.

If in dividing the Plot of a Field there be Outward Angles, you may change them after the following manner.

Suppoſe A B C D E be the Plot of a Field; and B the outward Angle.

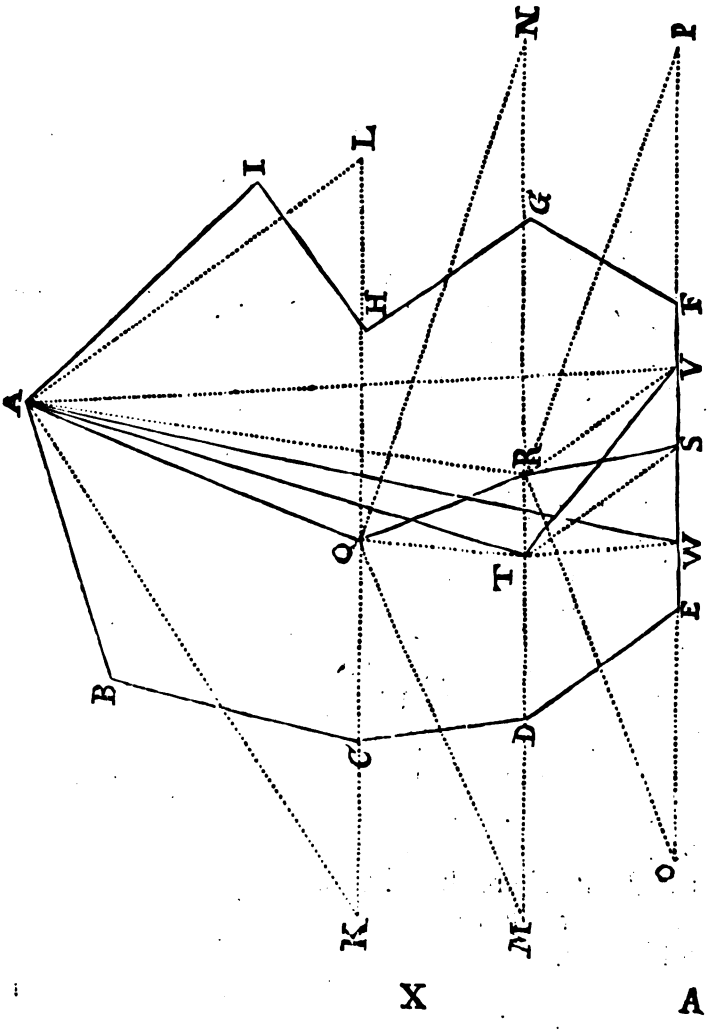


Draw the Line C A, and parallel thereto the Line B F.

Laſtly, The Line C F ſhall be of as much force as the Lines C B and B A. So is that five-ſided Figure, having one outward Angle reduced into a four-ſided Figure, or *Trapezia*; which you may again reduce into a Triangle, as has been before taught.

How

How to Divide an Irregular Plot of any number of Sides, according to any given Proportion, by a ſtreight Line through it.



A B C D E F G H I is a Field to be divided between two Men in equal Halfs, by a ſtreight Line proceeding from A.

Firſt, conſider how to divide the Field into five-ſided Figures and Trapezias, that you may the better reduce it into Triangles: As by drawing the Line K L, you cut off the five-ſided Figure A B C H I; which reduce into the Triangle A K L, and meaſuring half the Baſe thereof, which will fall at Q, draw the Line Q A.

Secondly, Draw the Line M N, and from the Point Q reduce the Trapezia C D G H into the Triangle M N Q; which again divide into Halfs, and draw the Line Q R.

Thirdly, From the Point R, reduce the Trapezia D E F G into the Triangle R O P; and taking half the Baſe thereof, draw the Line R S; and then have you divided this Irregular Figure into two Equal Parts by the three Lines A Q, Q R, R S.

Fourthly, Draw the Line A R, alſo Q T parallel thereto. Draw alſo A T, and then have you turned two of the Lines into one.

Fifthly, From T draw the Line T S; and parallel thereto, the Line R V. Draw alſo T V. Then is your Figure divided into two Equal Parts, by the two Lines A T and T V.

Laſtly, Draw the Line A V, and parallel thereto T W. Draw alſo A W, which will cut the Figure into two Equal Parts by a ſtreight Line, as was required.

You may, if you pleaſe, divide ſuch a Figure all into Triangles; and then divide each Triangle from the Point where the Diviſion of the laſt fell, and then will your Figure be divided by a crooked Line, which you may bring into a ſtreight one, as above.

This

This above is a good way of Dividing Lands, but Surveyors ſeldom take ſo much pains about it. I ſhall therefore ſhew you how commonly they abbreviate their Work, and is indeed

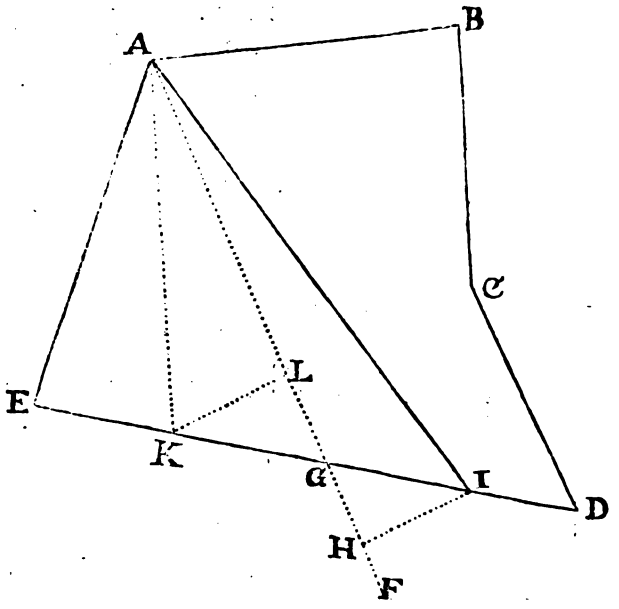
An eaſie way of Dividing Lands.

Admit the following Figure A B C D E contain 46 Acres, to be divided in Halfs between two Men, by a Line proceeding from A.

Draw firſt a Line by gueſs, through the Figure, as the Line A F. Then caſt up the Content of either Half, and ſee what it wants, or what it is more than the true Half ſhould be.

As for Example. I caſt up the Content of A E G, and find it to be but 15 Acres; whereas the true Half is 23 Acres; 8 Acres being in the part A B C D G, more than A E G. Therefore I make a Triangle containing 8 Acres, and add it to A E G, as the Triangle A G I; then the Line A I parts the Figure into equal Halfs.

But more plainly how to make this Triangle: Meaſure firſt the Line A G, which is 23 Chains, 60 Links. Double the 8 Acres, they make 16; to which add five Cyphers to turn them into Chains and Links, and then they make 160000; which divide by A G 2360, the Quotient is 6 Chains, 77 Links; for the Perpendicular H I, take from your Scale 6 Chains, 77 Links, and ſet it ſo from the Baſe A G F, that the end of the perpendicular may juſt touch the Line E D, which will be at I. Then draw the Line A I, which makes the Triangle A G I



juſt 8 Acres, and divides the whole Figure, as deſired.

If it had been required to have ſet off the Perpendicular the other way, you muſt ſtill have made the end of it but juſt touch the Line E D, as L K does: For the Triangle A K G is equal to the Triangle A G I, each 8 Acres.

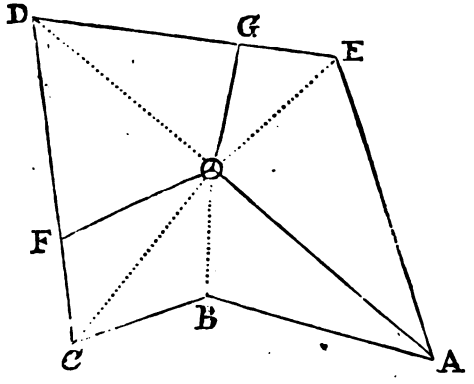
And thus you may divide any piece of Land of never ſo many Sides and Angles, according to any Proportion, by ſtreight Lines through it, with as much certainty, and more eaſe than the former way.

Mark, you might alſo have drawn the Line A D, and meaſured the Triangle A G D, and afterwards have divided the Baſe G D, according to Proportion, in

in the Point I; which I will make more plain in this following Example.

Suppoſe the following Field, containing 27 Acres, is to be divided between three Men, each to have Nine Acres; and the Lines of Diviſion to run from a Pond in the Field, ſo that every one may have the benefit of the Water, without going over one another's Land.

Firſt from the Pond ⊙ draw Lines to every Angle, as ⊙A, ⊙B, ⊙C, ⊙D, ⊙E,; and then is the Figure



divided into five Triangles, each of which meaſure, and put the Contents down ſeverally; which Contents reduce all into Perches, ſo will the Triangle

A ⊙ B		674	
B ⊙ C		390	
C ⊙ D	be	1238	Perches,
D ⊙ E		911	
E ⊙ A		1107	

the whole Content being 4320 Perches, or 27 Acres, each Man's Proportion being 1440 Perches.

From

From ⊙ to any Angle draw a Line for the first Division-line, as ⊙ A. Then consider that the first Angle A ⊙ B is but 674 Perches, and the second B ⊙ C 390, both together but 1064 Perches, less by 376 than 1440, one Man's Portion. You must therefore cut off from the third Angle C ⊙ D 376 Perches for the first Man's Dividing-line; which thus you may do: The Base D C is 18 Chains; the Content of the Triangle 1238 Perches: Say then, if 1238 Perches give Base 18 Chains, 00 Links: What shall 376 Perches give? Answer 5 Chains, 45 Links; which set from C to F, and drawing the Line ⊙ F, you have the first Man's part, *viz.* A ⊙ F.

Secondly, See what remains of the Triangle C ⊙ D 376 being taken out, and you will find it to be 862 Perches, which is less by 578 than 1440. Therefore from the Triangle D ⊙ E cut off 578 Perches, and the point of Division will fall in G. Draw the Line ⊙ G, which with ⊙ A and ⊙ F, divides the Figure into three Equal Parts.

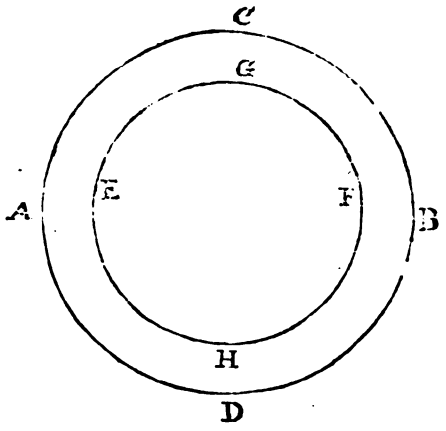
How to Divide a Circle according to any Proportion, by a Line Concentrick with the first.

All Circles are in Proportion to one another as the Squares of their Diameters; therefore if you divide the Square of Diameter or Semi-diameter, and extract the Root, you will have your desire.

EXAMPLE.

Let A B C D be a Circle to be equally divided between two Men.

The



The Diameter thereof is 2 Chains:
The Semi-diameter 1 Chain, or 100 Links:
The Square thereof 10100:
Half the Square . 5050:
The Root of the Half 71 Links, which take from your Scale, and upon the ſame Centre draw the Circle GEHF, which divides the Circle A B C D into Equal Parts.

CHAP. XII.

Trigonometry: *Or the Menſuration of Right Lined Triangles.*

THe Uſe of the Table of Logarithm Numbers, I have ſhewed you in Chap. I. concerning the Extraction of the Square Root. Here follows

The

The use of the Tables of Sines and Tangents.

Any Angle being given in Degrees and Minutes, how to find the Sine or Tangent thereof.

Let 25 Degrees 10 Minutes be given to find the Sine and Tangent thereof; first in the Table of Sines and Tangents, at the Head thereof seek for 25, and having found it, look down the first Column on the Left-hand under M for the 10 Minutes, and right against under the Title *Sin.* stands the Sine required, *viz.* 9,659517; also in the same Line under the Title *Tang.* stands the Tangent of 25°: 10', *viz.* 9,710282. But if the Degrees exceed 45, then look at the Foot of the Tables for the Degrees, and up the Right-hand Column for the Minutes; and right against you will find the Sine and Tangent above the Title *Sine Tang.* thus the Sine of 64° Degrees 50' Minutes is 9,956684; the Tangent thereof is 10,328037.

How to find the Cosine or Sine Complement; the Cotangent or Tangent Complement of any given Degrees and Minutes.

The Cosine or Cotangent is nothing more but the Sine and Tangent of the remaining Degrees and Minues after substraction from 90, thus, take 25 Degrees 10 Minutes from 90 Degrees, 00 Minutes, there will remain 64 Degrees 50 Minutes, the Sine of which, is as before 9,956684, and that is the Sine Complement of 25 Degrees 10 Minutes.

But

But the more ready way to find the Coſine or Cotangent of any number of Degrees given, is to look for the Degrees and Minutes, as before taught, for Sines and Tangents, and right againſt, under the Titles Coſine and Cotangent; or above, if the Degrees exceed 45, you will find the Coſine or Cotangent required: Thus the Coſine of 30 Degrees 15 Minutes is 9,702236; the Cotangent of 58 Degrees 10 Minutes is 9,792974.

Any Sine or Tangent, Co-ſine or Co-tangent being given, to find the Degrees and Minutes belonging thereto.

This is only the converſe of the former, for you muſt ſeek in the Tables for the Sine, *&c.* given, or the nigheſt that can be be found thereto; and right againſt it you will find the *Minutes* and *Degrees* overhead. Let the Sine 8,742259 be given, right againſt it ſtands 3 Degrees 10 Minutes.

Remember well that Multiplication is performed with theſe Logarithm Tables by Addition, and Diviſion by Subſtraction. If I were to multiply 5 by 4, firſt I look for the Logarithm of 5, which is 0,698970
The Logarithm of 4 is 0,602060

Added together, they make 1,301030

which 1,301030 I ſeek for in the Logarithm Tables, and right againſt, under Title *Num.* ſtands 20, the Product of 5 multiplyed by 4.

If I were to divide 20 by 5, firſt I look for the Logarithm of 20, which as above, is 1,301030
The Logarithm of 5 is 0,698970

After Subſtraction remains 0,602060

and the Number anſwering to that Logarithm, you will find to be 4.

And thus by Addition and Subſtraction the Rule of Three, is performed with the Logarithms, *viz.* by adding the two laſt together, and out of their Product ſubſtracting the Firſt.

EXAMPLE.

If 15 give 32, what ſhall 45 give?
The Logarithm of 15 is 1,176091

The Logarithm of 45 is 1,653212
The Logarithm of 32 is 1,505150

The two laſt added together, make 3,158362

Out of which I ſubſtract the firſt, and there remains } 1,982271

Againſt which 1,982271, I find the Number 96. I anſwer therefore, If 15 gives 32, 45 ſhall give 96.

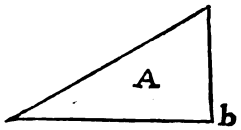
This you muſt obſerve to do in the following Caſes of Triangles, always to add the ſecond and third numbers together, and from their Product to Subſtract the firſt, the remainder will be the Logarithm Number, Sine or Tangent, of your required Line or Angle.

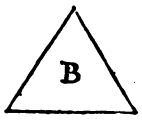
Certain

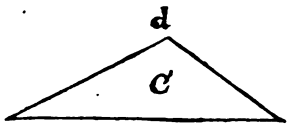
Certain Theorems for the better underſtanding Right-Lined Triangles.

1. A Right-Lined Triangle is a Figure comprehended within three Streight Lines.

2. Which is either Right-Angled as *A*, having one Right Angle, which contains juſt 90 Degrees, *viz.* that at *b*; or elſe Oblique as B, which conſiſts of three Acute Angles, neither of them ſo great as 90 Degrees; or which conſiſts of two Acute Angles and one Obtuſe, *viz.* at that D.



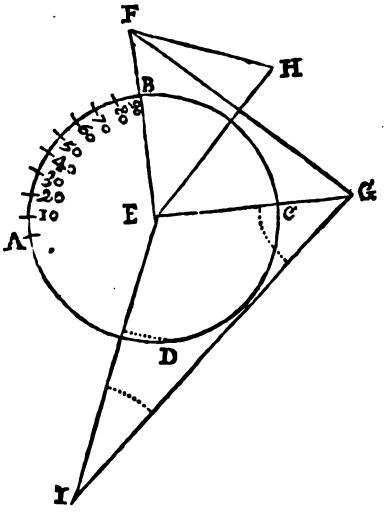




3. All the three Angles of any Triangle are equal to two Right Angles, or 180 Degrees; ſo that one Angle being known, the other two together are known alſo; or two being known, the third is alſo known by Subſtracting the two known Angles out of 180 Degrees, the remainder is the third Angle.

4. To know well what the Quantity of an Angle is, take this following Demonſtration.

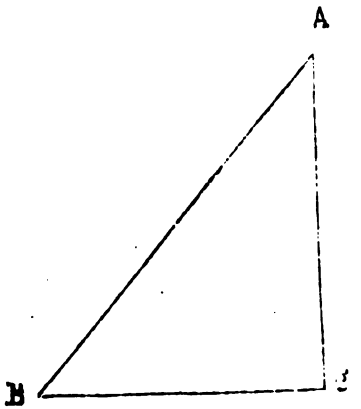
Let A B C D be a Circle, whoſe Circumference is divided (as all Circles you muſt eſteem ſo to be) into 360 Equal Parts, which are called Degrees, and each of thoſe Degrees into 60 Equal Parts more, which are called Minutes: Now a Right-Angled Triangle is that which cuts off one fourth



part of this Circle, *viz.* Degrees, as you ſee the Triangle E F G to do.

An Angle that cuts off leſs than 90 Degrees, is called an Acute Angle, as H E F, which takes but 45 Degrees from the Circle.

G EI is an Obtuſe Angle, for the two Lines that



proceed

proceed from E, take in between them more than a quarter of the Circle, *viz.* 113 Degrees.

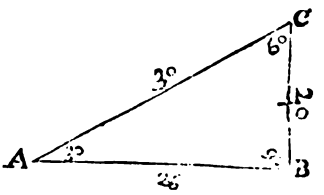
5. Every Triangle hath ſix Parts, *viz.* three Sides and three Angles; the Sides are ſometimes called Legs, but moſt commonly in Right-Angled Tria ngles, the Bottom Line, as B C is called the Ba ſe, A C the Perpendicular, and the longeſt Line A B is called the Hypothenuſe. The Sides are all in proportion to the Sines of their oppoſite Angles; ſo that any three parts of the ſix being known, the reſt may eaſily be ſearched out.

6. When an Angle exceeds 90 Degrees, ſubſtract it out of 180, and work by the remainder.

CASE i.

In Right-Angled Triangles, the Baſe being given, and the Acute Angle at the Baſe; how to find the Hypothenuſal Line, and the Perpendicular.

In the Right-Angled Triangle A B C, there is given the Baſe A B, which is 26 Equal Parts, as Perches, or the like; the Angle at A is alſo given, which is 30 Degrees: Now to find the Length of the Hypothenuſe A C, ſay thus,



As the Sine Complement of the Angle at A
is to the Logarithm of the Baſe 26,
So is Radius or the Sine of 90°
to the Logarithm of the Hypothenuſe A C 30.

The

The Sine Complement of 30 Degrees is	9,937531
The Logarithm of 26 is	1,414973
The Radius, or Sine of 90°	10,000000
The two laſt added together	11,414973
Remains, after Subſtracting the firſt Number	1,477442

Which if you look for in your Logarithm Tables, you will find the Number anſwering thereto to be 30, and ſo long is the Hypothenuſal-line required.

