	ye. aft. Chriſt.
Epiphanes.	
Theodoſius Emperor, ——	379
Zozimus, *St. Auſtin.*	
Honorius Emperor of Rome, ——	396
Rome taken by the Goths, —	410
The monarchy of *France* founded,	420
Venice built, — —	421
Valentinian III. Emperor, —	425
Theodoret.	
Auguſtulus, the laſt Emperor of Rome,	476
Arthur king of Britain, — —	516
Juſtinian Emperor, — —	527
The Chriſtian æra begun to reckon by,	532
The ſeat of the empire removed to *Conſtantinople*, — ——	550
Procopius.	
Tiberius II. Emperor, — —	575
Mahomet's flight to Medina, —	622
Damaſcus and *Jeruſalem* taken by the Saracens,	636
Conſtantius Emperor, — —	699
Ven. *Bede.*	
Juſtinian II. Emperor, but expelled after,	686
Theodoſius III. Emperor, — —	714
The *Spaniards* defeat the Moors at Tours,	716
Pepin king of France.	
Charles the great, king of France,	767
Alphonſus king of Spain, who freed it from the tribute of 100 virgins, —	793
Charlemaign Emperor of Rome, —	800
Egbert firſt ſole monarch of England,	819
Ethelwolf king of England, —	837
Alfred, king of England, founds the univerſity of Oxford, — —	874
The *Normans* ſettle in Normandy, —	884
Eudo king of France drives out the Normans,	889
Lewis IV. Emperor, the pope ſets up another,	900

	ye. aft. Chriſt.
Alexander, Emperor of the Eaſt, ——	911
Athelſton king of England,	924
Otho the great, Emperor of the Weſt,	938
J. Zimiſca, Emperor of the Eaſt,	969
Otho II. Emperor of the Weſt,	973
Edward (the martyr) king of England,	975
The *Danes* invade England and are beaten,	1002
Henry (duke of Saxony) choſen Emperor,	1008
Edmund (Ironſide) king of England,	1016
Guido Aretinus, invents the notes of muſic,	1022
Herald the Dane, king of England,	1036
Edward (the Confeſſor) king of England,	1042
Harrold uſurps the crown of England,	1066
William the conqueror king of England,	1066
The *Turks* conquer Perſia, take Jeruſalem, &c. — — —	1070
The holy war againſt the Turks, —	1096
Jeruſalem regained from the Turks,	1099
Henry V. Emperor of Germany,	1106
J. Comnenus, Emperor of Greece, —	1118
E. Comnenus, Emperor at Conſtantinople,	1143
Henry II. king of England, — —	1154
Saladine, ſultan of the Turks, —	1170
London bridge built of ſtone, — —	1187
Jeruſalem retaken by the Turks,	1187
Richard I. king of England, —	1189
Henry VI. Emperor of Germany, —	1190
Baronius.	
John, king of England, and granted Magna Charta, — — —	1199
Henry III. king of England, — —	1216
The inquiſition firſt erected againſt the *Albagenſes*, — — —	1222
Frederic, Emperor of Germany, recovers Jeruſalem, — —	1229
Henry III. confirms Magna Charta, —	1253

Richard

	ye. aft. Chriſt.
Richard (brother to king Henry) Emperor,	1256
The *Barons* take king Henry priſoner, for breaking Magna Charta, — —	1258
M. Paleologus regains Conſtantinople,	1260
Ottoman the founder of the preſent Turkiſh Empire, — —	1297
The *Mariner's* compaſs found out,	1302
The oppoſers of the Romiſh ſuperſtition burnt at *Auſtria*, — —	1315
Edward III. king of England, beat the French, and took the French king priſoner, — — —	1327
A. Peleologus III, Emperor at Conſtantinople,	1326
Gunpowder invented in *Germany*,	1344
Charles IV. (K. Bohemia) Emperor of Germany, — — —	1347
The *Turks* take Adrianople, —	1359
Richard II. king of England, —	1377
Tamerlane the Tartar reigns, — —	1387
Bajazet the Turk reigns, — —	1388
Tamerlane defeats Bajazet, conquers Babylon, Perſia, China, India, —	1399
The great *Mogul* deſcended from him.	
Richard II. depoſed, — —	1399
Henry IV. king of England, the firſt of the line of Lancaſter, — —	1399
Civil wars in *Germany*, — —	1404
Sigiſmond (king of Hungary) Emperor,	1410
Henry V. king of England, — —	1413
——Beats the French at the battle of Agincourt, — —	1415
Henry VI. king of England, —	1422
J. Huniades, Emperor of Conſtantinople,	1442
The Art of Printing invented, —	1449
Mahomet II. ſultan of the Turks, takes Conſtantinople, — — —	1453