Note in your Tables, when you cannot find exactly the Logarithm you look for, you muſt take the neareſt thereto, as in this Example I find 1,477121 to be the neareſt to 1477442. Mark alſo, that whereas I ſay, as the Sine-complement of the Angle at A, *&c.* you may as well ſay, as the Sine of the Angle at C is to the Log. *&c.* for the Angle at A being given in a Right-angled Triangle, you cannot be ignorant of the Angle at C. If you mind the Rule above, that all the three Angles of a Triangle are equal to two right Angles, or 180 Degrees; for if you take the Right-Angle at B 90°, and that at A 30° both known, and ſubſtract them out 180°, there remains only 60° for the Angle at C. But in purſuance of our Queſtion.

How to find the Perpendicular.

As the Sine of the Angle ACB 60°
is to the Log. of the Baſe 26 AB;
So the Sine of the Angle CAB 30°
to the Log. of the Perpendicular CB 15.

Note,

Note, when I put three Letters to expreſs an Angle, the Middlemoſt Letter denotes the Angular-Point.

The Sine of 60 *deg.* is	9,937531
The Log. of the Baſe 26 A B, is	1,414973
The Sine of 30 *deg.* is	9,698970
The two laſt added	11,113943

From which ſubſtract the firſt, and remains 1,176412

The neareſt number anſwering to which is 15, which is the Length of the Perpendicular-line C B.

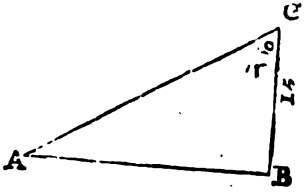
Or otherwiſe; the Hypothenuſal-line being firſt found, viz. *A C* 30. *you may find the Perpendicular thus:*

As the Sine of the Right-Ang. CBA or Rad.	10,000000
is to the Log. of the Hypoth. A C 30	1,477121
So is the Sine of the Angle CAB 30 *deg.*	9,698970
to the Log. of the Perpendicular 15	11,176091

CASE ii.

The Perpendicular and Angle A C B being given to find the Baſe and Hypothenuſal.

Let the Perpendicular be C B 15, as before the Angle ACB 60 *deg.* to find the Baſe, work thus:



As

As the Co-ſine of the Angle ACB
is to the Logarith. of the Perpendicular B C 15;
So is the Sine of the Angle A C B
to the Logarith. of the Baſe A B 26.

The Co-ſine of the Angle A C B 60°, is	9,698970
The Log. of C B 15, is	1,176091
The Sine of the Angle A C B 60, is	9,937531
	11,113622
The neareſt Log. anſwering to 26, is	1,414652

For the Hypothenuſal.

As the Sine-complement of the Angle A C B 60°
is to the Log. of the Perpendicular C B 15
So is the Sine of the Angle ABC, or Radius 90°
to the Log. of the Hypothenuſal 30°

The Co-ſine of the Angle A C B, is	9,698970
The Log. of the Perpend. C B 15, is	1,176091
The Radius	10,000000
The Log. of the Hypothenuſal 30	1,477121

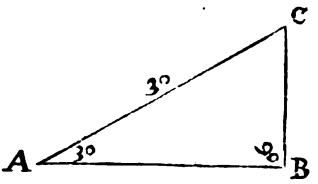
Or otherwiſe thus; the Baſe being firſt found, to find the Hypothenuſal.

As the Sine of the Angle A CB 60°	9,937531
is to the Log. of the Baſe 26	1,414973
So is Radius	10,000000
to the Log. of the Hypothenuſal (30)	1,477442

Caſe

CASE iii.

The Hypothenuſal, and either of the Acute Angles given, to find the Baſe and Perpendicular.



Let the Hypothenuſal be A C 30
The Angle C A B 30°

To find the Baſe A B, work thus:

As the Sine of the Right-Angle C B A 90°, or Radius	}	10,000000
is to the Log. of the Hypoth. A C 30		1,477121
So is the Co-ſine of the Angle C A B 30		9,937531
to the Log. of the Baſe A B	(26)	11,414652

To find the Perpendicular C B, work thus.

As the Sine of the Right-Angle CBA 90°, or Radius	}	10,000000
is to the Log. of the Hypoth. A C 30		1,477121
So is the Sine of the Angle C A B 30		9,698970
to the Log. of the Perpend.	(15)	11,176091

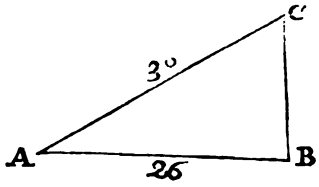
Or otherwiſe; the Baſe being found, to find the Perpendicular thus:

As the Co-ſine of the Angle C A B 30°	9,937531
is to the Log. of the Baſe A B 26	1,414973
So is the Sine of the Angle C A B (30°)	1,698970
	11,113943
to the neareſt Log. of the Perpend. (15)	1,176412

CASE iv.

The Hypothenuſal and Baſe being given, to find the two Acute Angles, viz. *A C B, and C A B.*

Let A C, the Hypothenuſal, be 30°
A B the Baſe 26. and the Angle A C B required.



As the Logarithm of the Hypothenuſal A C 30
is to Radius, or the Sine of the Angle C B A 90;
So is the Logarithm of the Baſe A B 26
to the Sine of the Angle A C B 60.

The

The Operation.

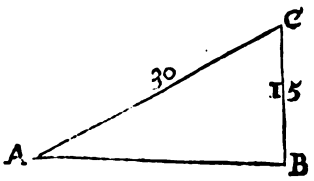
The Logar. of the Hypothenuſal A C 30 is	1,477121
The Radius	10,000000
The Logarithm of the Baſe A B 26	1,414973
The Sine of A C B, the Angle required, 60°	9,937852

For the Angle C A B, work thus.

As the Logar. of the Hypothenuſe A C 30	1,477121
is to the Radius 90	10,000000
So is the Logarithm of the Baſe A B 26	1,414973
to the Coſine of the Angle required 30	9,937852

CASE V.

The Hypothenuſal and Perpendicular being given, to find the Angles and Baſe.



The Hypothenuſal is 30
The Perpendicular 15
A B C a Right Angle.

Now to find the Angle at A work thus.

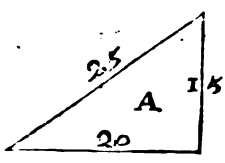
As the Logar. of the Hypothenuſal A C 30	1,477121
to the Radius	10,000000
So is the Logar. of the Perpendicular 15 CB	1,176091
to the Sine of the Angle at A 30°	9,698970

To find the Angle at C work thus.

As the Logarithm of the Hypothenuſal A C 30
is to the Radius 90 Degrees,
So is the Logarithm of the Perpendicular C B 15
to the Co-ſine of the Angle at A 30, *viz.* 60 Deg.
Laſtly to find the Baſe, work as you were taught in Caſe 2.

Here note that any two Sides of a Right Angled Triangle being given: the third Side may be found by extraction of the Square Root.

E X A M P L E.



In the Right Angled Triangle A, let the given Baſe be 20, the Perpendicular 15, and the Hypothenuſal required.

Square the Baſe 20, or multiply it by it ſelf, and it makes 400; Square alſo the Perpendicular 15, and it makes 225, add the two Squares together, and they make 625, from which Summ extract the Square Root, which Root is the length

length of the Hypothenuſal, *viz.* 25; but if the Hypothenuſal, and either of the other Sides be given to find the third, you muſt Subſtract the Leſſer Square out of the Greater, and the Root of the remainder is the Side required: As for Example, the Hypothenuſal 25 is given, and the Baſe 20, to find the Perpendicular multiply the Hypothenuſal in it ſelf, and it makes 625

20
625 (25
45

Multiply the Baſe in it ſelf and it makes 400

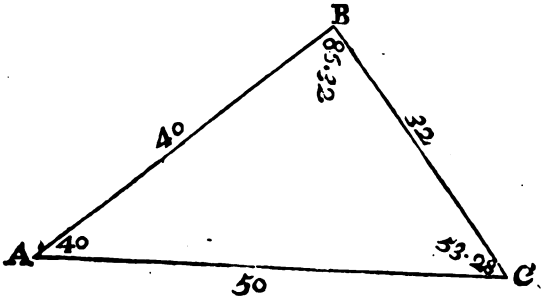
which 400 Subſtract from 625, there remains 225

the Root of which is 15, the Perpendicular required.

CASE vi.

Of Oblique Angled Plain Triangles.

Two Sides of an Oblique Triangle being given, and an Angle oppoſite to either of the Sides, how to find the other two Angles and the third Side.



In

In the Triangle A B C there is given the Side AB 40,
the Side B C 32,
the Angle at A 40 Degrees,
and the Angle at C is required.

Note that in Oblique Triangles, the ſame Rule holds good as in Right-Angled Triangles; *viz.* That the Sides are in ſuch proportion one to another, as the Sines of their oppoſite Angles.

As the Logarithm of the Side B C 32	1,505150
is to the Sine of the Angle A 40	9,808067
So is the Logarithm of the Side A B 40	1,602060
	11,410127
to the Sine of the Angle at C 53° : 28′	9.904977

To find the Angle at B,

Add the two known Angles together, *viz.* that at A 40, and that at C. 53. 28, and they make 93 Degrees 28 Minutes; which ſubſtracted from 180 Degrees, leaves 86 Degrees 32 Minutes, which is the Angle at B.

Laſtly, to find the Line AC, ſay,

As the Sine of the Angle A 40	9,808067
is to the Logarithm of the Side B C 32	1,505150
So is the Sine of the Angle B 86°: 32	9,999204
	11,504354
to the Log. of the Side A C required 50	1,696287

Mark

Mark, that though the neareſt whole number anſwering to the Logarithm 1,696287 be 50; yet if you go to Fractions, the length of the Line A C is but $49\frac{6}{10}$.

CASE vii.

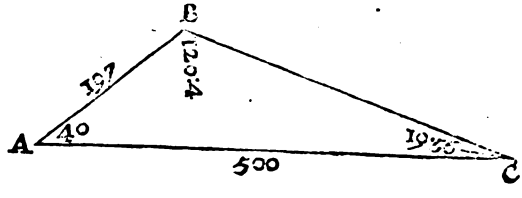
Two Angles being given, and a Side oppoſite to one of them, to find the other oppoſite Side.

In the foregoing Triangle there is given the Angle A 40 Degrees, the Angle C 53 Degrees 28 Minutes; alſo the Side A B 40: To find the Side B C work thus.

As the Sine of the Angle C 53°: 28′	9,904992
is to the Logarithm of the Side A B 40	1,602060
So is the Sine of the Angle A 40	9,808067
	11,410127
To the Log. of the Side B C, neareſt 32	1,505135

CASE viii.

Two Sides of a Triangle being given, with the Angle contained by them, to find either of the other Angles.



In

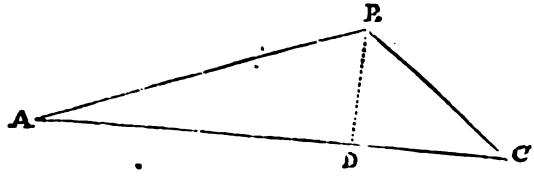
In the Triangle A B C
there is given the Side A B 197
The Side A C 500
The Angle at A 40 Degrees ;
Now to find either of the other Angles work thus.

As the Log. of the Summ of the 2 Sides	697	2,843233
is to the Logar. of their Difference	303	2, 481443
So is the Tang. of the half Summ of the two Oppoſite Angles	70 Degrees	10,438934
		12,920377
to the Tangent of	50 Degrees 4 Min.	10,077144

which 50° 4′ added to the half Summ of the two unknown Angles, *viz.* 70° makes 120° 4′, which is the Quantity of the Angle at B, alſo taken from 70, leaves 19 *deg.* 56′, which is the Angle at C.

CASE ix.

Three Sides of an Oblique Triangle being given, to find the Angles.



You muſt firſt Divide your Oblique Triangle into two Right-Angled Triangles thus.

In

In the Triangle A B C

The Side A C is	50
The Side A B	36
The Side B C	20
The Summ of the two Leſſer Sides	56
The Difference of the two Leſſer Sides	16

As the Log. of the greateſt Side A C 50	1,698970
is to the Logar. of the Summ of the two Leſſer Sides 56	1,748188
So is the Differ. of the two Leſſer Sides 16	1,204120
	2,952308
to the Log. of a fourth Number 18	1,253338

Subſtract this 18 out of the greateſt Side A C 50, and there remains 32, the half of which, *viz.* 16, is the Baſe of the Leſſer Right-Angled Triangle, and the remainer of the Line A C, *viz.* A D 34 is the Baſe of the Greater Right-Angled Triangle, with which this Oblique Triangle is divided.

And now of either Right-Angled Triangle B D C, or B D A, you have the Baſe and Hypothenuſe given to find the Angles; which you muſt do as you were before taught, Caſe iv.

Note that you may better and eaſier find the fourth Number, for dividing an Obliqne-angled Triangle into two Right-Angled Triangles by Vulgar Arithmetick,

than by the Tables of Logarithms, for in the above Triangle, if you ſay, If 50 give 56, what ſhall 16 give? Multiply and Divide, the Anſwer is $17\frac{6}{10}$. There is another way uſed by Arithmeticians, in my Opinion better than the former, which is this.

Square the three given Sides, add the two greater Squares together; and from that Summ Subſtract the Leſſer; half the remainder divide by the greateſt Side; the Quotient will be the Baſe of the Greater Right-Angled Triangle.

EXAMPLE.

In the fore-going Triangle, the Square of the greateſt Side A C 50, is	2500
The Square of the Side A B 36, is	1296
Added together, make	3796
From which ſubſtract the Square of the leaſt Side	400
Remains	3396
The Half	1698

Which 1698 divide by 50 the longeſt Side; the Quotient is $33\frac{48}{100}$, the Baſe of the greater Right-Angled Triangle, *viz.* A D; and that being ſubſtracted out of 50, leaves $16\frac{52}{100}$ for the Baſe of the ſmaller Right-Angled Triangle, *viz.* D C.

Caſe

CASE x.

The three Sides of an Oblique Triangle being given, how to find the Superficial Content without knowing the Perpendicular.

From half the Sum of the three Sides, ſubſtract each particular Side. Add the Logarithms of the three Differences, alſo the Log. of half the Sum of the three Sides together. Half the Total is the Log. of the Content required.

In the foregoing Triangle, the Sides are 50, 36, 20, their Sum is 106 : The half Sum 53.

The differences between the half Sum and each particular Side, are	3	Log. 0.477121
	17	1.230449
	33	1.518514
The half Sum	53	1.724276
	Total added	4.950360
	The Half	2.475180

The Number anſwering to that Log. is 298 which is the Content of the Triangle required.

By Vulgar Arithmetick, thus.

Multiply the Firſt Difference by the Second; that Product by the Third; that Product by the Half Sum. Laſty, Extract the Square-Root, and you have the

Superficial Content. So 3 multiplied by 17. makes 51; which multiplied by 33, makes 1683. that multiplied by 53, the half Sum makes 89199. the Square-Root of which is 298, the Content required.

CHAP. XIII.

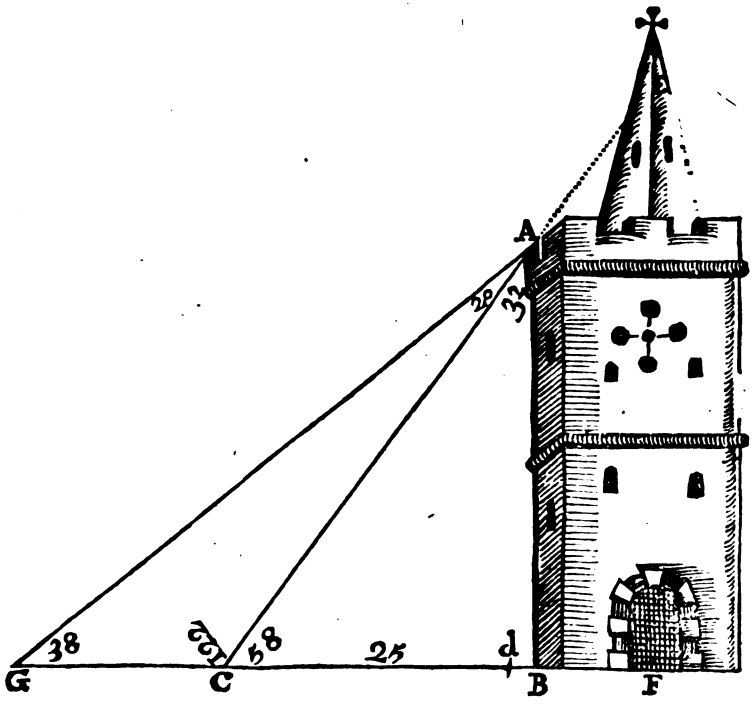
Of Heights and Distances.

How to take the Heighth of a Tower, Steeple, Tree, or any such thing.

LEt AB be a Tower, whose Height you would know.

First, At any convenient distance, as at C, place your Semi-circle, or what other Instrument you judge more fit for the taking an Angle of Altitude, as a large Quadrant, or the like, and there observe the Angle A C B. But to be more plain, place your Semi-circle at C; and having turn'd it down by a Plumb, make it to stand Horizontal, which it does when a Plummet-line fixt to the Centre, falls just upon 90 *deg.* (in some Semi-circles there is a Line on the Back-side of the Brass Limb on purpose for the setting of it Horizontal.) Then (first skrewing the Instrument fast) move the Index up and down, till through the Sights you espy the top of the Tower at A. See then what Deg. upon the Limb are cut by the Index, which

which let be 58, ſo much is your Angle of Altitude. Meaſure next the diſtance betwen your Inſtrument and the foot of the Tower, *viz.* the Line C D, which



let be 25 Yards: Then have you all the Angles given, (admitting the Angle the Tower makes with the Ground, *viz.* *d* to be a Right-Angle) and the Baſe to find the Perpendicular A B; which you may do, as you were taught in *Caſe* I. *of Trigonometry*: For if you take 58 from 90, there remains 32 for the Angle at A. Then ſay,

As

As the Sine of the Angle A 32	9724210
is to the Log. of the Baſe C D 25	1397940
So is the Sine of the Angle C 58	9928420
to the Log. Heighth of the Tower, A B, or rather A D, 40 Yards	11326360
	1,602150

To this 40 Yards you muſt add the height of your Inſtrument from the Ground; or which is better, look through your Fixed Sight to the Tower, and mark where your Sight falls upon the Tower, and meaſure from that place to the ground, which add to the former Heighth found. In this way of taking Heighths, the Ground ought to be very level, or you may make great Miſtakes. Alſo the Tower or Tree ſhould ſtand perpendicular: Or elſe you muſt meaſure to ſuch a place, where a Perpendicular would fall, if let down; as A B is not a Perpendicular, but A *d*, therefore meaſure the Diſtance C *d*, for your Baſe.

This you may plainly underſtand by the foregoing Figure; for if ſtanding at C, you were to take the Heighth of the Tower and Steeple to E: The Angle ECB is the ſame as the Angle A C B; and if you meaſure only C B or C D, you will make the Heighth F E the ſame as D A; which by the Figure you plainly perceive to be a great Error: Therefore to take the Heighth FE, you ſhould meaſure from C to F.

How

How to take the Heighth of a Tower, &c. when you cannot come nigh the Foot thereof.