The

	ye. aft. Chriſt.
The *Turks* conquer *Peloponneſus* or *Morea*,	1459
Henry VI. depoſed, and *Edward* IV. made king, — — —	1460
Edward V. king of England, —	1483
Richard III. king of England, —	1483
Henry VII. king of England, —	1485
C. Columbus (a Genoeſe) diſcovered America,	1493
Americus Veſpaſius diſcovers South America,	1497
Henry VIII. king of England, —	1509
M. Luther begins the Reformation,	1517
Boetius, Eraſmus, Copernicus.	
Solyman Emperor of the Turks, —	1520
Belgrade taken by the Turks, — —	1521
The Streights of *Magellan* diſcovered by *F. Magellan*, — —	1521
The Council of *Trent*, — —	1540
Edward VI. king of England, —	1547
Mary, queen of England, reſtores Popery,	1553
Eliſabeth, queen of England, reſtores the Reformation, — —	1558
Charles IX. king of France, ——	1560
The Maſſacre of the Proteſtants at *Paris*,	1572
Mercator.	
The *Venetians* defeat the Turks at ſea,	1572
Henry III. king of France, —	1574
Rodulphus II. Emperor, — —	1576
The holy League in *France*, — —	1576
Holland revolts from Spain, —	1579
Sir *Francis Drake* ſails round the Globe,	1580
Tycho Brahe, Scaliger.	
Pope *Gregory* XIII. corrects the Calendar,	1582
Mary queen of Scots beheaded, —	1587
The *Spaniſh Armado* deſtroyed by the Engliſh	1588
Henry III. of France, ſtabbed by Clement, a friar, —— —	1589
Philip III. king of Spain, — —	1598

Vieta

	ye. aft. Chriſt.
Vieta.	
James I. king of England, —	1603
Gunpowder Plot, — —	1605
Henry IV. of France ſtabb'd by Ravillac,	1610
Lewis XIII. king of France, —	1610
Guſtavus Adolphus, king of Sweden,	1611
The *New River* brought to London,	1614
Frederic II. Emperor, — —	1619
Des Cartes.	
Philip IV. king of Spain, — —	1621
Charles I. king of England, —	1625
G. Adolphus ſlain in battle, —	1632
Ferdinand III. Emperor, — —	1637
Portugal revolts from Spain, —	1640
Lewis XIV. king of France, —	1643
King *Charles* I. beheaded, — —	1649
Oliver Cromwell died, —	1658
King *Charles* II. reſtored, —	1660
The great Plague at *London*, —	1665
London burnt down, — —	1666
Ricciolus.	
Peace concluded with the *Dutch*,	1674
St. *Paul's* church begun to rebuild, —	1675
The *Czar of Muſcovy* dies, and his ſons rule jointly, — —	1682
The Emperor at war with the *Turks*,	1682
The *Turks* defeated before Vienna,	1683
The great Froſt,	1684
King *Charles* II. died, and is ſucceeded by James II. — —	1685
James II. depoſed, — — —	1688
William and *Mary* king and queen of England, — — —	1689
The battle of *Boyne* in Ireland, —	1690
An Earthquake in England,	1692
Queen *Mary* died, — — —	1694

Queen

	ye. aft. Chriſt.
Queen *Anne* came in, — —	1702
Battle of *Blenheim*, — —	1704
Battle of *Ramalies*, — —	1706
England and *Scotland* united, — —	1707
St. *Paul's* church finiſhed,	1708
Queen Anne died, — —	1714
George I. king, — — —	1714.
A total eclipſe of the ſun at London, April 22d, — —	1715
Rebellion at *Preſton*, — —	1715
The *Aurora Borealis* firſt obſerved,	1716
The *Spaniſh* fleet deſtroyed near Sicily,	1718
Sir *I. Newton* died, — —	1727
George II. king, — — —	1727
A great Froſt 1739, and — —	1740
Battle of *Dettingen*, — —	1743
A bright Comet, in the ſpring, —	1744
Rebellion at *Culloden*, — —	1746
Correction of the Calendar in *England*,	1752
George III. king, — —	1760
Peace with *France* and Spain, — —	1763

FINIS.