In the foregoing Figure, let A B be the Tower, and ſuppoſe C B to be a Moat, or ſome other hindrance, that you cannot come nigher than C to take the Heighth. Therefore at C plant your Inſtrument, and take (as before) the Angle A C B 58 *deg.* Then go backwards any convenient diſtance, as to G, there alſo take the Angle A G B 38 *deg.* This done, ſubſtract 58 from 180, ſo have you 122 *deg.* the Angle A C G. Then 122 and 38 being taken from 180, remains 20 for the Angle G A C. The Diſtance G C meaſured, is 26. Now by *Trigonometry*, ſay,

As the Sine of the Angle A 20	9534052
is to the Log. of the Diſtance G C 26	1414973
So is the Sine of the Angle G 38	9789342
	11204315
to the Log of the Line A C 47	1,670263

Again,

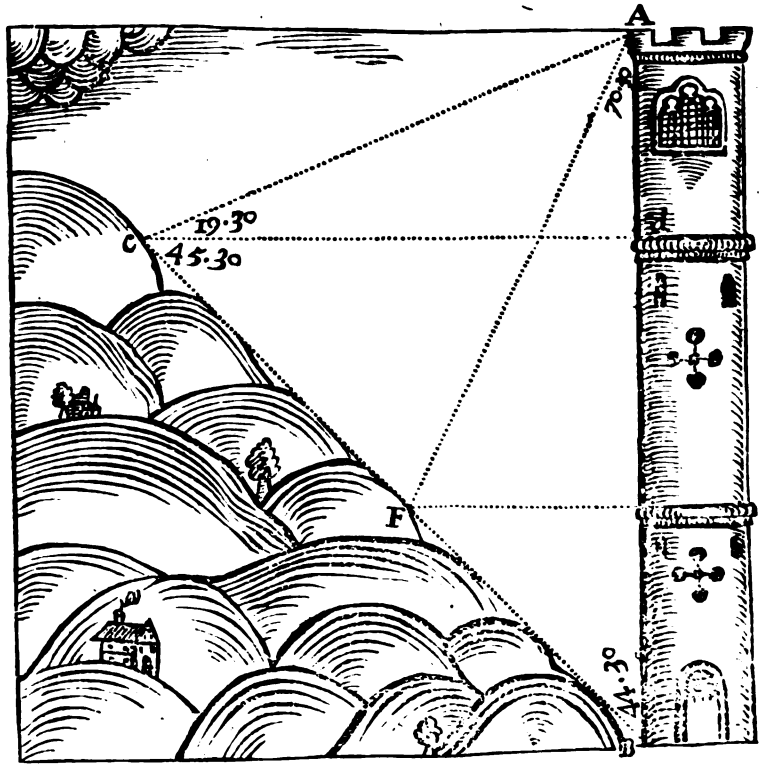
As Radius the Right-Angle B	10,000000
is to the Log. of the Line A C 47	1672098
So is the Sine of the Angle C 58	9928420
To the Log. Heighth of the Tower 40 Yards	11,600518

But ſtill, as I told you before, the Ground is underſtood to be level. However, if it be not, I will ſhew you,

How

How to take the Heighth of a Tower, &c. when the Ground either riseth or falls.

A B is the Tower, C B the Hill whereon you are to take the Heighth of the Tower; plant your Semi-



cirle in any place of the Hill, as at C, then turn it down, and make it stand Horizontal, as before directed, the Diameter then pointing to *d* of the Tower,

er, turn the Moveable Index to A, and take the Angle A C *d*; which let be 19 Degrees 30 Minutes. Take also the Angle *d* C B, which is 45 Degrees 30 Minutes; measure also the Distanee C B 56 Yards, take 19 Degrees 30 Minutes out of 90 Degrees 00 Minutes, there remains 70 Degrees 30 Minutes for the Angle at A, then say

As Sine 70° : 30′	9974346
is to the Distance C B 56 Yards, Logar.	1748188
So are both the Angles at C 19 30 and 45 30, *viz.* 60° 00′ Sine	9957276
	11705464
to the Heighth of the Tower 54 Yards, Log.	1,731118

To take this at two Stations, without approaching the Foot of the Tower, is no more than what has been said before; for if you take your Angles at C, and then measure to F, and there in like manner, as before, take your Angles again, thereby you may find all the Angles, and the Line A F, then say,

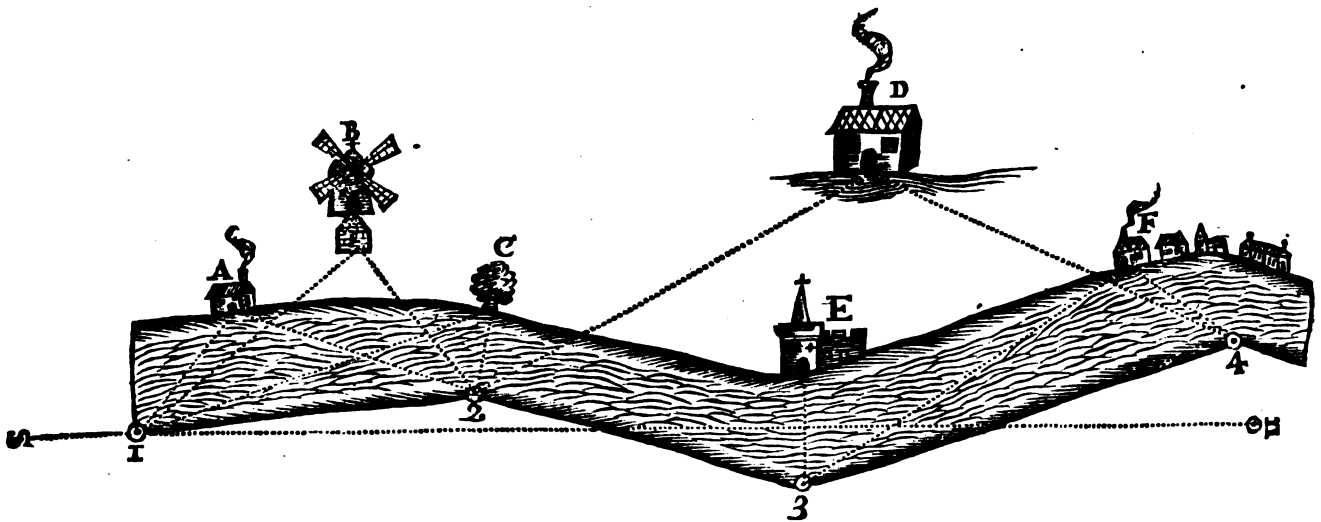
As the Sine of the Angle A B F
is to the Logarithm of the Line F A,
So is the Sine of the Angle A F B
To the Logarithm of the Heighth of the Tower A B.

Of Distances.

Although I have before shewed how to take Distances by Surveying a Field at two Stations, yet since it seems naturally to come in here again, I will give you one Example thereof: Suppose this following Figure to be a Piece of a River, and you measuring

along one Side of it, would as well know the Breadth of it, as alſo make a true Plot thereof, by putting down what remarkable things are ſeen on the other Side.

Beginning at ⊙ 1, the firſt Station, cauſe one of your Aſſiſtants to go to the next Bend of the River, as ⊙ 2, and there ſet up a Mark for you; then ſee what Angle from the Meridian ⊙ 1, ⊙ 2 makes, which let be N. W. 6 Degrees; alſo ſeeing ſeveral Marks on the other Side of the River, take their Bearings, as the Houſe A, which ſtands upon the Bank, and is a good Mark for the Bredth of the River bears N. W. 52 Degrees, the Wind-mill B up in the Land, bears N. W. 40 *deg.* The Tree C by the Water-ſide, bears N. W. 17 *deg.* All this note down in your Field-Book, and meaſure the diſtance ⊙ 1, ⊙ 2, 18 Chains, 20 Links. After this coming to ⊙ 2, ſee how the next bend of the River bears from you, *viz.* ⊙ 3; which is N E 15 *deg.* See alſo how the Houſe A there bears from you, *viz.* S. W. 20 *deg.* The Wind-mill S. W. 50 *deg.* The Tree N. W. 77. Alſo as you are going forward, if you ſee any thing more at this ſecond Station, take the bearing thereof, as a noted Houſe D up in the Land, bears N. W. 28° And a Church E cloſe by the Rivers brink N. W. 4° Meaſure the diſtance 2, 3, and placing your Inſtrument at 3, the Church bears from you N.W. 88 *deg.* The Houſe up in the Land D you cannot ſee for the Church, therefore let it alone for the next Station. But here you may ſee forward a little Village F, the firſt Houſe whereof bears from you N. W. 32 *deg.* Meaſure the diſtance 3, 4, and planting your Inſtrument in 4, the firſt Houſe of the Village F bears from you S. W. 32 *deg.* and the Houſe D, which you could not



not see at the third Station, S. W. 24°. Having put down all these things in your Field-Book, it will not look much unlike this,

⊙ 1 N. W. 6° 18 Ch. 20 Lin.			
Observation	A Tree upon the brink of the River, bears	N. W. 17° 00′	
	A Wind-mill up in the Land	N. W. 40° 00′	
	A House upon the Rivers bank	N. W. 52° 00′	
⊙ 2 N. E. 15° 18 Ch. 10 Lin.			
	The Tree	N. W. 77°	These look back to the Observation of ⊙ 1.
	The House	S. W. 20°	
	The Wind-mill	S. W. 50°	
	A noted House far up in the Land	N. W. 28°	Forward Observations.
	A Church upon the Rivers bank	N. W. 4°	
⊙ 3 N. W. 15° 20 Ch. 50 Lin.			
	The Church bears	N. W. 88°	These look back to the Obser. of ⊙ 2.
	The noted House cannot be seen		
	The end of a little Village	N. W. 32	A forward Observation.
⊙ 4			
	The end of the little Village	S. W. 32°	These respect ⊙ 3 and ⊙ 2.
	The House respecting ⊙ 2 in the Land	S. W. 24°	

To Protract this, draw the Line N S for a Meridian, and laying your Protractor upon it, the Centre thereof to ⊙ 1; against N W 6 make a Mark for the Line that goes to ⊙ 2. Also against N W 17 make a Mark for the Tree, and against 40 and 52, for

for the Wind-mill and Houſe. Then from ⊙ 1 through theſe Marks draw the Lines ⊙A, ⊙B, ⊙C, ⊙2.

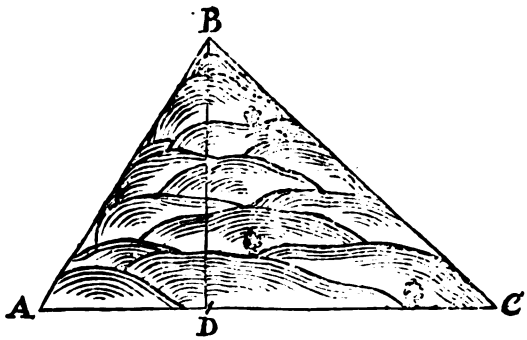
Secondly, Take from your Scale 18 Ch. 20 Lin. and ſet it off upon the Line ⊙ 2, which will reach to ⊙ 2. There lay again the Centre of your Protractor, the Diameter thereof parallel to the Line N S, and make Marks, as you ſee in the Field-Book, againſt N E 15. N W 77. S W 20. S W 50. N W 28. N W 4°. and through theſe Marks draw Lines. The firſt Line directs to your third Station; the ſecond Line N W 77. directs you to the Tree C upon the Rivers bank; for that Line cutting the Line ⊙1C, ſhews you by the Interſection where the Tree ſtood, and alſo the Bredth of the River. Alſo the Line S W 20 cuts the Line from the firſt Station N W 52, in the place where the Houſe A ſtands upon the Bank of the River. If therefore you draw a Line from A to C, it will repreſent the farther Bank of the River. And ſo you may proceed on Plotting, according to the Notes in your Field-Book; and you will not only have a true Plot of the River, but alſo know how far the Wind-mill B, and the Houſe D, ſtand from the Water-ſide.

How to take the Horizontal-line of a Hill.

When you meaſure a Hill, you muſt meaſure the Superficies 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 thereof; which you muſt ſhadow over with the reſemblance of a Hill, that other Surveyors, when they apply your Scale

Scale thereto, may not ſay you was Miſtaken. And you may find this Horizontal or Baſe-line, after the ſame manner as you have been taught to take Heighths.

For ſuppoſe A B C D a Hill, whoſe Baſe you would know. Plant your Semi-circle at A, and cauſe a Mark to be ſet up at B, ſo high above the top of the



Hill, as the Inſtrument ſtands from the Ground at A; and making your Inſtrument Horizontal, take the Angle B A D 58 *deg.* Meaſure the Diſtance A B 16 Chains, 80 Links. Then ſay,

As Radius	10000000
is to the Line A B 16 Ch. 80 Lin.	3225309
So is the Sine Complement of A 88°	9724210
to part of the Baſe A D 8 Ch. 90 Lin.	x2,949519

But if you have occaſion to meaſure the whole Hill, plant again your Inſtrument at B, and take the Angle C B D, which let be 46 *deg.* Meaſure alſo the Diſtance B C 21 Ch. Then ſay,

As

As Radius	10000000
is to the Line BC 21 Ch. 00 Lin. (Log.)	1322219
So is the Line of the Angle CBD 46	9856934
to the part of the Baſe DC 15 Ch. 12 Lin.	11,179153

Which 15. 12. added to 8.90, makes 24 Chains, 2 Links, for the whole Baſe A G; which is to be plotted, and not A B and B C; although they are to be meaſured to find the Content of the Land.

I mentioned this way, for your better underſtanding how to take the Baſe of part of a Hill; for many times your Survey ends upon the ſide of a Hill. But if you find you are to take in the whole Hill, you need not take altogether ſo much pains as by the former way. As thus: Take, as before, the Angle A 58 *deg.* Meaſure alſo A B. Then at B take the whole Angle ABC 78 *deg.* Subſtract theſe two from 180 *deg.* remains 44 for the Angle at C. Then ſay,

As the Sine of the Angle C 44
is to the Log. of the Side A B;
So is the Sine of the Angle A B C
to the Log. of the Baſe A C.

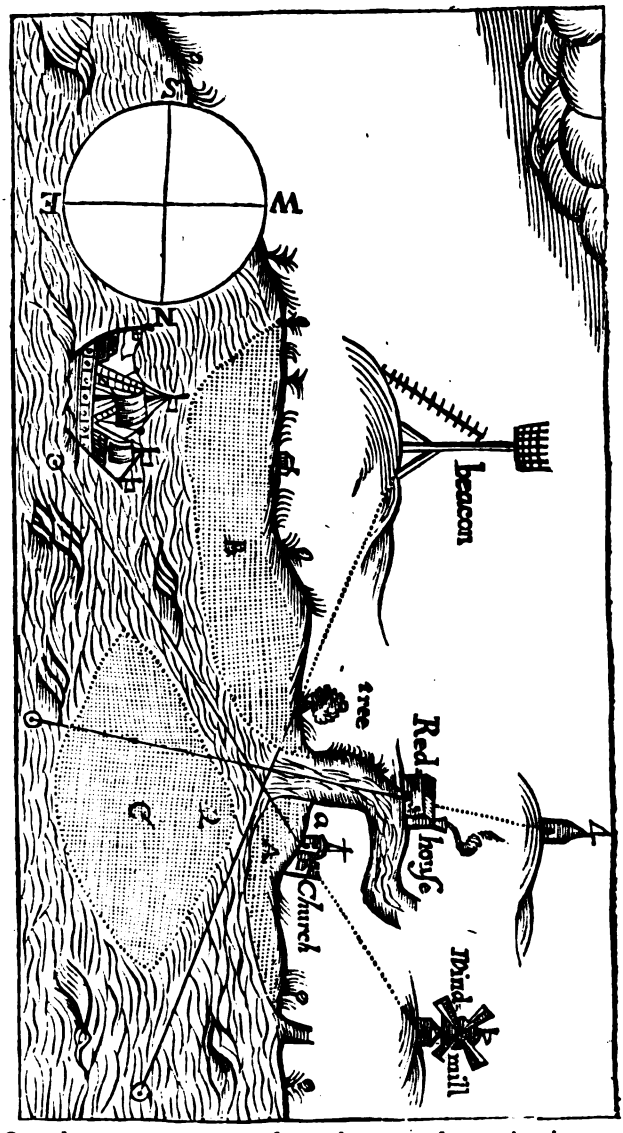
How to take the Shoals of a Rivers Mouth, and Plot the ſame.

Meaſure firſt the Sea coaſt on both Sides of the Rivers Mouth, as far as you think you ſhall have occaſion to make uſe thereof; and make a fair Draught thereof, putting down every remarkable thing in its true Situation, as Trees, Houſes, Towns, Wind-mills, *&c.* Then going out in a Boat to ſuch Sands

Sands or Rocks as make the Entrance difficult, at every conſiderable bend of the Sands, take with a Sea-Compaſs the bearing thereof to two known Marks upon the Shore, and having ſo gon round all the Sands and Rocks, you may eaſily upon the Plot before taken, draw Lines which ſhall interſect each other at every conſiderable Point of the Sands, whereby you may truly prick out the Sands, and give good Directions either for laying Buyos, or making Marks upon the Shore for the Direction of Shipping.

EXAMPLE.

Suppoſe the following Figure to be a piece of ſome Sea-Coaſt. Firſt I make a fair Draught of it, with the Mouth of the River as far up as there is occaſion, putting down every remarkable thing, as you ſee here, all but the Rocks and Sands excepted, which I am now going to ſhew you how to take. Go in a Boat down the River, till you find the beginning of the firſt Sand A, as at *a*, and there take a Sight to the Red-Houſe, which let be S.W. 86 *deg.* alſo to the Tree, which is S.E. 6 *deg.* To Plot which, draw Lines quite contrary to your Obſervations; as from the Red-Houſe draw a Line N. E. 86, and from the Tree a Line N. W. 6 *deg.* which two Lines will interſect each other in the Point *a*, which ſhews you the beginning of the Sand A. Row along the ſame Sand, ſounding as you go, till you find it have a conſiderable bending, and there take again two Obſervations, as before, and Protract them too, when you come a-ſhore, in like manner. The like do at the bending of every Sand, till either you come round the



the Sand, or come to the place where it joyns with the Shore.

It would be too tedious for you, and troublesom

for me, to give you all the Obſervations, I having already in this Treatiſe ſo often deſcribed the ſame thing before; therefore I will mention only one place of Obſervation more; and if by that you do not underſtand the whole, I know not how to make you. In the Sand C, I find the bend (2,) and there, as I ſhould do at all the reſt, I take two Obſervations to ſuch things on the Shore, as are moſt conſpicuous unto me, *viz.* Firſt, to the Beacon, which bears from me S. W. 25 *deg.* Secondly, to the Wind-mill, which bears from me N. W. 40 *deg.* Now after I have taken the other Angles or Bends of that Sand, and am come Home, I draw a Line from the Beacon oppoſite to my Obſervation S. W. 25 *deg. viz.* N. E. 25 *deg.* Alſo from the Wind mill I draw a Line S. E. 40 *deg.* Now where theſe two Lines interſect each other, as they do at 2, I mark for one Point of the Sand C. In like manner as I did this, I obſerve, and protract every Line of the Sand C, and of all the other Sands and Rocks, be there never ſo many; and ſo will you have a fair Map, fitting for Seamens Uſe, better done, I think, than in any place of the World yet, except for the Harbours of *Eutopia*.

Now to give Direction for Seamens coming in here, draw a Line through the middle of the South Channel, which Line will cut both the Church and Wind-mill; ſo that if a Ship coming from the Southward, brings the Church and Wind-mill both into one, and keep them ſo, ſhe may boldly run in, till ſhe brings the Rivers mouth fair open, and then ſail up the River. Likewiſe coming from the Northward, muſt firſt bring the Tree and Beacon both into one, and keep them ſo till the Rivers mouth is fair open. But leſt they ſhould miſtake, and run upon the ends of the Sands A or B, it would be neceſſary that

that a Mark was ſet up behind the Red-Houſe, in a ſtreight Line with the middle of the River, as  Then a Ship coming from the Southward, or Northward, let her keep her former Marks both in one, till ſhe bring the Red Houſe and both in one; and then keeping them ſo, run boldly up the River, till all Danger is paſt. I have put down this Wind-mill and Beacon, not as if ſuch good Marks would always happen; but to ſhew you how to place Marks, if it be required; or to lay Buoys.