CALCULATION,

LIBRATION,

AND

MENSURATION;

Or the ARTS of

RECKONING, WEIGHING, AND MEASURING.

BEING A

MECHANICAL WORK,

ADAPTED

To the Buſineſs and Practice of TRADESMEN and ARTIFICERS, in the ſhorteſt Method poſſible; and deſigned purely for common Uſe.

Pondere, menſura, et numero, Deus omnia fecit.

LONDON:
Printed for J. NOURSE, in the Strand;
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MDCCLXX.

THE PREFACE.

I Believe there never was a courſe of the Mathematicks printed, but what included the practical parts thereof, and ſuch things as are of conſtant and daily uſe among mankind. Therefore, leſt ours ſhould appear defective in this point, we ſhall comply with this cuſtom; and to oblige the lower ſort of readers (for every one is not deſtined to ſtudy the ſublime parts of the Mathematicks) I have compoſed the following Treatiſe.

In the firſt part I have put together a great number of ru for the reckoning up of ſuch things as commonly occur in trade and buſineſs; wherein I have endeavoured to ſuit the capacities of the loweſt claſs of tradeſmen and artificers, by laying down ſuch ſhort rules, for computing the values of things, as may with eaſe be retained in the memory, are readily and eaſily wrought, or rather performed in the mind, which are to be uſed as occaſion offers; and therefore muſt be very ſerviceable to ſuch as never had an opportunity of learning Arithmetic. And even to ſuch people as underſtand numbers, theſe rules will ſave them ſo much trouble and time. For men cannot always allow time to ſit down and compute every trifling matter, which may be done at once by this way of reckoning. For few of theſe rules need the uſe of Arithmetic; and thoſe that do require but an eaſy calculation. But where there is any danger of making miſtakes, it is proper, for thoſe that underſtand it, to uſe a little Arithmetic. And that no doubt or obſcurity may ap-

pear in theſe rules, I have given examples thereof, in the common caſes of trade; ſo that the meaneſt reader cannot be at a loſs for underſtanding them. And before this part, the common definitions are prefixt, alſo an account of weights and meaſures, tables of ſpecific gravity, the practice of workmen in meaſuring their work, and ſuch other things as are uſeful in a Treatiſe of this kind.

In the ſecond part are delivered ſuch common problems, as are requiſite in the art of Meaſuring, being ſuch as are introductory to what is to follow. Here we treat of the meaſuring of lines; and how, by having one line in a figure given, to find another. To this part is prefixt the deſcription and uſe of the ſliding rule, an inſtrument of great diſpatch in the art of meaſuring.

The third part teaches how to meaſure the areas of plane figures, and the ſurfaces of ſolids, and this both arithmetically with the pen, and inſtrumentally with the ſliding rule. In this part it is alſo ſhewn, how theſe fixt numbers are found, which are made uſe of in the different methods of finding the area of the circle, by the ſliding rule.

In part the fourth, we have the menſuration of ſolids, eſpecially the moſt common; and particularly the meaſuring of timber; and this both by Arithmetic with the pen, and alſo by the ſliding rule, when not too troubleſome. In this part it is alſo ſhewn how all the fixt numbers are found, which are made uſe of on the ſliding rule, for meaſuring cylinders and ſpheres.

The fifth and laſt part is gauging, contained in a narrow compaſs. Here it is ſhewn how to find the areas of plain figures, and the contents of ſolids, according to the common method of gauging; that is in ale or wine gallons, inſtead of inches or feet. How to inch any tun; and a general rule for gauging all caſks; and how to find the ullage; alſo how to gauge malt. To this part is prefixt a ſhort account of the

ſliding

ſliding rule adapted to this buſineſs; an inſtrument which very much ſhortens all calculations in gauging. And in this part is ſhewn likewiſe, how to find the fixt numbers and gauge points, made uſe of on the rule, and how to work with them. In all theſe articles are given proper examples, to make the rules plain, which are wrought in the ſhorteſt method, both by the pen, and alſo with the ſliding rule, when it can conveniently be done.