You muſt mind after you have taken all the Sands, to take the Soundings alſo, quite croſs the Channels, all up and down, and to put them down accordingly; the beſt time for doing which, is at Low-Water, in Spring-Tides.

How to know whether Water may be made to run from a Spring-head to any appointed Place.

For this Work, the Diameter of the Semi-circle is a little too ſhort; however an indifferent ſhift may be made therewith, but it is better to get a Water-level, ſuch as you may buy at the Inſtrument-Makers; with which being provided, as alſo with two Aſſiſtants, and each of them with a Staff divided into Feet, Inches, and Parts of an Inch, go to the Spring-head; and cauſing your firſt Aſſiſtant to ſtand there with his Staff perpendicular, make the other go in a Right-line towards the place deſigned for bringing the Water, any convenient diſtance, as 100, 150, or 200 Yards, and there let him ſtand, and hold his Staff perpendicular alſo. Then ſet your Inſtrument nigh the Mid-way between them, making it ſtand Level, or Horizontal; and look through the Sights thereof to your firſt Aſſiſtant's Staff, he moving a white piece of Paper up or down the Staff,

Staff, according to the Signs you make to him, till through the Sights you eſpy the very Edge of the Paper. Then by a Sign make him to underſtand 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 Aſſiſtant's place, and there let him again ſtand with his Staff; and let the ſecond Aſſiſtant go forward 100 or 200 Yards, as before; and placing your ſelf and Inſtrument in the midſt, between them, take your Obſervations altogether, as before, and let them put them down in 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 therefore Water may be well conveyed. But if the firſt's Notes exceed the ſeconds, you may conclude it impoſſible, without Engines, or the like.

The firſt Aſſiſtant's Note

Stat.	Feet	Inch.	Pts.
⊙1	4	3	5
⊙2	12	4	2
⊙3	3	5	1
	20	0	8

The ſecond Aſſiſtants Note

Stat.	Feet	Inch.	Pts.
⊙1	14	5	1
⊙2	4	6	3
⊙3	9	2	4
	28	1	8

Here you ſee the ſecond Aſſiſtant's Note exceeds 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 ½ Fall in a Mile to make the Water run.

A

A

TABLE

OF THE

Northing or Southing, Eafting or Weſting of every Degree from the Meridian, according to the Number of Chains run upon any Degree.

A Table of Northing, or Southing,

Distance,	1 Deg. N.	1 Deg. S.	1 Deg. E.W.	Distance,	2 Deg. N.	2 Deg. S.	2 Deg. E.W	Distance,	3 Deg. N.	3 Deg. S.	3 Deg. E.W.
1	1.0		.0	1	1.0		.0	1	1.0		.1
2	2.0		.0	2	2.0		.1	2	2.0		.1
3	3.0		.0	3	3.0		.1	3	3.0		.1
4	4.0		.1	4	4.0		.1	4	4.0		.2
5	5.0		.1	5	5.0		.2	5	5.0		.2
6	6.0		.1	6	6.0		.2	6	6.0		.3
7	7.0		.1	7	7.0		.2	7	7.0		.4
8	8.0		.1	8	8.0		.3	8	8.0		.4
9	9.0		.2	9	9.0		.3	9	9.0		.5
10	10.0		.2	10	10.0		.3	10	10.0		.5
20	20.0		.4	20	20.0		.7	20	20.0		1.0
30	30.0		.5	30	30.0		1.0	30	30.0		1.6
40	40.0		.7	40	40.0		1.4	40	40.0		2.1
50	50.0		.9	50	50.0		1.7	50	50.0		2.6
60	60.0		1.1	60	60.0		2.1	60	59.9		3.1
70	70.0		1.2	70	70.0		2.4	70	69.9		3.7
80	80.0		1.4	80	80.0		2.8	80	79.9		4.2
90	90.0		1.6	90	89.9		3.1	90	89.9		4.7
100	00.0		1.8	100	99.9		3.5	100	99.9		5.2
Dist.	E.W.	N. S.		Dist.	E.W.	N. S.		Dist.	E.W.	N. S.	
	89 Deg.				88 Deg.				87 Deg.		

Easting, or Westing.

Distance,	4 Deg. N. S.	4 Deg. E.W.	5 Deg. N. S.	5 Deg. E.W.	6 Deg. N. S.	6 Deg. E.W.
1	1.0	.1	1.0	.1	1.0	.1
2	2.0	.1	2.0	.2	2.0	.2
3	3.0	.2	3.0	.3	3.0	.3
4	4.0	.3	4.0	.3	4.0	.4
5	5.0	.3	5.0	.4	5.0	.5
6	6.0	.4	6.0	.5	6.0	.6
7	7.0	.5	7.0	.6	7.0	.7
8	8.0	.6	8.0	.7	8.0	.8
9	9.0	.6	9.0	.8	8.9	.9
10	10.0	.7	10.0	.9	9.9	1.0
20	20.0	1.4	19.9	1.7	19.9	2.1
30	29.9	2.1	29.9	2.6	29.8	3.1
40	39.9	2.8	39.8	3.5	39.8	4.2
50	49.9	3.5	49.8	4.4	49.7	5.2
60	59.9	4.2	59.8	5.3	59.7	6.3
70	69.8	4.9	69.7	6.1	69.6	7.3
80	79.8	5.7	79.7	7.1	79.6	8.3
90	89.8	6.3	89.7	7.9	89.5	9.4
100	99.8	7.0	99.6	8.7	99.5	10.4
Dist.	E.W.	N. S.	E.W.	N. S.	E.W.	N. S.
	86 Deg.		85 Deg.		84 Deg.	

A Table of Northing, or Southing,

Distance,	7 Deg. N. S.	7 Deg. E.W.	Distance,	8 Deg. N. S.	8 Deg. E.W.	Distance,	9 Deg. N. S.	9 Deg. E.W.
1	1.0	.1	1	1.0	.1	1	1.0	.2
2	2.0	.2	2	2.0	.3	2	2.0	.3
3	3.0	.4	3	3.0	.4	3	3.0	.5
4	4.0	.5	4	4.0	.6	4	4.0	.6
5	5.0	.6	5	5.0	.7	5	4.9	.8
6	6.0	.7	6	5.9	.8	6	5.9	.9
7	6.9	.8	7	6.9	1.0	7	6.9	1.1
8	7.9	1.0	8	7.9	1.1	8	7.9	1.3
9	8.9	1.1	9	8.9	1.3	9	8.9	1.4
10	9.9	1.2	10	9.9	1.4	10	9.9	1.6
20	19.9	2.4	20	19.8	2.8	20	19.8	3.1
30	29.8	3.7	30	29.7	4.2	30	29.6	4.7
40	39.7	4.9	40	39.6	5.6	40	39.5	6.3
50	49.6	6.1	50	49.5	7.0	50	49.4	7.8
60	59.6	7.3	60	59.4	8.3	60	59.3	9.4
70	69.5	8.5	70	69.3	9.7	70	69.1	10.9
80	79.4	9.8	80	79.2	11.1	80	79.0	12.5
90	89.3	11.0	90	89.1	12.5	90	88.9	14.1
100	99.3	12.2	100	99.0	13.9	100	98.8	15.6
Dist.	E.W.	N. S.	Dist.	E.W.	N. S.	Dist.	E.W.	N. S.
	83 Deg.			82 Deg.			81 Deg.	

Easting, or Westing.

Distance,	10 Deg. N. S.	10 Deg. E.W.	Distance,	11 Deg. N. S.	11 Deg. E.W.	Distance,	12 Deg N. S.	12 Deg E.W
1	1.0	.2	1	1.0	.2	1	1.0	.2
2	2.0	.3	2	2.0	.4	2	2.0	.4
3	3.0	.5	3	2.9	.6	3	2.9	.6
4	3.9	.7	4	3.9	.8	4	3.9	.8
5	4.9	.9	5	4.9	.9	5	4.9	1.0
6	5.9	1.0	6	5.9	1.1	6	5.9	1.2
7	6.9	1.2	7	6.9	1.3	7	6.8	1.5
8	7.9	1.4	8	7.8	1.5	8	7.8	1.7
9	8.9	1.6	9	8.8	1.7	9	8.8	1.9
10	9.9	1.7	10	9.8	1.9	10	9.8	2.1
20	19.7	3.5	20	19.6	3.8	20	19.6	4.2
30	29.6	5.2	30	29.4	5.7	30	29.3	6.2
40	39.4	6.9	40	39.3	7.6	40	39.1	8.3
50	49.2	8.7	50	49.1	9.5	50	48.9	10.4
60	59.1	10.4	60	58.9	11.4	60	58.7	12.5
70	68.9	12.1	70	68.7	13.4	70	68.5	14.6
80	78.8	13.9	80	78.5	15.3	80	78.3	16.6
90	88.6	15.6	90	88.3	17.2	90	88.0	18.7
100	98.5	17.4	100	98.9	19.1	100	97.8	20.8
Dist.	E.W.	N. S.	Dist.	E.W.	N. S.	Dist.	E.W.	N. S.
	80 Deg.			79 Deg.			78 Deg.	

A Table of Northing, or Southing,

Distance,	13 Deg. N. S.	13 Deg. E.W.	14 Deg N. S.	14 Deg E.W.	15 Deg. N. S.	15 Deg. E.W.
1	1.0	.2	1.0	.2	1.0	.3
2	2.0	.4	1.9	.5	1.9	.5
3	2.9	.7	2.9	.7	2.9	.8
4	3.9	.9	3.9	1.0	3.9	1.0
5	4.9	1.1	4.8	1.2	4.8	1.3
6	5.9	1.3	5.8	1.4	5.8	1.6
7	6.8	1.6	6.8	1.7	6.8	1.8
8	7.8	1.8	7.8	1.9	7.7	2.1
9	8.8	2.0	8.7	2.2	8.7	2.3
10	9.8	2 2	9.7	2.4	9.7	2.6
20	19.5	4.5	19.4	4.8	19.3	5.2
30	29.2	6.7	29.1	7.3	29.0	7.8
40	39.0	9.0	38.8	9.7	38.6	10.3
50	48.7	11.2	48.5	12.1	48.3	12.9
60	58.5	13.5	58.2	14.5	58.0	15.5
70	68.2	15.7	67.9	16.9	67.6	18.1
80	78.0	18.0	77.6	19.4	77.3	20.7
90	87.7	20.2	87.3	21.8	86.9	23.3
100	97.4	22.5	97.0	24.2	96.6	25.9
Dist.	E.W.	N. S.	E W.	N. S.	E.W	N. S.
	77 Deg.		76 Deg.		75 Deg.	

Easting, or Westing.

Distance,	16 Deg N. S.	16 Deg E.W.	Distance,	17 Deg. N. S.	17 Deg. E.W.	Distance,	18 Deg N. S	18 Deg E.W.
1	1.0	.3	1	1.0	.3	1	1.0	.3
2	1.9	.6	2	1.9	.6	2	1.9	.6
3	2.9	.8	3	2.9	.9	3	2.8	.9
4	3.8	1.1	4	3.8	1.2	4	3.8	1.2
5	4.8	1.4	5	4.8	1.5	5	4.7	1.5
6	5.8	1.7	6	5.7	1.7	6	5.7	1.8
7	6.7	1.9	7	6.7	2.0	7	6.6	2.2
8	7.7	2.2	8	7.6	2.3	8	7.6	2.5
9	8.6	2.5	9	8.6	2.6	9	8.5	2.8
10	9.6	2.8	10	9.6	2.9	10	9.5	3.1
20	19.2	5.5	20	19.1	5.8	20	19.0	6.2
30	28.8	8.3	30	28.7	8.8	30	28.5	9.3
40	38.4	11.0	40	38.3	11.7	40	38.0	12.4
50	48.1	13.8	50	47.8	14.6	50	47.6	15.4
60	57.7	16.5	60	57.4	17.5	60	57.1	18.5
70	67.3	19.3	70	66.9	20.5	70	66.6	21.6
80	76.9	22.0	80	76.5	23.4	80	76.1	24.7
90	86.5	24.8	90	86.1	26.3	90	85.6	27.8
100	96.1	27.6	100	95.6	29.2	100	95.1	30.9
Dist.	E.W.	N. S.	Dist.	E.W.	N. S.	Dist.	E.W.	N. S.
	74 Deg.			73 Deg.			72 Deg.	

A Table of Northing, or Southing,

Distance,	19 Deg. N. S.	19 Deg. E.W.	Distance,	20 Deg. N. S.	20 Deg. E.W.	Distance,	21 Deg. N. S.	21 Deg. E.W.
1	.9	.3	1	.9	.3	1	.9	.4
2	1.9	.6	2	1.9	.7	2	1.9	.7
3	2.8	1.0	3	2.8	1.0	3	2.8	1.1
4	3.8	1.3	4	3.8	1.4	4	3.7	1.4
5	4.7	1.6	5	4.7	1.7	5	4.7	1.8
6	5.7	2.0	6	5.6	2.0	6	5.6	2.1
7	6.6	2.3	7	6.6	2.4	7	6.5	2.5
8	7.5	2.6	8	7.5	2.7	8	7.5	2.9
9	8.5	2.9	9	8.5	3.1	9	8.4	3.2
10	9.4	3.3	10	9.4	3.4	10	9.3	3.6
20	18.9	6.5	20	18.8	6.8	20	18.7	7.2
30	28.4	9.8	30	28.2	10.3	30	28.0	10.7
40	37.8	13.10	40	37.6	13.7	40	37.3	14.3
50	47.3	16.3	50	47.0	17.1	50	46.7	17.9
60	56.7	19.5	60	56.4	20.5	60	56.0	21.5
70	66.2	22.8	70	65.8	23.9	70	65.3	25.1
80	75.6	26.1	80	75.2	27.4	80	74.7	28.7
90	85.1	29.3	90	84.6	30.8	90	84.0	32.3
100	94.5	32.6	100	94.0	34.2	100	93.3	35.8
Dist.	E.W.	N. S.	Dist.	E.W.	N. S.	Dist.	E.W.	N. S.
	71 Deg.			70 Deg.			69 Deg.	

Easting, or Westing.

Distance,	22 Deg. N. S.	22 Deg. E.W.	23 Deg. N. S.	23 Deg. E.W.	24 Deg. N. S.	24 Deg. E.W.
1	.9	.4	.9	.4	.9	.4
2	1.9	.7	1.8	.8	1.8	.8
3	2.8	1.1	2.8	1.2	2.7	1.2
4	3.7	1.5	3.7	1.6	3.6	1.6
5	4.6	1.9	4.6	1.9	4:6	2.0
6	5.6	2.2	5.5	2.3	5.5	2.4
7	6.5	2.6	6.4	2.7	6.4	2.8
8	7.4	3.0	7.4	3.1	7.3	3.2
9	8.3	3.4	8.3	3.5	8.2	3.7
10	9.3	3.7	9.2	3.9	9.1	4.1
20	18.5	7.5	18.4	7.8	18.3	8.1
30	27.8	11.2	27.6	11.7	27.4	12.2
40	37.1	15:0	36.8	15.6	36.5	16.3
50	46.4	18.7	46.0	19.5	45.7	20.3
60	55.6	22.5	55.2	23.4	54.8	24.4
70	64.9	26.2	64.4	27.3	53.9	28.5
80	74.2	30.0	73.6	31.2	73.1	32.5
90	83.4	33.7	82.8	35.2	82.2	36.6
100	92.7	37.5	92.0	39.1	91.3	40.7
Dist.	E.W.	N. S.	E.W.	N. S.	E.W	N.S.
	68 Deg.		67 Deg.		66 Deg.	

A Table of Northing, or Southing,

Distance,	25 Deg. N. S.	25 Deg. E.W.	26 Deg. N. S.	26 Deg. E.W.	27 Deg. N. S.	27 Deg. E.W.
1	.9	.4	.9	.4	.9	.5
2	1.8	.8	1.8	.9	1.8	.9
3	2.7	1.3	2.7	1.3	2.7	1.4
4	3.6	1.7	3.6	1.8	3.6	1.8
5	4.5	2.1	4.5	2.2	4.5	2.3
6	5.4	2.5	5.4	2.6	5.3	2.7
7	6.3	3.0	6.3	3.1	6.2	3.2
8	7.2	3.4	7.2	3.5	7.1	3.6
9	8.1	3.8	8.1	3.9	8.0	4.1
10	9.1	4.2	9.0	4.4	8.9	4.5
20	18.1	8.4	18.0	8.8	17.8	9.1
30	27.2	12.7	27.0	13.1	26.7	13.6
40	36.2	16.9	36.0	17.5	35.6	18.2
50	45.3	21.1	44.9	21.9	44.5	22.7
60	54.4	25.4	53.9	26.3	53.5	27.2
70	63.4	29.6	62.9	30.7	62.4	31.8
80	72.5	33.8	71.9	35.1	71.3	36.3
90	81.6	38.0	80.9	39.4	80.2	40.9
100	90.6	42.3	89.9	43.8	89.1	45.4
Dist.	E.W.	N. S.	E.W.	N. S.	E.W.	N. S.
	65 Deg.		64 Deg.		63 Deg.	

Easting, or Westing.

Distance,	28 Deg. N. S.	28 Deg. E.W.	29 Deg. N. S.	29 Deg. E.W.	30 Deg. N. S.	30 Deg. E.W.
1	.9	.5	.9	.5	.9	.5
2	1.8	.9	1.7	1.0	1.7	1.0
3	2.6	1.4	2.6	1.4	2.6	1.5
4	3.5	1.9	3.5	1.9	3.5	2.0
5	4.4	2.3	4.4	2.4	4.3	2.5
6	5.3	2.8	5.2	2.9	5.2	3.0
7	6.2	3.3	6.1	3.4	6.1	3.5
8	7.1	3.7	7.0	3.9	6.9	4.0
9	7.9	4.2	7.9	4.3	7.8	4.5
10	8.8	4.7	8.7	4.8	8.7	5.0
20	17.7	9.4	17.5	9.7	17.3	10.0
30	26.5	14.1	26.2	14.5	26.0	15.0
40	35.3	18.8	35.0	19.4	34.6	20.0
50	44.1	23.5	43.7	24.2	43.3	25.0
60	53.0	28.2	52.5	29.1	52.0	30.0
70	61.8	32.9	61.2	33.9	60.6	35.0
80	70.6	37.6	70.0	38.8	69.3	40.0
90	79.5	42.2	78.7	43.6	77.9	45.0
100	88.3	46.9	87.5	48.5	86.6	50.0
Dist.	E.W.	N. S.	E.W.	N. S.	N. S.	N. S.
	62 Deg.		61 Deg.		60 Deg.	

A Table of Northing, or Southing,

Distance,	31 Deg. N. S.	31 Deg. E.W.	32 Deg. N. S.	32 Deg. E.W.	33 Deg. N. S.	33 Deg. E.W.
1	.9	.5	.8	.5	.8	.5
2	1.7	1.0	1.7	1.1	1.7	1.1
3	2.6	1.5	2.5	1.6	2.5	1.6
4	3.5	2.1	3.4	2.1	3.4	2.2
5	4.3	2.6	4.2	2.6	4.2	2.7
6	5.1	3.1	5.1	3.2	5.0	3.3
7	6.0	3.6	5.9	3.7	5.9	3.8
8	6.9	4.1	6.3	4.2	6.7	4.4
9	7.7	4.6	7.6	4.8	7.6	4.9
10	8.6	5.1	8.5	5.3	8.4	5.4
20	17.1	10.3	17.0	10.6	16.8	10.9
30	25.7	15.4	25.4	15.9	25.2	16.3
40	34.3	20.6	33.9	21.2	33.5	21.8
50	42.9	25.7	42.4	26.5	41.9	27.2
60	51.4	30.9	50.9	31.8	50.3	32.7
70	60.0	36.0	59.4	37.1	58.7	38.1
80	68.6	41.2	67.8	42.4	67.1	43.6
90	77.1	46.3	76.3	47.7	75.5	49.0
100	85.7	51.5	84.8	53.0	83.9	54.5
Dist.	E.W	N. S.	Dist.	E.W.	N. S.	Dist.	E.W.	N. S.
	59 Deg.			58 Deg.			57 Deg.	