I have given no demonſtrations here, of any of theſe rules; for the practical Mechanic does not want them, and a mathematical reader may have them elſewhere, as in the Geometry, Conic Sections, Algebra, &c.

There is no ſtate of life which does not require the uſe of ſome ſort of meaſures, either in length or capacity, dry or liquid; on theſe moſt trades depend, whether it be thoſe that procure food for us, or thoſe that furniſh us cloathing. Menſuration is the ground of all arts, and of all things depending on trade, without which they could not ſubſiſt.

In meaſuring and gauging, the practitioner muſt underſtand common Arithmetic, without which theſe rules cannot be put in practice; and alſo decimals, as all ſorts of computations are eaſieſt made thereby; and particularly contractions in multiplication and diviſion, which often ſave long calculations. Tho' in ſuch caſes, I would adviſe to make uſe of logarithms, which in moſt caſes will be ſhorter.

As geometrical rules are made uſe of for ſuch purpoſes as require calculations to be made to the utmoſt exactneſs; ſo the ſhort rules in this Treatiſe, are moſt of them only approximations, being contrived to compute, or meaſure things for common uſe with expedition, and which require not that degree of exactneſs. They are adapted for preſent extemporary buſineſs, and for ſuch things as require to be done off hand.

When any plane figure or ſolid body is propoſed to be meaſured, we have no rule to determine it to be any particular geometrical figure or ſolid, but by gueſs. And therefore it is to be looked on as a mechanical figure or ſolid; and muſt be meaſured by ſome ſhort mechanical rule, ſuch as ſuits it, and its ſhortneſs will make amends for other defects. For by ſuch a rule the content may be found as truly, as the dimenſions can be taken, and that is ſufficient. And all ſuch rules muſt be eſteemed good rules; when they come very near, at a medium; as if in one caſe they give a ſmall matter too much, and in another caſe a ſmall matter ſhort of the truth, we may admit them as true rules; ſince the figure we meaſure may not have that geometrical exactneſs that we ſuppoſe; and it is mere chance if it has.

W. Emerſon.

Marks and Abbreviations.

+ to be added.
— to be ſubſtracted.
× to be multiplied by.
÷ to be divided by.
√ the ſquare root of.
a^2 the ſquare of *a*.
a^3 the cube of *a*, &c.
= is equal to.
a : *b* : : *c* : *d*, as *a* to *b*, ſo is *c* to *d*.
AG, ale gallons.
WG, wine gallons.
MB, malt buſhels.
GP, gauge point.

Calcu-

Calculation, Libration, &c.

DEFINITIONS.

1. *COMPUTATION* or Numbering is the Art of Reckoning; which is ſometimes performed barely by the memory; but generally by the help of theſe figures, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

2. *Libration* is the Art of Weighing any ſort of bodies. This is performed by ſome proper inſtrument, as a pair of ſcales, a ſteelyard, &c. and by the help of certain fixt weights, agreed on to be the ſtandard, for weighing all other things by.

3. *Menſuration* is a mechanical art, teaching how to find the content of any ſurface, or ſolid body, from the dimenſions thereof, taken by actually meaſuring them. The content of any ſurface is commonly called the *Area* of it.

4. *A Line* is the length or diſtance between any two points; and this length is eſtimated by the number it contains, of ſome known meaſure, as yards, feet, inches, &c.

5. *A Superficies* is that which hath length and breadth, and its quantity is meaſured by the number of ſquares it contains, whoſe ſides are lineal units, of that meaſure it is meaſured by.

6. *A Solid* is that which hath three dimenſions, length, breadth, and thickneſs. And its content is eſtimated by the number of cubes it contains, whoſe ſides are linear units of that ſort of meaſure it is meaſured by.

7. *A right Angle* is that made by one line DC ſtanding upright upon another BA, ſo that CD 14.

Fig. lean no more to one ſide than to another; thus CDA is a right angle, and alſo CDB. If CD is not upright, it is an *oblique angle*; an *acute angle* is leſs, and an *obtuſe* one greater, than a right angle.

1. 8. *Parallel lines* are thoſe that are every where equidiſtant, as AB and CD.

14. 9. *A Perpendicular*, is a line which ſtands at right
15. angles upon a line or a plane, and inclines to no ſide. This is the neareſt diſtance from any point to a line or a plane, as CD.

14. 10. *A Triangle* is a figure contained under three
15. right lines. If one angle be right, it is a *right angled triangle.*

16. 11. *A Square* is a figure contained by 4 equal ſtreight lines and 4 right angles, as ABCD.

17. 12. *A Parallelogram* is a figure contained by
18. four right lines, ſo that the oppoſite be equal and parallel.

18. 13. *A Trapezoid* is a four ſided figure, whereof ſome two oppoſite ones are parallel, as ABCD.

19. 14. *A Trapezium* is any figure included by four lines, as ABCD. A line drawn thro' the oppoſite angles is called a *Diagonal*, as AC.

21. 15. *A Polygon* is a figure conſiſting of any num-
22. ber of ſides. If all the ſides and angles are equal, it is a *regular Polygon*; if it have three ſides, it is called an *equilateral Triangle*; if four, a *Square*; if five, a *Pentagon*; if ſix, a *Hexagon*, &c.

23. 16. *A Circle* is a figure bounded by the curve line ABCD, called the Circumference, in which all lines drawn from the *Center* C to the circumference are equal. Any line AD paſſing thro' the center C is called a *Diameter*; and any line CD, drawn from the center C to the circumference, is called the *Radius.* Any right line drawn through it is called a *Chord.*

17.

17. *A Cube* is a ſolid contained under 6 equal ſquares ſtanding at right angles to one another; like a die. Fig. 38.

18. *A Parallelepipedon* is a ſolid contained under 6 planes, whereof every two oppoſite ones are parallel. 40.

19. *A Priſm* is a ſolid whoſe two ends are equal and like, and parallel to one another. 41. 42.

20. *A Cylinder* is a ſolid whoſe ends are two equal circles, parallel to one another. 39.

21. *A Pyramid* is a ſolid whoſe baſe is any plane figure, and the ſides all triangles meeting in a point called the Vertex, as D. 44.

22. *A Cone* is a ſolid ABC contained between a circular baſe, and a convex ſurface ending in a point A called the Vertex. 43.

23. *A Poliedron* is a ſolid contained under ſeveral planes, if all the planes be any regular poligon, it is called a *regular body*, of which there are but five. 1. The *Tetraedron*, has four faces equilateral triangles. 2. The *Cube* has ſix ſquares. 3. The *Octaedron*, 8 triangles. 4. The *Dodecaedron*, 12 pentagons. 5. The *Icoſaedron*, 20 triangles.

24. *A Sphere* ABCD, is a ſolid contained under one curve ſurface; within which there is a point called the *Center*, from which all lines drawn to the ſurface are equal, and called the *Radius*. Any line paſſing thro' the center is a *diameter*. 33.

25. *A Segment* is any part of a figure or ſolid cut off by a line or a plane.

26. *A Fruſtum* is the thick end of a ſolid cut off by a plane parallel to the baſe.

27. *Vaults* are curved arches, that ſpring from the oppoſite ſide walls; and meet in a right line over the middle of the building. If they meet in an angle, they are called Gothic arches. The arches of a bridge are in this form.

28. *Dome's*

28. *Dome's* or *Cupolo's* are arched roofs that meet in a point at the top; the baſe being a circle or poligon.

29. *A Saloon* is a flat roof or cieling, joined to the ſide walls by arches.

30. *A Groin* is when a vaulted roof is interſected by ſome other vaults.

31. *A Meaſure* is a certain length made uſe of to meaſure another greater length by, in order to know how many of theſe the greater contains. When a length is to be meaſured, it is meaſured by a line, and is called *lineal meaſure*. When a ſurface is to be meaſured, it is done by the ſquare of that line, and is called *ſuperficial meaſure*. If a ſolid is to be meaſured, the meaſure is the cube of that lineal meaſure, and then it is called *ſolid meaſure*. Thus a foot in length meaſures any other length; and a ſquare foot, any ſurface; and a cube foot any ſolid; and ſhews how many feet each contains. And the like for inches, yards, &c.

In meaſuring any ſurface or ſolid, all the dimenſions muſt be taken in one and the ſame kind of meaſure, except it be otherwiſe expreſſed.

A Table of Numbers.

12 Units	make	a Dozen,
12 Dozen		a Groſs,
20 Units		a Score,
5 Score		a ſhort Hundred (℔)
6 Score		a long Hundred (C)
10 Hundred		a Thouſand (M)

A Table of Money.