Easting, or Westing.

Distance,	34 Deg. N. S.	34 Deg. E.W.	35 Deg. N. S.	35 Deg. E.W.	36 Deg. N. S.	36 Deg. E.W.
1	.8	.6	.8	.6	.8	.6
2	1.7	1.1	1.7	1.1	1.6	1.2
3	2.5	2.7	2.5	1.7	2.4	1.8
4	3.3	2.2	3.3	2.3	3.2	2.3
5	4.1	2.8	4.1	2.9	4.0	2.9
6	5.0	3.4	4.9	3.4	4.8	3.5
7	5.8	3.9	5.7	4.0	5.7	4.1
8	6.6	4.5	6.6	4.6	6.5	4.7
9	7.5	5.0	7.4	5.2	7.2	5.3
10	8.3	5.6	8.2	5.7	8.1	5.9
20	16.6	11.2	16.4	11.5	16.2	11.8
30	24.9	16.8	24.6	17.2	24.3	17.6
40	33.2	22.4	32.8	22.9	32.4	23.5
50	41.4	28.0	41.0	28.7	40.4	29.4
60	49.7	33.5	49.1	34.4	48.5	35.3
70	58.0	39.1	57.3	40.2	56.6	41.1
80	66.3	44.7	65.5	45.9	64.7	47.0
90	74.6	50.3	73 7	51.6	72.8	52.9
100	82.9	55.9	81.9	57.4	80.9	58.8
Dist.	E.W.	N. S.	E.W.	N. S.	E.W.	N. S.
	56 Deg.		55 Deg.		54 Deg.	

A Table of Northing, or Southing,

Distance,	37 Deg. N. S.	37 Deg. E.W.	38 Deg. N. S.	38 Deg. E.W.	39 Deg. N. S.	39 Deg. E.W.
1	.8	.6	.8	.6	.8	.6
2	1.6	1.2	1.6	1.2	1.6	1.3
3	2.4	1.8	2.4	1.8	2.3	1.9
4	3.2	2.4	3.1	2.5	3.1	2.5
5	4.0	3.0	3.9	3.1	3.9	3.1
6	4.8	3.6	4.7	3.7	4.7	3.8
7	5.6	4.2	5.5	4.3	5.4	4.4
8	6.4	4.8	6.3	4.9	6.2	5.0
9	7.2	5.4	7.1	5.5	7.0	5.7
10	8.0	6.0	7.9	6.2	7.8	6.3
20	16.0	12.0	15.8	12.3	15.5	12.6
30	24.0	18.0	23.6	18.5	23.3	18.9
40	31.9	24.1	31.5	24.6	31.1	25.2
50	39.9	30.1	39.4	30.8	38.8	31.5
60	47.9	36.1	47.3	36.9	46.6	37.8
70	55.9	42.1	55.2	43.1	54.4	44.0
80	63.9	48.1	63.3	49.0	62.2	50.3
90	71.9	54.2	70.9	55.4	69.9	56.6
100	79.9	60.2	78.8	61.6	77.7	62.9
Dist.	E.W.	N. S.	E.W.	N. S.	E.W.	N. S.
	53 Deg.		52 Deg.		51 Deg.	

Easting, or Westing.

Distance,	40 Deg. N. S.	40 Deg. E.W.	Distance,	41 Deg. N. S.	41 Deg. E.W.	Distance,	42 Deg. N. S.	42 Deg. E.W.
1	.8	.6	1	.8	.7	1	.7	.7
2	1.5	1.3	2	1.5	1.3	2	1.5	1.3
3	2.3	1.9	3	2.3	2.0	3	2.2	2.0
4	3.1	2.6	4	3.0	2.6	4	3.0	2.7
5	3.3	3.2	5	3.8	3.3	5	3.7	3.3
6	4.6	3.8	6	4.5	3.9	6	4.4	4.0
7	5.4	4.5	7	5.3	4.6	7	5.2	4.7
8	6.1	5.1	8	6.0	5.2	8	5.9	5.3
9	6.9	5.8	9	6.8	5.9	9	6.7	6.0
10	7.7	6.4	10	7.5	6.6	10	7.4	6.7
20	15.3	12.9	20	15.1	13.1	20	14.9	13.4
30	23.0	19.3	30	22.6	19.7	30	22.3	20.1
40	30.6	25.7	40	30.2	26.2	40	29.7	26.8
50	38.3	32.1	50	37.7	32.8	50	37.2	33.5
60	46.0	38.6	60	45.3	39.4	60	44.6	40.1
70	53.6	45.0	70	52.8	45.9	70	52.0	46.8
80	61.3	51.4	80	60.4	52.5	80	59.4	53.5
90	68.9	57.9	90	57.9	59.0	90	66.9	60.2
100	76.6	64.3	100	75.5	65.6	100	74.3	66.9
Dist.	E.W.	N. S.	Dist.	E.W.	N. S.	Dist.	E.W	N. S.
	50 Deg.			49 Deg.			48 Deg.	

A Table of Northing, or Southing,

Distance,	43 Deg. N. S.	43 Deg. E.W.	Distance,	44 Deg. N. S.	44 Deg. E.W.	Distance,	45 Deg N S	45 Deg E.W.
1	.7	.7	1	.7	.7	1	.7	.7
2	1.5	1.4	2	1.4	1.4	2	1.4	1.4
3	2.2	2.0	3	2.2	2.1	3	2.1	2.1
4	2.9	2.7	4	2.9	2.8	4	2.8	2.8
5	3.6	3.4	5	3.6	3.5	5	3.5	3.5
6	4.4	4.1	6	4.3	4.2	6	4.2	4.2
7	5.1	4.8	7	5.0	4.9	7	4.9	4.9
8	5.8	5.4	8	5.8	5.6	8	5.6	5.6
9	6.6	6.1	9	6.5	6.2	9	6.4	6.4
10	7.3	6.8	10	7.2	6.9	10	7.1	7.1
20	14.6	13.6	20	14.4	13.9	20	14.1	14.1
30	21.9	20.5	30	21.6	20.8	30	21.2	21.2
40	29.2	27.3	40	28.8	27.8	40	28.3	28.3
50	36.6	34.1	50	36.0	34.7	50	35.3	35.3
60	43.9	40.9	60	43.2	41.7	60	42.4	42.4
70	51.2	47.7	70	50.3	48.6	70	49.5	49.5
80	58.5	54.6	80	57.5	55.6	80	56.6	56.6
90	65.8	61.4	90	64.7	62.5	90	63.6	63.6
100	73.1	68.2	100	71.9	69.5	100	70.7	70.7
Dist.	E.W.	N. S.	Dist.	E.W.	N. S.	Dist.	E.W.	N. S.
	47 Deg.			46 Deg.			45 Deg.	

THE USE OF THE Foregoing Table.

I Have already ſufficiently in the *6th.* Chapter of this Book Taught you the uſe of this Table; however, becauſe it is made ſomewhat different from ſuch of this kind as have been made by others, I will briefly byan Example, or two, Explain it to you. Admit in Surveying a Wood, or the like, you run a Line N. E. 40 Degrees, 10 Chains: or in plainer terms, a Line 10 Chains in Length, that makes an Angle with the Meridian of 40 Degrees to the Eaſt-ward; and you would put down in your Field-Book the Northing, and Eaſting of this Line under their proper Titles N. and E. according to Mr. *Norwood*'s way of Surveying Taught in the *6th.* Chapter.

Firſt at the Head of the Table find 40 Degrees, then in the Column of diſtances ſeek for 10 Chains: which had, you will find to ſtand right againſt it under the Title N. 7. 7, for the Northing, which is 7 Chains, $\frac{7}{10}$ of a Chain: and for the Eaſting under the Title E. 6. 4, which is 6 Chains $\frac{4}{10}$. of a Chain, as nigh as may be expreſt in the Tenth part of a Chain: But if you would know to one Link, add an 0 to the diſtance, ſo will 10 be 100, which ſeek for in the ſame Page of the Table,

and right againſt it you will find under Title N. 76. 6 or 7 Chains, 66 Links for your Northing, and under Title E, 64. 3, or 6 Chains 43 Links for your Eaſting: which found, put down in your Field-Book accordingly; and having done ſo by all your Lines, if you find the Northing, and Southing, the ſame, alſo the Eaſting, and Weſting, you may be ſure you have wrought true, otherwiſe not.

If the diſtance conſiſts of odd Chains, and Links, as moſt commonly it ſo falls out, then take them ſeverally out of the Table, and by adding all together you will have your deſire: as for Example.

Suppoſe my diſtance run upon any Line be NW. 35 Degrees, 15 Chains, 20 Links:

First in the Table I find the	Ch.	Ch.	Lin.
Northing of 10 Chains to be	10	8	19
	5	4	10
	20 Links	0	16
		12	45

which added together makes 12 Chains 45 Links, for the Northing of that diſtance run: In like manner under 35 Degrees, and Title W,

I find the Weſting of the	Ch.	Ch.	L.
ſame Line, as here	10	5	74
	5	2	87
	20 Links		11
		8	72

by which I conclude the Northing of that Line to be 12 Chains 45 Links, and the Weſting 8 Chains 72 Links: which thus you may prove by the Logarithms.

As

As *Radius*——————————10, 000000
Is to the distance 15. 20——————3, 181844
So is the Sign of the Corse 35 Deg.—9, 758772

To the Westing 8 Chains 72 Links—r2, 940616

And, as *Radius*——————————10, 000000
To the distance 15 Chains 20 Links—3, 181844
So Cosine of the Course 55——————9, 913364

To the Northing 12 Chains 45 Links-r3, 095208

Mark that if your Course had been S E, it would have been the same thing as N W: for you see in the Tables N, and S. E, and W, are joyned together. If your Degrees exceed 45, then seek for them at the Foot of the Table: and over the Titles N S, E W, find out the Northing, Southing, Easting or Westing.

I think this to be as much as need be said concerning the preceeding Table: As for the finding the Horizontal Line of a Hill, and such like things by the Table, before you have half well read through the Chapter of Trigonometry, your own Ingenuity will fast enough prompt you to it.

A

TABLE

OF

Sines & Tangents

To every Fifth Minute

OF THE

QUADRANT.

0.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	0.000000	10.000000	0.000000	Infinita	60
5	7.162696	10.000000	7.162696	12.837304	55
10	7.463726	9.999998	7.463727	12.536273	50
15	7.639816	9.999996	7.639820	12.360180	45
20	7.764754	9.999993	7.764761	12.235239	40
25	7.861662	9.999989	7.861674	12.138326	35
30	7.940842	9.999983	7.940858	12.059142	30
35	8.007787	9.999977	7.007809	11.992191	25
40	8.065776	9.999971	8.065806	11.934194	20
45	8.116926	9.999963	8.116963	11.883037	15
50	8.162681	9.999954	8.162737	11.837273	10
55	8.204070	9.999944	8.204126	11.795874	5
60	8.241855	9.999934	8.241921	11.758079	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

89.

1.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.241855	9.999934	8.241921	11.758079	60
5	8.276614	9.999922	8.276691	11.723309	55
10	8.308794	9.999910	8.308884	11.691116	50
15	8.338753	9.999897	8.338856	11.661144	45
20	8.366777	9.999882	8.366895	11.633105	40
25	8.393101	9.999867	8.393234	11.606766	35
30	8.417919	9.999851	8.418068	11.581932	30
35	8.441394	9.999834	8.441560	11.558440	25
40	8.463665	9.999816	8.463849	11.536151	20
45	8.484848	9.999797	8.485050	11.514950	15
50	8.505045	9.999778	8.505267	11.494733	10
55	8.524343	9.999757	8.524586	11.475414	5
60	8.542819	9.999735	8.543084	11.456916	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

88.

2.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.542819	9.999735	8.543084	11.456916	60
5	8.560540	9.999713	8.560828	11.439172	55
10	8.577566	9.999689	8.577877	11.422123	50
15	8.593948	9.999665	8.594283	11.405717	45
20	8.609734	9.999640	8.610094	11.389906	40
25	8.624965	9.999614	8.625352	11.374648	35
30	8.639680	9.999586	8.640093	11.359907	30
35	8.653911	9.999558	8.654352	11.345648	25
40	8.667689	9.999529	8.668160	11.331840	20
45	8.681043	9.999500	8.681544	11.318456	15
50	8.693998	9.999469	8.694529	11.305471	10
55	8.706577	9.999437	8.707140	11.292860	5
60	8.718800	9.999404	8.719396	11.280604	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

87.

3.

M.	SIN	Co-sine	TAN.	Co-Tangent.	
0	8.718800	9.999404	8.719396	11.280604	60
5	8.730688	9.999371	8.731317	11.268683	55
10	8.742259	9.999336	8.742922	11.257078	50
15	8.753528	9.990301	8.754227	11.245773	45
20	8.764511	9.999265	8.765246	11.234754	40
25	8.775223	9.999227	8.775995	11.224005	35
30	8.785675	9.999189	8.786486	11.213514	30
35	8.795881	9.999150	8.796731	11.203269	25
40	8.805852	9.999110	8.806742	11.103258	20
45	8.815599	9.999069	8.816529	11.183471	15
50	8.825130	9.999027	8.826103	11.173897	10
55	8.834456	9.998984	8.835471	11.164529	5
60	8.843585	9.998941	8.844644	11.155356	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

86.

The Table of Sines and Tangents.

4

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.843585	9.998941	8.844644	11.155356	60
5	8.852525	9.998896	8.853628	11.146372	55
10	8.861283	9.998851	8.862433	11.137567	50
15	8.869868	9.998804	8.871064	11.128936	45
20	8.878285	9.998757	8.879529	11.120471	40
25	8.886542	9.998708	8.887833	11.112167	35
30	8.894643	9.998659	8.895984	11.104016	30
35	8.902596	9.998609	8.903987	11.096013	25
40	8.910404	9.998558	8.911846	11.088154	20
45	8.918073	9.998506	8.919568	11.080432	15
50	8.925609	9.998453	8.927156	11.072844	10
55	8.933015	9.998399	8.934616	11.065384	5
60	8.940296	9.998344	8.941952	11.058048	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

85

5.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.940296	9.998344	8.941952	11.058048	60
5	8.947456	9.998289	8.949168	11.050832	55
10	8.954499	9.998232	8.956267	11.043733	50
15	8.961429	9.998174	8.963255	11.036745	45
20	8.968249	9.998116	8.970133	11.029867	40
25	8.974962	9.998056	8.976906	11.023094	35
30	8.981573	9.997996	8.983577	11.016423	30
35	8.988083	9.997935	8.990149	11.009851	25
40	8.994497	9.997872	8.996624	11.003376	20
45	9.000816	9.997809	9.003007	10.996993	15
50	9.007044	9.997745	9.009298	10.990702	10
55	9.013182	9.997680	9.015502	10.984498	5
60	9.019235	9.997614	9.021620	10.978380	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

84.

6.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.019235	9.997614	9.021620	10.978380	60
5	9.025203	9.997547	9.027655	10.972345	55
10	9.031089	9.997480	9.033609	10.966391	50
15	9.036896	9.997411	9.039485	10.960515	45
20	9.042625	9.997341	9.045284	10.954716	40
25	9.048279	9.997271	9.051008	10.948992	35
30	9.053859	9.997199	9.056659	10.943341	30
35	9.059367	9.997127	9.062240	10.937760	25
40	9.064806	9.997053	9.067752	10.932248	20
45	9.070176	9.996979	9.073197	10.926803	15
50	9.075480	9.995904	9.078576	10.921424	10
55	9.080719	9.996828	9.083891	10.916109	5
60	9.085894	9.996751	9.089144	10.910856	0
	Co sine	SIN.	Co-Tang.	TAN.	M

83.

7.

M.	SIN	Co sine	TAN.	Co-Tangent.	
0	9.085894	9.996751	9.089144	10.910850	60
5	9.091008	9.996673	9.094336	10.905664	55
10	9.096062	9.996594	9.099468	10.900532	50
15	9.101056	9.996514	9.104542	10.895458	45
20	9.105992	9.996433	9.109559	10.890441	40
25	9.110873	9.996351	9.114521	10.885479	35
30	9.115698	9.996269	9.119429	10.880571	30
35	9.120469	9.996185	9.124284	10.875716	25
40	9.125187	9.996100	9.129087	10.870913	20
45	9.129854	9.996015	9.133839	10.866161	15
50	9.134470	9.995928	9.138542	10.861458	10
55	9.139037	9.995841	9.143196	10.856804	5
60	9.143555	9.995753	9.147803	10.852197	0
	Co sine	SIN.	Co Tang.	TAN.	M

82.

The Table of Sines and Tangents.

8

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.143555	9.995753	9.147803	10 852197	60
5	9.148026	9.995664	9.152363	10.847637	55
10	9.152451	9.995573	9.156877	10 843123	50
15	9.156830	9.995482	9.161347	10.838653	45
20	9.161164	9.995390	9.165774	10.834226	40
25	9.165454	9.995297	9.170157	10.829843	35
30	9.169702	9.995203	9.174499	10.825501	30
35	9.173908	9.995108	9.178799	10.821201	25
40	9.178072	9.995013	9.183059	10.816941	20
45	9.182196	9.994916	9.187280	10.812720	15
50	9.186280	9.994818	9.191462	10.808538	10
55	9.190325	9.994720	9.195606	10.804394	5
60	9.194332	9.994620	9.199713	10.800287	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

81

9.

M.	SIN.	Cosine.	TAN	Co-Tangent.	
0	9.194332	9 994620	9.199713	10.800287	60
5	9.198302	9.994159	9.203782	10.796218	55
10	9.202234	9.994418	9.207817	10.792183	50
15	9.206131	9.994316	9.211815	10.788185	45
20	9.209992	9.994212	9.215780	10.784220	40
25	9.213818	9.994108	9.219710	10.780290	35
30	9.217609	9.994003	9.223607	10.776393	30
35	9.221367	9.993897	9.227471	10.772529	25
40	9.225092	9.993789	9 231302	10.768698	20
45	9.228784	9.993681	9.235103	10.764897	15
50	9.232444	9.993572	9.238872	10.761128	10
55	9.236073	9.993462	9.242610	10.757390	5
60	9.239670	9.993351	9.246319	10.753681	0
	Co sine.	SIN.	Co-Tang.	TAN.	M.

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10.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.239670	9 993351	9.246319	10.753681	60
5	9.243237	9.993240	9.249998	10.750002	55
10	9.246775	9 993127	9.253648	10.746352	50
15	9.250282	9.993013	9.257269	10.742731	45
20	9.253761	9 992898	9.260863	10.739137	40
25	9.257211	9.992783	9.264428	10.735572	35
30	9.260633	9.992666	9.267967	10.732033	30
35	9.264027	9.992549	9.271479	10.728521	25
40	9.267395	9.992430	9.274964	10.725036	20
45	9.270735	9.992311	9.278424	10.721576	15
50	9.274049	9.092190	9.281858	10.718142	10
55	9.277337	9.992069	9.285268	10.714732	5
60	9.280599	9 991947	9 288652	10.711348	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

79.

11.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.280599	9.991974	9.288652	10 711348	60
5	9 283836	9.991823	9.292013	10.707987	55
10	9.287048	9.991699	9.295349	10.704651	50
15	9.290236	9.991574	9.298662	10.701338	45
20	9.293399	9.991448	9.301951	10.698049	40
25	9.296539	9.991321	9.305218	10 694782	35
30	9.299655	9.991193	9.308463	10 691537	30
35	9.302748	9.991064	9.311685	10 688315	25
40	9 305819	9 990934	9 314885	10.685115	20
45	9 308867	9.990803	9.318064	10.681936	15
50	9.311893	9.990671	9 321222	10 678778	10
55	9.314897	9.990538	9.324358	10.675642	5
60	9.317879	9 990404	9.327475	10 672525	0
	Co-sine.	SIN.	Co Tang.	TAN.	M

The Table of Sines and Tangents.