4 Farthings		1 Penny (d)
2 Pence		1 Groat,
12 Pence		1 Shilling (s)
5 Shillings		1 Crown,
6 Shil. 8 d.	make	1 Noble,
10 Shillings		1 Angel,
13 Shill: 4 d.		1 Mark,
20 Shillings		1 Pound (l)
21 Shillings		1 Guinea.

A Table of Time.

60 Seconds (″)		1 Minute (′)
60 Minutes		1 Hour,
24 Hours		1 Day natural,
7 Days	make	1 Week,
4 Weeks		1 Month,
$365\frac{1}{4}$ Days		1 Year.

Goods ſold by the Dozen are,

Buttons, candles, hats, ſtockings, lint, bottles, bruſhes, China ware, pigeons, apricots, and peaches.

Goods ſold by the Groſs are,

Buttons, beads, tobacco-pipes, combs, comb-caſes, playing cards, knives, thread, ſilk hair, tobacco-boxes, buckles, ink-horns, bodkins, pepper-boxes, tinder-boxes, waſh-balls, and ſpectacle-caſes.

Goods ſold by the Score are,

Paper, walking-ſticks, marbles.

Goods ſold by the ſhort Hundred are,

Capers, thrums, ginger, cloves, indigo, packthread, quick-ſilver, cotton-wool, braſs and tin-work,

work, ſeveral ſorts of ſkins, braſs and tin implements.

Goods ſold by the long Hundred are,

Herring, ling, cod, and all ſtock-fiſh, balks, clap-boards, nails, fiſh-hooks, pipe-ſtaves, bow-ſtaves, deals, ſpurs, outlandiſh cloth, lamb-ſkins, ſeveral ſorts of outlandiſh cloth, and eggs.

Goods ſold by the Thouſand are,

Paſte-boards, tennis-balls, lemons, oranges, boards, quills, teazles, tiles, bricks, tacks, tenter-hooks, thimbles, pins and needles, billets, lanthorn-horns, barrel-hoops, ox-horns, ſquirrel-ſkins, ſlates, &c.

Standard gold is 11^{oz} fine, and 1^{oz} alloy.

Standard ſilver is 11^{oz} 2^{dw} fine, and 18^{dw} alloy.

A pennyweight of gold coin is worth 3 s. $10d\frac{1}{2}$, which is near 2 d. a grain.

$44\frac{1}{2}$ Guineas make 1 pound Troy; and 1 guinea, 129 grains.

An ounce of ſilver with alloy is worth 5 ſhillings.

An ounce of gold is worth 3 l. 18 s.

22 Pence in copper is about 1 l. Averdupoiſe.

A Table of Averdupoiſe weight.

16 Drams		1 Ounce (oz)
16 Ounces		1 Pound (lb)
14 Pounds	make	1 Stone (St)
8 Stone		1 Hundred weight (C)
20 Hundred		1 Tun. (T)

8 lb make a ſtone among the London butchers.

A Table

A Table of Troy Weight.

20 Mites			1 grain, (gr)
24 Grains			1 Penny weight, (dw)
32 gr. Wheat	}	make	1 Penny weight,
20 Penny weight			1 Ounce, (oz)
12 Ounces			1 Pound. (lb)

The Apothecaries divide the Troy ounce thus, 20 grains make a ſcruple (℈), 3 ſcruples a dram (ʒ), 8 drams an ounce (℥).

By Averdupoiſe weight, is weighed mercery ware, and groceries, and all things that can waſte, as pitch, tar, roſin, wax, tallow, flax, hemp, fleſh, butter, cheeſe, ſalt, candles, ſoap, ſtarch, ſpices, coffee, tea, chocolate, ſilk, bread in the country, and ſometimes oil; alſo copper, tin, iron, ſteal, lead, &c.

By Troy weight is weighed gold, ſilver, jewels, amber, apothecaries drugs, bread, liquors, precious ſtones.

Weights compared.

The Averdupoiſe pound is 7000 grains, the Troy pound 5760 grains.

The Averdupoiſe ounce is 437½ grains, the Troy ounce 480 grains.

The Troy pound is to the Averdupoiſe pound, as 5 to 11, or rather, as 14 to 17.

The Averdupoiſe ounce is to the Troy ounce, as 73 to 80, or more exactly, as 73 to 80.

The London pound is to the *Paris* pound, as 100 to 109.

The Troy ounce is to the *Paris* ounce, as 64 to 63.

And the Averdupoiſe ounce is to the *Paris* ounce, as 63 to 68.

A Table

A Table of long Meaſures.

12 Lines	make	1 Inch,
3 Barley corns		1 Inch,
12 Inches		1 Foot,
3 Feet		1 Yard,
5 Feet		1 Pace,
2 Yards		1 Fathom,
$5\frac{1}{2}$ Yards		1 Pole or Rod,
4 Poles, 100 links		1 Chain,
40 Poles		1 Furlong,
8 Furlongs		1 Mile,
$69\frac{1}{2}$ Miles		1 Degree on the earth.

Alſo 1 finger or thumb is an inch; 4 inches a hand; 9 inches a ſpan; 2 ſpans a cubit; 5 ſpans an ell; 16 nails a yard; 7 yards 1 rod in the north; a geographical mile 2030 yards; the *Engliſh*, *French* and *Swediſh* feet are to one another, as 1 to 1.056, and 0.97; a toiſe is 6 *French* feet.

A Table of ſquare Meaſures.

144 Inches	make	1 Foot,
9 Feet		1 Yard,
$30\frac{1}{4}$ Yards		1 Pole or Perch,
100 Feet		1 Square,
16 Poles		1 Chain,
40 Poles		1 Rood,
10 Chains		1 Acre,
4 Roods		1 Acre,
640 Acres		1 Mile.

A Table of ſolid Meaſure.

1728 Inches	make	1 Foot,
27 Feet		1 Yard.

A Table

A Table of dry Meaſure.

268.8 cub. Inches, or	make	1 Gallon,
4 Quarts,		1 Peck,
2 Gallons		
4 Pecks, or		1 Buſhel,
2150.4 cub. Inches		1 Quarter,
8 Buſhels		1 Cauldron,
4 Quarters		1 Laſt.
10 Quarters		

Alſo 2 pints make a quart; 2 pottles 1 gallon; 2 buſhels a ſtrike; 4 buſhels a comb; 2 weys a laſt.

Water meaſure is upheap'd meaſure, or elſe allows 5 ſtriped pecks to the buſhel.

By this, grain, coals, ſalt, lime, are meaſured.

A Table of liquid Meaſure.

4 Jacks	make	1 Pint,
2 Pints		1 Quart,
4 Pints		1 Gallon,
231 cub. Inches		1 Gallon of wine,
282 cub. Inches		1 Gallon of ale or beer,
8½ Gallons		1 Firkin or Anchor,
2 Firkins, or		
51 Gallons		1 Hogſh. of ale or beer,
63 Gallons		1 Hogſhead of wine,
4 Hogſheads		1 Tun.

Alſo 4 gills make a pint; 2 quarts, a pottle; 18 gallons, a runlet; 42 gallons, a terce; 2 terces, a puncheon; 2 firkins, a kilderkin; 4 firkins, a barrel; 2 hogſheads, a pipe or butt.

Note, 8 gallons make a firkin of ale, and 9 of beer, in London; and the hogſhead proportionable. Alſo 4 gills make a pint there.

A *Paris* pint contains 49 cubic inches.

Meaſures

Meaſures compared.

Oil, honey, &c. are meaſured by wine meaſure, and ſometimes by weight Averd. Alſo brandy, ſpirits, mead, perry, cyder, vinegar, verjuice, ſweets, mum, &c.

A Wincheſter buſhel ought to be 8 inches deep, and $18\frac{1}{2}$ inches diameter.

A ſtraked buſhel is to the ſame unheaped as 3 to 4; therefore the heap is $\frac{1}{3}$ the buſhel; or, as ſome ſay, $\frac{1}{4}$ thereof.

The old wine gallon was 224 cubic inches.

The old corn gallon 272 cubic inches.

The corn gallon is to the ale gallon, as 20 to 21.

A hogſhead of water (wine meaſure) is about $8\frac{1}{3}$ ſolid feet; the ſame by ale meaſure at 51 gallons per hogſhead. And wine meaſure to ale meaſure, as 9 to 11.

A cubic foot is to the Wincheſter buſhel, as 4 to 5; or exactly, as 45 to 56.