12

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.317879	9.990404	9 327475	10.672525	60
5	9.320840	9 990270	9.330570	10.669430	55
10	9.323780	9.990134	9 333646	10.666354	50
15	9.326700	9.989997	9.336702	10.663298	45
20	9.329599	9.989860	9.339739	10.650261	40
25	9.332478	9.989721	9.342757	10.667243	35
30	9.335337	9.989582	9.445755	10.664245	30
35	9.338176	9.989441	9.348735	10.651265	25
40	9.340996	9.989300	9 351697	10.648303	20
45	9.343797	9.989157	9.354640	10.645360	15
50	9.346579	9.989014	9.357566	10.642434	10
55	9 349343	9.988869	9.360474	10.639526	5
60	9 352088	9 988724	9.363364	10.636636	0
	Co sine.	SIN.	Co-Tang.	TAN.	M.

77

13.

M.	SIN.	Cosine.	TAN.	Co-Tangent.	
0	9.352088	9.988724	9.363364	10.636636	60
5	9.354815	9.988578	9.366237	10.633763	55
10	9 357524	9.988430	9.369094	10 630906	50
15	9.360215	9.988282	9.371933	10.628067	45
20	9.362889	9.988133	9 374756	10 625244	40
25	9.365546	9 987983	9 377563	10.622437	35
30	9.368185	9.987832	9.380354	10.619646	30
35	9 370808	9.987679	9 383129	10.616871	25
40	9.373414	9.987526	9.385888	10.614112	20
45	9 376003	9.987372	9.388631	10 611369	15
50	9.378577	9.087217	9.391360	10.608640	10
55	9.381134	9.987061	9.394073	10.605927	5
60	9.383675	9.986904	9 396771	10.903229	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

76.

14.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.383675	9.986904	9.396771	10.603229	60
5	9.386201	9.986746	9.399455	10.600545	55
10	9.388711	9.986587	9.402124	10.597876	50
15	9.391206	9.986427	9.404778	10.595222	45
20	9.393685	9.986266	9.407419	10.592581	40
25	9.396150	9.986104	9.410045	10.589955	35
30	9.398600	9.985942	9.412658	10.587342	30
35	9.401035	9.985778	9.415257	10.584743	25
40	9.403455	9.985613	9.417842	10.582158	20
45	9.405862	9.985447	9.420415	10.579585	15
50	9.408254	9.985280	9.422974	10.577026	10
55	9.410632	9.985113	9.425519	10.574481	5
60	9.412996	9.984944	9.428052	10.571948	0
	Co-sine.	SIN.	Co Tang.	TAN.	M.

75.

15.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.412996	9.984944	9.428052	10.571948	60
5	9.415347	9.984774	9.430573	10.569427	55
10	9.417684	9.984603	9.433080	10.566920	50
15	9.420007	9.984432	9.435576	10.564424	45
20	9.422318	9.984259	9.438059	10.561941	40
25	9.424615	9.984085	9.440529	10.559471	35
30	9.426899	9.983911	9.442988	10.557012	30
35	9.429170	9.983735	9.445435	10.554565	25
40	9.431429	9.983558	9.447870	10.552130	20
45	9.433675	9.983381	9.450294	10.549706	15
50	9.435908	9.983202	9.452706	10.547294	10
55	9.438129	9.983022	9.455107	10.544893	5
60	9.440338	9.982842	9.457496	10.542504	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

74.

0.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	0.000000	10.000000	0.000000	Infinita	60
5	7.162696	10.000000	7.162696	12.837304	55
10	7.463726	9.999998	7.463727	12.536273	50
15	7.639816	9 999996	7.639820	12.360180	45
20	7.764754	9 999993	7.764761	12.235239	40
25	7.861662	9.999989	7 861674	12.138326	35
30	7.940842	9.999983	7.940858	12.059142	30
35	8.007787	9 999977	7.007809	11.992191	25
40	8.065776	9.999971	8.065806	11.934194	20
45	8.116926	9 999963	8.116963	11.883037	15
50	8.162681	9.999954	8.162737	11.837273	10
55	8.204070	9 999944	8 204126	11.795874	5
60	8.241855	9.999934	8.241921	11.758079	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

1.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.241855	9.999934	8.241921	11.758079	60
5	8.276614	9.999922	8.276691	11.723309	55
10	8.308794	9.999910	8.308884	11.691116	50
15	8.338753	9.999897	8.338856	11.661144	45
20	8 366777	9.999882	8.366895	11.633105	40
25	8.393101	9.999867	8.393234	11.606766	35
30	8.417919	9.999851	8.418068	11.581932	30
35	8 441394	9.999834	8.441560	11.558440	25
40	8.463665	9.999816	8.463849	11.536151	20
45	8.484848	9.999797	8.485050	11.514950	15
50	8.505045	9.999778	8.505267	11.494733	10
55	8.524343	9.999757	8.524586	11.475414	5
60	8.542819	9.999735	8.543084	11.456916	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

2.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.542819	9.999735	8.543084	11.456916	60
5	8.560540	9.999713	8.560828	11.439172	55
10	8.577566	9.999689	8.577877	11.422123	50
15	8.593948	9.999665	8.594283	11.405717	45
20	8.609734	9.999640	8.610094	11.389906	40
25	8.624965	9.999614	8.625352	11.374648	35
30	8.639680	9.999586	8.640093	11.359907	30
35	8.653911	9.999558	8.654352	11.345648	25
40	8.667689	9.999529	8.668160	11.331840	20
45	8.681043	9.999500	8.681544	11.318456	15
50	8.693998	9.999469	8.694529	11.305471	10
55	8.706577	9.999437	8.707140	11.292860	5
60	8.718800	9.999404	8.719396	11.280604	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

87.

3.

M.	SIN	Co-sine	TAN.	Co-Tangent.	
0	8.718800	9.999404	8.719396	11.280604	60
5	8.730688	9.999371	8.731317	11.268683	55
10	8.742259	9.999336	8.742922	11.257078	50
15	8.753528	9.990301	8.754227	11.245773	45
20	8.764511	9.999265	8.765246	11.234754	40
25	8.775223	9.999227	8.775995	11.224005	35
30	8.785675	9.999189	8.786486	11.213514	30
35	8.795881	9.999150	8.796731	11.203269	25
40	8.805852	9.999110	8.806742	11.103258	20
45	8.815599	9.999069	8.816529	11.183471	15
50	8.825130	9.999027	8.826103	11.173897	10
55	8.834456	9.998984	8.835471	11.164529	5
60	8.843585	9.998941	8.844644	11.155356	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

86.

4

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.843585	9.998941	8.844644	11.155356	60
5	8.852525	9.998896	8.853628	11.146372	55
10	8.861283	9.998851	8.862433	11.137567	50
15	8.869868	9.998804	8.871064	11.128936	45
20	8.878285	9.998757	8.879529	11.120471	40
25	8.886542	9.998708	8.887833	11.112167	35
30	8.894643	9.998659	8.895984	11.104016	30
35	8.902596	9.998609	8.903987	11.096013	25
40	8.910404	9.998558	8.911846	11.088154	20
45	8.918073	9.998506	8.919568	11.080432	15
50	8.925609	9.998453	8.927156	11.072844	10
55	8.933015	9.998399	8.934616	11.065384	5
60	8.940296	9.998344	8.941952	11.058048	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

85

5.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.940296	9.998344	8.941952	11.058048	60
5	8.947456	9.998289	8.949168	11.050832	55
10	8.954499	9.998232	8.956267	11.043733	50
15	8.961429	9.998174	8.963255	11.036745	45
20	8.968249	9.998116	8.970133	11.029867	40
25	8.974962	9.998056	8.976906	11.023094	35
30	8.981573	9.997996	8.983577	11.016423	30
35	8.988083	9.997935	8.990149	11.009851	25
40	8.994497	9.997872	8.996624	11.003376	20
45	9.000816	9.997809	9.003007	10.996993	15
50	9.007044	9.997745	9.009298	10.990702	10
55	9.013182	9.997680	9.015502	10.984498	5
60	9.019235	9.997614	9.021620	10.978380	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

84.

6.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.019235	9.997614	9.021620	10.978380	60
5	9.025263	9.997547	9.027655	10.972345	55
10	9.031089	9.997480	9.033609	10.966391	50
15	9.036896	9.997411	9.039485	10.960515	45
20	9.042625	9.997341	9.045284	10.954716	40
25	9.048279	9.997271	9.051008	10.948992	35
30	9.053859	9.997199	9.056659	10.943341	30
35	9.059367	9.997127	9.062240	10.937760	25
40	9.064806	9.997053	9.067752	10.932248	20
45	9.070176	9.996979	9.073197	10.926803	15
50	9.075480	9.995904	9.078576	10.921424	10
55	9.080719	9.996828	9.083891	10.916109	5
60	9.085894	9.996751	9.089144	10.910856	0
	Co sine	SIN.	Co-Tang.	TAN.	M

83.

7.

M.	SIN	Co sine	TAN.	Co-Tangent.	
0	9.085894	9.996751	9.089144	10.910850	60
5	9.091008	9.996673	9.094336	10.905664	55
10	9.096062	9.996594	9.099468	10.900532	50
15	9.101056	9.996514	9.104542	10.895458	45
20	9.105992	9.996433	9.109559	10.890441	40
25	9.110873	9.996351	9.114521	10.885479	35
30	9.115698	9.996269	9.119429	10.880571	30
35	9.120469	9.996185	9.124284	10.875716	25
40	9.125187	9.996100	9.129087	10.870913	20
45	9.129854	9.996015	9.133839	10.866161	15
50	9.134470	9.995928	9.138542	10.861458	10
55	9.139037	9.995841	9.143195	10.856804	5
60	9.143555	9.995753	9.147803	10.852197	0
	Co sine	SIN.	Co Tang.	TAN.	M

82.

8

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.143555	9.995753	9.147803	10 852197	60
5	9.148026	9.995664	9.152363	10.847637	55
10	9.152451	9.995573	9.156877	10 843123	50
15	9.156830	9.995482	9.161347	10.838653	45
20	9.161164	9.995390	9.165774	10.834226	40
25	9.165454	9.995297	9.170157	10.829843	35
30	9.169702	9.995203	9.174499	10.825501	30
35	9.173908	9.995108	9.178799	10.821201	25
40	9.178072	9.995013	9.183059	10.816941	20
45	9.182196	9.994916	9.187280	10.812720	15
50	9.186280	9.994818	9.191462	10.808538	10
55	9.190325	9.994720	9.195606	10.804394	5
60	9.194332	9.994620	9.199713	10.800287	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

81

9.

M.	SIN.	Cosine.	TAN	Co-Tangent.	
0	9.194332	9 994620	9.199713	10.800287	60
5	9.198302	9.994159	9.203782	10.796218	55
10	9.202234	9.994418	9.207817	10.792183	50
15	9.206131	9.994316	9.211815	10.788185	45
20	9.209992	9.994212	9.215780	10.784220	40
25	9.213818	9.994108	9.219710	10.780290	35
30	9.217609	9.994003	9.223607	10.776393	30
35	9.221367	9.993897	9.227471	10.772529	25
40	9.225092	9.993789	9 231302	10.768698	20
45	9.228784	9.993681	9.235103	10.764897	15
50	9.232444	9.993572	9.238872	10.761128	10
55	9.236073	9.993462	9.242610	10.757390	5
60	9.239670	9.993351	9.246319	10.753681	0
	Co sine.	SIN.	Co-Tang.	TAN.	M.

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10.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.239670	9 993351	9.246319	10.753681	60
5	9.243237	9.993240	9.249998	10.750002	55
10	9.246775	9 993127	9.253648	10.746352	50
15	9.250282	9.993013	9.257269	10.742731	45
20	9.253761	9 992898	9.260863	10.739137	40
25	9.257211	9.992783	9.264428	10.735572	35
30	9.260633	9.992666	9.267967	10.732033	30
35	9.264027	9.992549	9.271479	10.728521	25
40	9.267395	9.992430	9.274964	10.725036	20
45	9.270735	9.992311	9.278424	10.721576	15
50	9.274049	9.092190	9.281858	10.718142	10
55	9.277337	9.992069	9.285268	10.714732	5
60	9.280599	9 991947	9 288652	10.711348	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

79.

11.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.280599	9.991974	9.288652	10.711348	60
5	9 283836	9.991823	9.292013	10.707987	55
10	9.287048	9.991699	9.295349	10.704651	50
15	9.290236	9.991574	9.298662	10.701338	45
20	9.293399	9.991448	9.301951	10.698049	40
25	9.296539	9.991321	9.305218	10 694782	35
30	9.299655	9.991193	9.308463	10 691537	30
35	9.302748	9.991064	9.311685	10 688315	25
40	9 305819	9 990934	9 314885	10.685115	20
45	9 308867	9.990803	9.318064	10.681936	15
50	9.311893	9.990671	9 321222	10 678778	10
55	9.314897	9.990538	9.324358	10.675642	5
60	9.317879	9 990404	9.327475	10 672525	0
	Co-sine.	SIN.	Co Tang.	TAN.	M

12

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.317879	9.990404	9.327475	10.672525	60
5	9.320840	9.990270	9.330570	10.669430	55
10	9.323780	9.990134	9.333646	10.666354	50
15	9.326700	9.989997	9.336702	10.663298	45
20	9.329599	9.989860	9.339739	10.660261	40
25	9.332478	9.989721	9.342757	10.667243	35
30	9.335337	9.989582	9.445755	10.664245	30
35	9.338176	9.989441	9.348735	10.651265	25
40	9.340996	9.989300	9.351697	10.648303	20
45	9.343797	9.989157	9.354640	10.645360	15
50	9.346579	9.989014	9.357566	10.642434	10
55	9.349343	9.988869	9.360474	10.639526	5
60	9.352088	9.988724	9.363364	10.636636	0
	Co sine.	SIN.	Co-Tang.	TAN.	M.

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13.

M.	SIN.	Cosine.	TAN.	Co-Tangent.	
0	9.352088	9.988724	9.363364	10.636636	60
5	9.354815	9.988578	9.366237	10.633763	55
10	9.357524	9.988430	9.369094	10.630906	50
15	9.360215	9.988282	9.371933	10.628067	45
20	9.362889	9.988133	9.374756	10.625244	40
25	9.365546	9.987983	9.377563	10.622437	35
30	9.368185	9.987832	9.380354	10.619646	30
35	9.370808	9.987679	9.383129	10.616871	25
40	9.373414	9.987526	9.385888	10.614112	20
45	9.376003	9.987372	9.388631	10.611369	15
50	9.378577	9.087217	9.391360	10.608640	10
55	9.381134	9.987061	9.394073	10.605927	5
60	9.383675	9.986904	9.396771	10.903229	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

76.

The Table of Sines and Tangents.

14.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.383675	9.986904	9.396771	10.603229	60
5	9.386201	9.986746	9.399455	10.600545	55
10	9.388711	9.986587	9.402124	10.597876	50
15	9.391206	9.986427	9.404778	10.595222	45
20	9.393685	9.986266	9.407419	10.592581	40
25	9.396150	9.986104	9.410045	10.589955	35
30	9.398600	9.985942	9.412658	10.587342	30
35	9.401035	9.985778	9.415257	10.584743	25
40	9.403455	9.985613	9.417842	10.582158	20
45	9.405862	9.985447	9.420415	10.579585	15
50	9.408254	9.985280	9.422974	10.577026	10
55	9.410632	9.985113	9.425519	10.574481	5
60	9.412996	9.984944	9.428052	10.571948	0
	Co-sine.	SIN.	Co Tang.	TAN.	M.

75.

15.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.412996	9.984944	9.428052	10.571948	60
5	9.415347	9.984774	9.430573	10.569427	55
10	9.417684	9.984603	9.433080	10.566920	50
15	9.420007	9.984432	9.435576	10.564424	45
20	9.422318	9.984259	9.438059	10.561941	40
25	9.424615	9.984085	9.440529	10.559471	35
30	9.426899	9.983911	9.442988	10.557012	30
35	9.429170	9.983735	9.445435	10.554565	25
40	9.431429	9.983558	9.447870	10.552130	20
45	9.433675	9.983381	9.450294	10.549706	15
50	9.435908	9.983202	9.452706	10.547294	10
55	9.438129	9.983022	9.455107	10.544893	5
60	9.440338	9.982842	9.457496	10.542504	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

74.

16.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.440338	9.982842	9.457496	10.542504	60
5	9.442535	9.982660	9.459875	10.540125	55
10	9.444720	9.982477	9.462242	10.537758	50
15	9.446893	9.982294	9.464599	10.535401	45
20	9.449054	9.982109	9.466945	10.533055	40
25	9.451204	9.981924	9.469280	10.530720	35
30	9.453342	9.981737	9.471605	10.528395	30
35	9.455469	9.981549	9.473919	10.526081	25
40	9.457584	9.981361	9.476223	10.523777	20
45	9.459688	9.981171	9.478517	10.521483	15
50	9.461782	9.980981	9.480801	10.519199	10
55	9.463864	9.980789	9.483075	10.516925	5
60	9.465935	9.980596	9.485339	10.514661	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

73.

17.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.465935	9.980596	9.485339	10.514661	60
5	9.467996	9.980403	9.487593	10.512407	55
10	9.470046	9.980208	9.489838	10.510162	50
15	9.472086	9.980012	9.492073	10.507927	45
20	9.474115	9.979816	9.494299	10.505701	40
25	9.476133	9.979618	9.496515	10.503485	35
30	9.478142	9.979420	9.498722	10.501278	30
35	9.480140	9.979220	9.500920	10.499080	25
40	9.482128	9.979019	9.503109	10.496891	20
45	9.484107	9.978817	9.505289	10.494711	15
50	9.486075	9.978615	9.507460	10.492540	10
55	9.488034	9.978411	9.509622	10.490378	5
60	9.489982	9.978206	9.511776	10.488224	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

72.

18.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.489982	9.978206	9.511775	10.488224	60
5	9 491922	9.978001	9.513921	10.486079	55
10	9 493851	9.977794	9.516057	10.483943	50
15	9.495772	9 977586	9.518186	10.481814	45
20	9.497682	9.977377	9.520305	10.479695	40
25	9.499584	9.977167	9.522417	10.477583	35
30	9.501476	9.976957	9.524520	10.475480	30
35	9.503360	9.976745	9.526615	10.473385	25
40	9.505234	9.976532	9.528702	10.471298	20
45	9.507099	9.976318	9.530781	10.469219	15
50	9.508956	9.976103	9.532853	10.467147	10
55	9.510803	9 975887	9.534916	10.465084	5
60	9.512642	9.975670	9.536972	10.463028	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

71.

19.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.512642	9.975670	9.536972	10.463028	60
5	9.514472	9.975452	9.539020	10.460980	55
10	9.516294	9.975233	9.541061	10.458939	50
15	9.518107	9 975013	9.543094	10.456906	45
20	9.519911	9.974792	9.545119	10.454881	40
25	9.521707	9.974570	9.547138	10.452862	35
30	9.523495	9.974347	9.549149	10.450851	30
35	9.525275	9.974122	9.551153	10 448847	25
40	9.527046	9 973897	9.553149	10 446851	20
45	9.528810	9 973671	9.555139	10.444861	15
50	9.530565	9.973444	9 557121	10.442879	10
55	9.532312	9.973215	9 559097	10.440903	5
60	9.534052	9 972986	9.561066	10.438934	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

70.

20.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.534052	9.972986	9.561066	10.438934	60
5	9.535783	9.972755	9.563028	10.436972	55
10	9.537507	9.972524	9.564983	10.435017	50
15	9.539223	9.972291	9.566932	10.433068	45
20	9.540931	9.972058	9.568873	10.431127	40
25	9.542632	9.971823	9.570809	10.429191	35
30	9.544325	9.971583	9.572738	10.427262	30
35	9.546011	9.971351	9.574660	10.425340	25
40	9.547689	9.971113	9.576576	10.423424	20
45	9.549360	9.970874	9.578486	10.421514	15
50	9.551024	9.970635	9.580389	10.419611	10
55	9.552680	9.970394	9.582286	10.417714	5
60	9.554329	9.970152	9.584177	10.415823	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

69.

21.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.554329	9.970152	9.584177	10.415823	60
5	9.555971	9.969909	9.586062	10.413938	55
10	9.557606	9.969665	9.587941	10.412059	50
15	9.559234	9.969420	9.589814	10.410186	45
20	9.560855	9.969173	9.591681	10.408319	40
25	9.562468	9.968926	9.593542	10.406458	35
30	9.564075	9.968678	9.595398	10.404602	30
35	9.565676	9.968429	9.597247	10.402753	25
40	9.567269	9.968178	9.599091	10.400909	20
45	9.568856	9.967927	9.600929	10.399071	15
50	9.570435	9.967674	9.602761	10.397239	10
55	9.572009	9.967421	9.604588	10.395412	5
60	9.573575	9.967166	9.606410	10.393590	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

68.

22.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.573575	9.967166	9.606410	10.393590	60
5	9.575136	9.966910	9.608225	10.391775	55
10	9.576689	9.966653	9.610036	10.389954	50
15	9.578236	9.966395	9.611841	10.388159	45
20	9.579777	9.966136	9.613641	10.386359	40
25	9.581312	9.965876	9.615435	10.384565	35
30	9.582840	9.965615	9.617224	10.382776	30
35	9.584361	9.965353	9.619008	10.380992	25
40	9.585877	9.965090	9.620787	10.379213	20
45	9.587386	9.964826	9.622561	10.377439	15
50	9.588890	9.964560	9.624330	10.375670	10
55	9.590387	9.964294	9.626093	10.373907	5
60	9.591878	9.964026	9.627852	10.372148	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

67.

23.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.591878	9.964026	9.627852	10.372148	60
5	9.593363	9.963757	9.629606	10.370394	55
10	9.594842	9.963488	9.631355	10.368645	50
15	9.596315	9.963217	9.633099	10.366900	45
20	9.597783	9.962945	9.634838	10.365162	40
25	9.599244	9.962672	9.636572	10.363428	35
30	9.600700	9.962398	9.638302	10.361698	30
35	9.602150	9.962123	9.640027	10.359973	25
40	9.603594	9.961846	9.641747	10.358253	20
45	9.605032	9.961569	9.643463	10.356537	15
50	9.606465	9.961290	9.645174	10.354826	10
55	9.607892	9.961011	9.646881	10.353119	5
60	9.609313	9.960730	9.648583	10.351417	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

66.

The Table of Sines and Tangents.

24.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.609313	9.960730	9.648583	10.351417	60
5	9.610729	9.960448	9.650281	10.349719	55
10	9.612140	9.960165	9.651974	10.348026	50
15	9.613545	9.959882	9.653663	10.346337	45
20	9.614944	9.959596	9.655348	10.344652	40
25	9.616338	9.959310	9.657028	10.342972	35
30	9.617727	9.959023	9.658704	10.341296	30
35	9.619110	9.958734	9.660376	10.339624	25
40	9.620488	9.958445	9.662043	10.337957	20
45	9.621861	9.958154	9.663707	10.336293	15
50	9.623229	9.957863	9.665366	10.334634	10
55	9.624591	9.957570	9.667021	10.332979	5
60	9.625948	9.957276	9.668673	10.331327	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

65.

25.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.625948	9.957276	9.668673	10.331327	60
5	9.627300	9.956981	9.670320	10.329680	55
10	9.628647	9.956684	9.671963	10.328073	50
15	9.629989	9.956387	9.673602	10.326398	45
20	9.631326	9.956089	9.675237	10.324763	40
25	9.632658	9.955789	9.576869	10.323131	35
30	9.633984	9.955488	9.678496	10.322504	30
35	9.635306	9.955186	9.680120	10.319880	25
40	9.636623	9.954883	9.681740	10.318260	20
45	9.637935	9.954579	9.683356	10.316644	15
50	9.639242	9.954274	9.684968	10.315032	10
55	9.640544	9.953968	9.686577	10.313423	5
60	9.641842	9.953660	9.688182	10.311818	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

64.

26.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.641842	9.953660	9.688182	10.311818	60
5	9.643135	9.953352	9.689783	10.310217	55
10	9.644423	9.953042	9.691381	10.308619	50
15	9.645706	9.952731	9.692975	10.307025	45
20	9.646984	9.952419	9.694566	10.305434	40
25	9.648258	9.952106	9.696153	10.303847	35
30	9.649527	9.951791	9.697736	10.302264	30
35	9.650792	9.951476	9.699316	10.300684	25
40	9.652052	9.951159	9.700893	10.299107	20
45	9.653308	9.950841	9.702781	10.297534	15
50	9.654558	9.950522	9.704036	10.295964	10
55	9.655805	9.950202	9.705603	10.294397	5
60	9.657047	9.949881	9.707166	10.292834	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

63.

27.

M.	SIN	Co sine	TAN.	Co-Tangent.	
0	9.657047	9.949881	9.707166	10.292834	60
5	9.658284	9.949558	9.708726	10.291274	55
10	9.659517	9.949235	9.710282	10.289718	50
15	9.660746	9.948910	9.711836	10.288104	45
20	9.661970	9.948584	9.713386	10.286614	40
25	9.663190	9.948257	9.714933	10.285057	35
30	9.664406	9.947929	9.716477	10.283523	30
35	9.665617	9.947600	9.718017	10.281983	25
40	9.666824	9.947269	9.719555	10.280445	20
45	9.668027	9.946937	9.721089	10.278911	15
50	9.669225	9.946604	9.722621	10.277379	10
55	9.670419	9.946270	9.724149	10.275851	5
60	9.671609	9.945935	9.725674	10.274326	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

62.

28.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.671609	9.945935	9.725674	10.274326	60
5	9.672795	9.945598	9.727197	10.272803	55
10	9.673977	9.945261	9.728716	10.271284	50
15	9.675155	9.944922	9.730233	10.269767	45
20	9.676328	9.944582	9.731745	10.268254	40
25	9.677498	9.944241	9.733257	10.266743	35
30	9.678663	9.943899	9.734764	10.265236	30
35	9.679824	9.943555	9.736269	10.263731	25
40	9.680982	9.943210	9.737771	10.262229	20
45	9.682135	9.942864	9.739271	10.260729	15
50	9.683284	9.942517	9.740767	10.259233	10
55	9.684430	9.942169	9.742261	10.257739	5
60	9.685571	9.941819	9.743752	10.256248	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

61.

29.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.685571	9.941819	9.743751	10.256248	60
5	9.686709	9.941469	9.745240	10.254760	55
10	9.687843	9.941117	9.746726	10.253274	50
15	9.688972	9.940763	9.748209	10.251791	45
20	9.690098	9.940409	9.749689	10.250311	40
25	9.691220	9.940054	9.751167	10.248833	35
30	9.692339	9.939697	9.752642	10.247358	30
35	9.693453	9.939339	9.754115	10.245885	25
40	9.694564	9.938980	9.755585	10.244415	20
45	9.695671	9.938619	9.757052	10.242948	15
50	9.696775	9.938258	9.758517	10.241483	10
55	9.697874	9.937895	9.759979	10.240021	5
60	9.698970	9.937531	9.761439	10.238561	0
	Co sine	SIN.	Co-Tang.	TAN.	M.

60.

30.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.698970	9.937531	9.761439	10.238561	60
5	9.700062	9.937165	9.762897	10.237103	55
10	9.701151	9.936799	9.764352	10.235648	50
15	9.702236	9.936431	9.765805	10.234195	45
20	9.703317	9.936062	9.767255	10.232745	40
25	9.704395	9.935692	9.768703	10.231297	35
30	9.705469	9.935320	9.770148	10.229852	30
35	9.706539	9.934948	9.771592	10.228408	25
40	9.707606	9.934574	9.773033	10.226967	20
45	9.708670	9.934199	9.774471	10.225529	15
50	9.709730	9.933822	9.775908	10.224092	10
55	9.710786	9.933445	9.777342	10.222658	5
60	9.711839	9.933066	9.778774	10.221226	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

59.

31.

M.	SIN	Co sine	TAN.	Co-Tangent.	
0	9.711839	9.933066	9.778774	10.221226	60
5	9.712889	9.932685	9 780203	10.219797	55
10	9.713935	9.932304	9.781631	10.218369	50
15	9.714978	9.931921	9.783056	10.216944	45
20	9.716017	9.931537	9 784479	10.215521	40
25	9.717053	9 931152	9.785900	10.214100	35
30	9.718085	9.930766	9.787319	10 212681	30
35	9.719114	9.930378	9.788736	10.211264	25
40	9.720140	9.929989	9.790151	10.209849	20
45	9.721162	9.929599	9.791563	10.208437	15
50	9.722181	9.929207	9.792974	10.207026	10
55	9.723197	9.928815	9.794383	10.205617	5
60	9.724210	9.928420	9 795789	10.204211	0
	Co-sine.	SIN.	Co Tang.	TAN.	M

58.

32.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.724210	9 928420	9.795789	10.204211	60
5	9.725219	9.928025	9.797194	10.202806	55
10	9.726225	9 927629	9.798596	10.201404	50
15	9.727228	9.927231	9 799997	10.200003	45
20	9.728227	9 926831	9 801396	10.198604	40
25	9.729223	9 926431	9 802792	10.197208	35
30	9.730217	9.926029	9.804187	10.195813	30
35	9 731206	9 925626	9.805580	10.194420	25
40	9 732193	9.925222	9.806971	10.193029	20
45	9 733177	9.924816	9.808361	10.191639	15
50	9.734157	9 924409	9.809748	10.190252	10
55	9.735135	9.924001	9.811134	10.188866	5
60	9.736109	9.923591	9 812517	10.187483	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

57.

33.

M.	SIN.	Cosine.	TAN	Co-Tangent.	
0	9.736109	9.923591	9.812517	10.187483	60
5	9.737080	9.923181	9.813899	10.186101	55
10	9.738048	9.922769	9.815280	10.184720	50
15	9.739013	9 922355	9.816658	10.183342	45
20	9.739975	9.921940	9.818035	10.181965	40
25	9.740934	9.921524	9.819410	10.180590	35
30	9.741889	9.921107	9.820783	10 179217	30
35	9.742842	9.920688	9.822154	10.177846	25
40	9.743792	9.920268	9.823524	10 176476	20
45	9.744739	9.919846	9.824893	10 175107	15
50	9 745683	9.919424	9.826259	10.173741	10
55	9.746624	9.919000	9.827624	10.172376	5
60	9.747562	9 918574	9.828987	10.171013	0
	Co-sine.	SIN.	Co Tang.	TAN.	M.

34.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.747562	9.918574	9.828987	10.171013	60
5	9.748497	9.918147	9.830349	10.169651	55
10	9.749429	9.917719	9.831709	10.168291	50
15	9.750358	9.917290	9.833068	10.166932	45
20	9.751284	9.916859	9.834425	10.165575	40
25	9.752208	9.916427	9.835780	10.164220	35
30	9.753128	9.915994	9.837134	10.162866	30
35	9.754046	9.915559	9.838487	10.161513	25
40	9.754960	9.915123	9.839838	10.160162	20
45	9.755872	9.914685	9.841187	10.158813	15
50	9.756782	9.914246	9.842535	10.157465	10
55	9.757688	9.913806	9.843882	10.156118	5
60	9.758591	9.913365	9.845227	10.154773	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

55.

35.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.758591	9.913365	9.845227	10.154773	60
5	9.759492	9.912922	9.846570	10.153430	55
10	9.760390	9.912477	9.847913	10.152087	50
15	9.761285	9.912031	9.849254	10.150746	45
20	9.762177	9.911584	9.850593	10.149407	40
25	9.763067	9.911136	9.851931	10.148069	35
30	9.763954	9.910686	9.853268	10.146732	30
35	9.764838	9.910235	9.854603	10.145397	25
40	9.765720	9.909782	9.855938	10.144062	20
45	9.766598	9.909328	9.857270	10.142730	15
50	9.767475	9.908873	9.858602	10.141398	10
55	9.768348	9.908416	9.859932	10.140068	5
60	9.769219	9.907958	9.861261	10.138739	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

54.

36.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.769219	9.907958	9.861261	10.138739	60
5	9.770087	9.907498	9.862589	10.137411	55
10	9.770952	9.907037	9.863915	10.136085	50
15	9.771815	9.906575	9.865240	10.134760	45
20	9.772675	9.906111	9.866564	10.133436	40
25	9.773533	9.905645	9.867887	10.132133	35
30	9.774388	9.905179	9.869209	10.130791	30
35	9.775240	9.904711	9.870529	10.129471	25
40	9.776090	9.904241	9.871849	10.128151	20
45	9.776937	9.903770	9.873167	10.126833	15
50	9.777781	9.903298	9.874484	10.125516	10
55	9.778624	9.902824	9.875800	10.124200	5
60	9.779463	9.902349	9.877114	10.122886	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

53.

37.

M.	SIN.	Cosine.	TAN	Co-Tangent.	
0	9.779463	9.902349	9.877114	10.122886	60
5	9.780300	9.901872	9.878428	10.121572	55
10	9.781134	9.901394	9.879741	10.120259	50
15	9.781966	9.900914	9.881052	10.118948	45
20	9.782796	9.900433	9.882363	10.117637	40
25	9.783623	9.899951	9.883672	10.116328	35
30	9.784447	9.899467	9.884980	10.115020	30
35	9.785269	9.898981	9.886288	10.113712	25
40	9.786089	9.898494	9.887594	10.112406	20
45	9.786906	9.898006	9.888900	10.111100	15
50	9.787720	9.897516	9.890204	10.109796	10
55	9.788532	9.897025	9.891507	10.108493	5
60	9.789342	9.806532	9.892810	10.107190	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

52.

38.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.789342	9.896532	9.892810	10.107190	60
5	9.790149	9.896038	9.894111	10.105889	55
10	9.790954	9.895542	9.895412	10.104588	50
15	9.791757	9.895045	9.896712	10.103288	45
20	9.792557	9.894546	9.898010	10.101990	40
25	9.793354	9.894046	9.899308	10.100692	35
30	9.794150	9.893544	9.900605	10.099395	30
35	9.794942	9.893041	9.901901	10.098099	25
40	9.795733	9.892536	9.903197	10.096803	20
45	9.796521	9.892030	9.904491	10.095509	15
50	9.797307	9.891523	9.905785	10.094215	10
55	9.798091	9.891013	9.907077	10.092923	5
60	9.798872	9.890503	9.908369	10.091631	0
	Co-sine.	SIN.	Co Tang.	TAN.	M.

51.

39.

M.	SIN.	Co-sine.	TAN	Co-Tangent.	
0	9.798872	9.890503	9.908369	10.091631	60
5	9.799651	9.889990	9.909660	10.090340	55
10	9.800427	9.889477	9.910951	10.089049	50
15	9.801201	9.888961	9.912240	10.087760	45
20	9.801973	9.888444	9.913529	10.086471	40
25	9.802743	9.887926	9.914817	10.085183	35
30	9.803511	9.887406	9.916104	10.083895	30
35	9.804276	9.886885	9.917391	10.082609	25
40	9.805039	9.886362	9.918677	10.081323	20
45	9.805799	9.885837	9.919962	10.080038	15
50	9.806557	9.885311	9.921247	10.078753	10
55	9.807314	9.884783	9.922530	10.077470	5
60	9.808067	9.884254	9.923814	10.076186	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

52.

40.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.808067	9.884254	9.923814	10.076186	60
5	9.808819	9.883723	9.925096	10.074904	55
10	9.809569	9.883191	9.926378	10.073622	50
15	9.810316	9.882657	9.927659	10.072341	45
20	9.811061	9.882121	9.928940	10.071060	40
25	9.811804	9.881584	9.930220	10.069781	35
30	9.812544	9.881046	9.931499	10.058501	30
35	9.813283	9.880505	9.932778	10.057222	25
40	9.814019	9.879963	9.934056	10.065944	20
45	9.814753	9.879420	9.935333	10.054667	15
50	9.815485	9.878875	9.936611	10.063389	10
55	9.816215	9.878328	9.937887	10.062113	5
60	9.816943	9.877780	9.939163	10.060837	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

49.

41.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.816943	9.877780	9.939163	10.060837	60
5	9.817668	9.877230	9.940439	10.059561	55
10	9.818392	9.876678	9.941713	10.058287	50
15	9.819113	9.876125	9.942988	10.057012	45
20	9.819832	9.875571	9.944262	10.055738	40
25	9.820550	9.875014	9.945535	10.054465	35
30	9.821265	9.874456	9.946808	10.053192	30
35	9.821977	9.873896	9.948081	10.051919	25
40	9.822688	9.873335	9.949353	10.050647	20
45	9.823397	9.872772	9.950625	10.049375	15
50	9.824104	9.872208	9.951896	10.048104	10
55	9.824808	9.871641	9.953167	10.046833	5
60	9.825511	9.871073	9.954437	10.045563	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

48.

42.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.825511	9.871073	9.954437	10 045503	60
5	9 826211	9.870504	9.955708	10.044292	55
10	9.8269 0	9.869933	9.956977	10.043023	50
15	9.827606	9.859360	9.958247	10.041753	45
20	9.828301	9.868785	9.959516	10.040484	40
25	9.828993	9.868209	9.960784	10.039216	35
30	9.829683	9.867631	9 962052	10.037948	30
35	9.830372	9.867051	9.963320	10.036680	25
40	9.831058	9.866470	9.964588	10.035412	20
45	9.831742	9 865887	9.965855	10.034145	15
50	9.832425	9.865302	9.967123	10.032877	10
55	9.833105	9.864716	9.968389	10 031611	5
60	9.833783	9.864127	9.969656	10.030344	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

47.

43.

M	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.833783	9.864127	9.969656	10.030344	60
5	9.834460	9.863538	9.970922	10.029078	55
10	9.835134	9.862946	9.972188	10.027812	50
15	9 835807	9.862353	9 973454	10 026546	45
20	9.836477	9.861758	9.974720	10.025280	40
25	9.837146	9.861161	9.975985	10.024015	35
30	9.837812	9.860562	9.977250	10.022750	30
35	9.838477	9.859962	9.978515	10 021485	25
40	9.839140	9.859360	9.979780	10 020220	20
45	9.839800	9.858756	9.981044	10.018956	15
50	9.840459	9.858151	9.982309	10.017691	10
55	9.841116	9.857543	9 983573	10 016427	5
60	9 841771	9 856934	9.984837	10.015163	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

46.

The Table of Sines and Tangents.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.841771	9.856934	9 984837	10.015162	60
5	9.842424	9.856323	9 986101	10.013899	55
10	9.843076	9.855711	9 987365	10.012635	50
15	9.843725	9.855096	9 988629	10.011371	45
20	9.844372	9.854480	9 989893	10.010107	40
25	9 845018	9.853862	9.991156	10.008844	35
30	9.845662	9.853242	9.992420	10.007580	30
35	9.846304	9.852620	9.993683	10.006317	25
40	9.846944	9.851997	9.994947	10.005053	20
45	9.847582	9.851372	9.996210	10.003790	15
50	9.848218	9.850745	9.997473	10.002527	10
55	9.848852	9.850116	9.998737	10.001263	5
60	9.849485	9.849485	10.000000	10.000000	0
	Co-sine	SIN.	Co-Tang.	TAN.	M

A

TABLE

OF

Logarithm Numbers.

N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.000000	41	1.612784	81	1.908485	121	2.082785
2	0.301030	42	1.623249	82	1.913814	122	2.086359
3	0.477121	43	1.633468	83	1.919078	123	2.089905
4	0.602060	44	1.643452	84	1.924279	124	2.093422
5	0.698970	45	1.653212	85	1.929419	125	2.096910
6	0.778151	46	1.662758	86	1.934498	126	2.100371
7	0.845098	47	1.672098	87	1.939519	127	2.103804
8	0.903090	48	1.681241	88	1.944482	128	2.107209
9	0.954242	49	1.690196	89	1.949390	129	2.110589
10	1.000000	50	1.698970	90	1.954242	130	2.113943
11	1.041393	51	1.707570	91	1.959041	131	2.117271
12	1.079181	52	1.716003	92	1.963788	132	2.120574
13	1.113943	53	1.724276	93	1.968483	133	2.123852
14	1.146128	54	1.732394	94	1.973128	134	2.127105
15	1.176091	55	1.740362	95	1.977723	135	2.130334
16	1.204120	56	1.748188	96	1.982271	136	2.233539
17	1.230449	57	1.755875	97	1.986772	137	2.136721
18	1.255272	58	1.763428	98	1.991226	138	2.139879
19	1.278753	59	1.770852	99	1.995635	139	2.143015
20	1.301230	60	1.778151	100	2.000000	140	2.146128
21	1.322219	61	1.785330	101	2.004321	141	2.159219
22	1.342422	62	1.792391	102	2.008600	142	2.152288
23	1.361728	63	1.799340	103	2.012837	143	2.155336
24	1.380211	64	1.806180	104	2.017033	144	2.158362
25	1.397940	65	1.812913	105	2.021189	145	2.161368
26	1.414973	66	1.819544	106	2.025306	146	2.164353
27	1.431364	67	1.826075	107	2.029384	147	2.167317
28	1.447158	68	1.832509	108	2.033424	148	2.170262
29	1.462398	69	1.838849	109	2.037426	149	2.173186
30	1.477121	70	1.845098	110	2.041393	150	2.176091
31	1.491361	71	1.851258	111	2.045323	151	2.178977
32	1.505150	72	1.857332	112	2.049218	152	2.181844
33	1.518514	73	1.863323	113	2.053078	153	2.184691
34	1.531479	74	1.869232	114	2.056905	154	2.187521
35	1.544068	75	1.875061	115	2.060698	155	2.190332
36	1.556303	76	1.880813	116	2.064458	156	2.193125
37	1.568202	77	1.886491	117	2.068186	157	2.195899
38	1.579783	78	1.892094	118	2.071882	158	2.198657
39	1.591064	79	1.897627	119	2.075547	159	2.201397
40	1.602060	80	1.903090	120	2.079181	160	2.204110

N.	Log.	N	Log.	N.	Log.	N.	Log
161	2.206826	201	2.303196	241	2.382017	281	2.448706
162	2.209515	202	2.305351	242	2.383815	282	2.450249
163	2.212187	203	2.307496	243	2.385605	283	2.451786
164	2.214844	204	2.309630	244	2.387389	284	2.453318
165	2.217484	205	2.311754	245	2.389166	285	2.454845
166	2.220108	206	2.313867	246	2.390935	285	2.456366
167	2.222716	207	2.315970	247	2.392697	287	2.457889
168	2.225309	208	2.318063	248	2.394452	288	2.459392
169	2.227887	209	2.320146	249	2.396199	289	2.460898
170	2.230449	210	2.322219	250	2.397940	290	2.462398
171	2.232996	211	2.324282	251	2.399674	291	2.463893
172	2.235528	212	2.326336	252	2.401401	292	2.465383
173	2.238046	213	2.328379	253	2.403121	293	2.466868
174	2.240549	214	2.330414	254	2.404834	294	2.468347
175	2.243038	215	2.332438	255	2.406540	295	2.469822
176	2.245513	216	2.334454	256	2.408239	296	2.471292
177	2.247973	217	2.336459	257	2.409933	297	2.472756
178	2.250420	218	2.338456	258	2.411519	298	2.474216
179	2.252853	219	2.340444	259	2.413299	299	2.475671
180	2.255273	220	2.342422	260	2.414973	300	2.477121
181	2.257679	221	2.344392	261	2.416641	301	2.478566
182	2.260071	222	2.346353	262	2.418301	302	2.480007
183	2.262451	223	2.348305	263	2.419956	303	2.481443
184	2.264818	224	2.350248	264	2.421604	304	2.482874
185	2.267172	225	2.352183	265	2.423246	305	2.484299
186	2.269513	226	2.354108	266	2.424882	306	2.485721
187	2.271842	227	2.356026	267	2.426511	307	2.487138
188	2.274158	228	2.357935	268	2.428135	308	2.488551
189	2.276462	229	2.359835	269	2.429752	309	2.489958
190	2.278754	230	2.361728	270	2.421364	310	2.491362
191	2.281033	231	2.363612	271	2.432969	311	2.492760
192	2.283301	232	2.365488	272	2.434569	312	2.494155
193	2.285557	233	2.367356	273	2.436163	313	2.495544
194	2.287802	234	2.369216	274	2.337751	314	2.496929
195	2.290035	235	2.371068	275	2.439333	315	2.498311
196	2.292256	236	2.372912	276	2.440909	316	2.499687
197	2.294466	237	2.374748	277	2.442479	317	2.501059
198	2.296665	238	2.376577	278	2.444045	318	2.502427
199	2.298853	239	2.378398	279	2.445604	319	2.503791
200	2.301029	240	2.380211	280	2.447158	320	2.505149

N.	Log.	N.	Log.	N.	Log.	N.	Log.
321	2.506505	361	2.557507	401	2.603144	441	2.644439
322	2.507856	362	2.558709	402	2.604226	442	2.645422
323	2.509203	363	2.559907	403	2.605305	443	2.646404
324	2.510545	364	2.561101	404	2.606381	444	2.647383
325	2.511883	365	2.562293	405	2.607455	445	2.648360
326	2.513218	366	2.563481	406	2.608526	446	2.649335
327	2.514548	367	2.564666	407	2.609594	447	2.650308
328	2.515874	368	2.565848	408	2.610660	448	2.651278
329	2.517196	369	2.567026	409	2.611723	449	2.652246
330	2.518514	370	2.568202	410	2.612784	450	2.653213
331	2.519828	371	2.569374	411	2.613842	451	2.654177
332	2.521138	372	2.570543	412	2.614897	452	2.655138
333	2.522444	373	2.571709	413	2.615950	453	2.656098
334	2.523746	374	2.572872	414	2.617000	454	2.657056
335	2.525045	375	2.574031	415	2.618048	455	2.658011
336	2.526339	376	2.575188	416	2.619093	456	2.658965
337	2.527629	377	2.576341	417	2.620136	457	2.659916
338	2.528916	378	2.577492	418	2.621176	458	2.660865
339	2.530199	379	2.578639	419	2.622214	459	2.661813
340	2.531479	380	2.579784	420	2.623249	460	2.662758
341	2.532754	381	2.580925	421	2.624282	461	2.663701
342	2.534026	382	2.582063	422	2.625312	462	2.664642
343	2.535294	383	2.583199	423	2.626340	463	2.665581
344	2.536558	384	2.584331	424	2.627366	464	2.666518
345	2.537819	385	2.585461	425	2.628389	465	2.667453
346	2.539076	386	2.586587	426	2.629409	466	2.668386
347	2.540329	387	2.587711	427	2.630428	467	2.669317
348	2.541579	388	2.588832	428	2.631444	468	2.670246
349	2.542825	389	2.589949	429	2.632457	469	2.671173
350	2.544008	390	2.591065	430	2.633468	470	2.672098
351	2.545307	391	2.592177	431	2.634477	471	2.673021
352	2.546543	392	2.593286	432	2.635484	472	2.673942
353	2.547775	393	2.594393	433	2.636488	473	2.674861
354	2.549003	394	2.595496	434	2.637489	474	2.675778
355	2.550228	395	2.596597	435	3.638489	475	2.676694
356	2.551449	396	2.597695	436	2.639486	476	2.677607
357	2.552668	397	2.598790	437	2.640481	477	2.678518
358	2.553883	398	2.599883	438	2.641475	478	2.679428
359	2.555094	399	2.600973	439	2.642465	479	2.680336
360	2.556303	400	2.602059	440	2.643453	480	2.681241

N.	Log.	N.	Log	N.	Log.	N.	Log.
481	2.682145	521	2.716838	561	2.748963	601	2.778874
482	2.683047	522	2.717671	562	2.749736	602	2.779596
483	2.683947	523	2.718502	563	2.750508	603	2.780317
484	2.684845	524	2.719331	564	2.751279	604	2.781037
485	2.685742	525	2.720159	565	2.752048	605	2.781755
486	2.686636	526	2.720985	566	2.752816	606	2.782473
487	2.687529	527	2.721811	567	2.753583	607	2.783189
488	2.688419	528	2.722634	568	2.754348	608	2.783904
489	2.689309	529	2.723456	569	2.755112	609	2.784617
490	2.690196	530	2.724276	570	2.755875	610	2.785329
491	2.691081	531	2.725095	571	2.756636	611	2.786041
492	2.691965	532	2.725912	572	2.757396	612	2.786751
493	2.692847	533	2.726727	573	2.758155	613	2.787460
494	2.693727	534	2.727541	574	2.758912	614	2.788164
495	2.694605	535	2.728354	575	2.759568	615	2.788875
496	2.695482	536	2.729165	576	2.760422	616	2.789581
497	2.696356	537	2.729974	577	2.761176	617	2.790285
498	2.697229	538	2.730782	578	2.761928	618	2.790988
499	2.698101	539	2.731589	579	2.762679	619	2.791691
500	2.698970	540	2.732394	580	2.763428	620	2.792392
501	2.699838	541	2.733197	581	2.764176	621	2.793092
502	2.700704	542	2.733999	582	2.764923	622	2.793791
503	2.701568	543	2.734799	583	2.765669	623	2.794488
504	2.702430	544	2.735599	584	2.766413	624	2.795185
505	2.703291	545	2.736397	585	2.767156	625	2.795880
506	2.704151	546	2.737192	586	2.767898	626	2.796574
507	2.705008	547	2.737987	587	2.768638	627	2.797268
508	2.705863	548	2.738781	588	2.769377	628	2.797959
509	2.706718	549	2.739572	589	2.770115	629	2.798651
510	2.707570	550	2.740363	590	2.770852	630	2.799341
511	2.708421	551	2.741152	591	2.771587	631	2.800029
512	2.709269	552	2.741939	592	2.772322	632	2.800717
513	2.710117	553	2.742725	593	2.773055	633	2.801404
514	2.710963	554	2.743509	594	2.773786	634	2.802089
515	2.711807	555	2.744293	595	2.774517	635	2.802774
516	2.712649	556	2.745075	596	2.775246	636	2.803457
517	2.713491	557	2.745855	597	2.775974	637	2.804139
518	2.714329	558	2.746634	598	2.776701	638	2.804821
519	2.715167	559	2.747412	599	2.777427	639	2.805501
520	2.716003	560	2.748188	600	2.778151	640	2.806179

N.	Log.	N.	Log.	N.	Log.	N.	Log.
641	2.806858	681	2.833147	721	2.857935	761	2.881385
642	2.807535	682	2.833784	722	2.858537	762	2.881955
643	2.808211	683	2.834421	723	2.859138	763	2.882525
644	2.808886	684	2.835056	724	2.859739	764	2.883093
645	2.809559	685	2.835691	725	2.860338	765	2.883661
646	2.810233	686	2.836324	726	2.860937	766	2.884229
647	2.810904	687	2.836957	727	2.861534	767	2 884795
648	2.811575	688	2.837588	728	2.862131	768	2.885361
649	2.812245	689	2.838219	729	2.862728	769	2.885926
650	2.812913	690	2.838849	730	2.863323	770	2.886491
651	2.813581	691	2 839478	731	2.863917	771	2.887054
652	2.814248	692	2.840106	732	2.864511	772	2.887617
653	2.814913	693	2.840733	733	2.865104	773	2.888179
654	2.815578	694	2.841359	734	2.865696	774	2 888741
655	2.816241	695	2.841985	735	2.866287	775	2.889302
656	2.816904	696	2.842609	736	2.866878	776	2.889862
657	2.817565	697	2.843233	737	2.867467	777	2.890421
658	2.818226	698	2.843855	738	2.868056	778	2.890979
659	2.818885	699	2.844477	739	2.868643	779	2.891537
660	2.819543	700	2.845098	740	2.869232	780	2.892095
661	2.820201	701	2.845718	741	2.869818	781	2.892651
662	2.820858	702	2.846337	742	2.870404	782	2.893207
663	2.821514	703	2.846955	743	2.870989	783	2.893762
664	2.822168	704	2.847573	744	2.871573	784	2.894316
665	2.822822	705	2.848189	745	2.872156	785	2.894869
666	2.823474	706	2.848805	746	2.872739	786	2.895423
667	2.824126	707	2.849419	747	2.873321	787	2.895975
668	2.824776	708	2.850033	748	2.873902	788	2.896526
669	2.825426	709	2.850646	749	2.874482	789	2.897077
670	2 826075	710	2.851258	750	2.875061	790	2 897627
671	2.826723	711	2.851859	751	2.875639	791	2.898176
672	2.827369	712	2.852479	752	2.876218	792	2.898725
673	2.828015	713	2.853089	753	2.876795	793	2.899273
674	2.828659	714	2.853698	754	2.877371	794	2.899821
675	2.829304	715	2.854306	755	2.877947	795	2.900367
676	2.829947	716	2.854913	756	2.878522	796	2.900913
677	2.830589	717	2 855519	757	2.879096	797	2 901458
678	2.830229	718	2.856124	758	2.879669	798	2.902003
679	2.832869	719	2.856729	759	2.880242	799	2 902547
680	2.832509	720	2.857332	760	2.880814	800	2.903089

N.	Log.	N.	Log.	N.	Log.	N.	Log.
801	2.903633	841	2.924756	881	2.944976	921	2.964259
802	2.904174	842	2.925312	882	2.945468	922	2.964731
803	2.904716	843	2.925828	883	2.945951	923	2.965202
804	2.905256	844	2.926342	884	2.946452	924	2.965672
805	2.905795	845	2.926857	885	1.946943	925	2.966142
806	2.906335	846	2.927370	886	2.947434	926	2.966611
807	2.906874	847	2.927883	887	2.947924	927	2.967079
808	2.907411	848	2.928396	888	2.948413	928	2.967548
809	2.907949	849	2.928908	889	2.948902	929	2.968016
810	2.908485	850	2.929419	890	2.949390	930	2.968483
811	2.909021	851	2.929929	891	2.940878	931	2.968949
812	2.909556	852	2.930439	892	2.950365	932	2.969416
813	2.910091	853	2.930949	893	2.950851	933	2.969882
814	2.910624	854	2.931458	894	2.951338	934	2.970347
815	2.911158	855	2.931966	895	2.951823	935	2.970812
816	2.911690	856	2.932474	896	2.952308	936	2.971276
817	2.912222	857	2.932981	897	2.952792	937	2.971739
818	2.912753	858	2.933487	898	2.953276	938	2.972203
819	2.913284	859	2.933993	899	2.953759	939	2.972656
820	2.913814	860	2.934498	900	2.954243	940	2.973128
821	2.914343	861	2.935003	901	2.954725	941	2.973589
822	2.914872	862	2.935507	902	2.955207	942	2.974050
823	2.915399	863	2.936011	903	2.955688	943	2.974512
824	2.915927	864	2.936514	904	2.956168	944	2.974972
825	2.916454	865	2.937016	905	2.956649	945	2.975432
826	2.916980	866	2.937518	906	2.957128	946	2.975891
827	2.917505	867	2.938019	907	2.957607	947	2.976349
828	2.918030	868	2.998519	908	2.958085	948	2.976808
829	2.918555	869	2.939019	909	2.958564	949	2.977266
830	2.819078	870	2.939519	910	2.959041	950	2.977724
831	2.919601	871	2.940018	911	2.959518	951	2.978181
832	2.920123	872	2.940516	912	2.959995	952	2.978637
833	2.920645	873	2.941014	913	2.960471	953	2.979093
834	2.921166	874	2.941511	914	2.960946	954	2.979548
835	2.921686	875	2.942008	915	2.961401	955	2.980003
836	2.922206	876	2.942504	916	2.961895	956	2.980458
837	2.922725	877	2.942999	917	2.962369	957	2.980912
838	2.923244	878	2.943495	918	2.962840	958	2.981366
839	2.923762	879	2.943989	919	2.963315	959	2.981819
840	2.924279	880	2.944483	920	2.963788	960	2.982271

N.	Log.	N.	Log.	N.	Log.	N.	Log.
961	2.982723	971	2.987219	981	2.991669	991	2.996074
962	2.983175	972	2.987666	982	2.992111	992	2.996512
963	2.983626	973	2.988113	983	2.992554	993	2.996949
964	2.984077	974	2.988559	984	2.992995	994	2.997386
965	2.984527	975	2.989005	985	2.993436	995	2.997823
966	2.984977	976	2.989449	986	2.993877	996	2.998259
967	2.985426	977	2.989895	987	2.994317	997	2.998695
968	2.985875	978	2.990339	988	2.994756	998	2.999133
969	2.986324	979	2.990783	989	2.995196	999	2.999565
960	2.988772	980	2.991226	990	2.995635	1000	3.000000

The uſe of theſe Tables hath been already at large ſhewed in the Firſt and Twelfth Chapters; therefore I ſhall ſay no more of them here.

FINIS.

How to make a Good Shining white Marbel

Take 4 Ounces of Cremortartor
—— 2 D°. of Lapis Calminalis
—— 1 D°. of Mastick
—— 1 D°. of Sandrick

to be pounded & to be Mix. in a Quart of Spirits of turpentine in a Bottle

To Make a Shining black Marbel

Take 4 Ounces of Antimoni
4 D°. of Arabek
2 D°. of Sal-Armonik

in 2 Quarts of Spirits of turpentine as above

How to make the Gold Lacker

Take 1 Ounce of Spanish orro Votto
½ D°. of Shel-Lack
¼ D°. of Dragons blood

in a half pint of Spirits of wine to be Mix. in a bottle Cold.

List of Graves kept in Order by E Harris & Son

Mr N Syod	2	Mr Yates	3
Mrs Coleman	3	Mrs Merriman	4
Mr J Gibson	4	Mr Phipps	1
Mr Hancock	1	Mrs Green	1
Mr Lane	1	Mrs R Hands	1
Mrs W Warner	2	Mr Simmonds	2
Miss Haines	1	Mr G Elborn	3
Mr Benfield	1	Miss Eden	2
Miss Makepeace	2	Mr Grinder	1
Mrs Hands	1		

16 : 34 — If the Superficiall Content of a piece of [illegible]
2 : 02 that hath its 4 Sides Equall Contain [illegible]
1268 ry worth £ 25-10-
42680 I Say that a piece of Land of the
128068 same Sort in a Circle whose Circum.
12272 is Equal to ye Sum of ye 4 Sides
90880 is worth £ 32 .. 8 .. 7¼

634 hath Circum.ce
201 half Diam.
634
12680
127434
127736
89440

317/4
1268
7
22) 8876 (403
201
76
10

160 :: 510 :: 203
510
2030
1015
160) 103530 (647
96
75
64
113
112
18
12
160) 120 (0
4
160) 480 (3
0