The Engliſh foot is to the *Paris* foot, as 107 to 114.

SCHOLIUM.

However theſe things may have varied; yet it is very probable that, originally, a hogſhead of wine and ale was the ſame in quantity; and a tun of water juſt a tun weight.

Hence we may ſuppoſe, that anciently 8 cubic feet of water made juſt a hogſhead, and 4 hogſheads a tun. And conſequently that a tun weighed 2000 lb.

Likewiſe that a hundred weight was then but 100 lb; for this multiplied by 20, makes 2000 lb. alſo for a tun; and was increaſed afterwards by merchandizing, upon account of the waſte in goods.

Alſo if a buſhel of good wheat weighs $62\frac{1}{2}$ lb, then the quarter would be 500 lb, and the chaul-

der

[illegible] 2000 lb. which is alſo a ton. So that originally what was a ton in meaſure was alſo a ton in weight. A ton in weight has been the common ſtandard of all things.

Weight and Meaſure compared.

1 lb. Troy of water is $22\frac{3}{4}$ inches ſolid.

1 lb. Averdupoiſe of water is $27\frac{1}{2}$ ſolid inches.

1 inch of water weighs .58 ounces Averdupoiſe.

A cubic foot of water weighs 76 lb. Troy, or $62\frac{1}{2}$ lb. Averdupoiſe, which is 1000 ounces, and contains $6\frac{1}{8}$ ale gallons.

A wine gallon of water weighs 8.35 lb. Averdupoiſe.

An ale gallon of water weighs 10.2 lb. Averdupoiſe.

A ton of water weighs $18\frac{3}{4}$ hundred weight.

A cylinder of water of d inches diameter, and a yard high, contains $\frac{1}{170}dd$ ale gallons; and weighs $1\frac{1}{2}dd$ pounds Averdupoiſe.

A Table of ſpecific Gravities, ſhewing the weight of a cubic Inch, of ſeveral bodies, in ounces Averdupoiſe.

	oz.		oz.
Fine gold —	11.366	Caſt iron —	4.090
Standard gold	10 930	Marble —	1.569
Quickſilver	8.302	Common glaſs	1.493
Lead —	6.554	Flint —	1 490
Fine ſilver	6.418	Portland ſtone	1.488
Standard ſilver	6.096	Free ſtone	1.465
Copper —	5.208	Common ſtone	1.446
Plate braſs —	4.832	Brick ——	1.157
Caſt braſs	4.630	Alabaſter —	1.084
Steel —	4.544	Ivory —	1.055
Iron —	4.423	Horn —	1.055
Pewter —	4.323	Water —	0.578
Tin —	4.236		

A Table ſhewing the weight of a cubic foot of ſeveral ſorts of Bodies, Averdupoiſe weight.

	lb.	oz.		lb.	oz.
Wheat —	48	0	Lignum vitæ	82	15
Oats —	29	8	Butter —	58	12
White peaſe	50	8	Pitch —	71	14
Barley —	41	2	Mahogany	66	7
Malt —	30	4	Box —	64	6
Field beans	50	8	Milk, Urine, and Sea water	63	2
Wheat meal unſifted —	31	0			
Rye meal unſifted	28	4	Rain water	62	8
Bay ſalt —	54	1	Red wine	61	14
White ſea ſalt	43	12	Bees wax	59	11
Sand —	85	4	Linſeed oil	58	4
Newcaſtle coal	67	12	Brandy	57	15
Pit coal (Wedneſbury) —	63	0	Oak —	57	8
			Oil olive	57	1
Gravel	109	5	Beech	53	6
Wood aſhes	58	5	Elm, Aſh —	49	1
Pump water	62	8			
Chalk —	112	10	Cedar —	38	7
Allum —	107	2	Fir —	26	4
Clay —	107	0	Cork —	14	8
Honey —	90	10	Air —	0	1¼

REMARKS.

20 cubic foot of hay is about a hundred weight.

56 lb. of butter make a firkin, which is 4 ſtone, Averdupoiſe.

When wheat is at 5 ſhillings the buſhel, the penny white loaf is to weigh 7¼ oz. out of London.

If a miller carries and recarries his corn, he has a quarter of a peck per buſhel, for toll and waſte. But if the owner carry it, he has but half ſo much.

40 feet of unhewn timber, or 50 feet of hewn timber, is reckoned a load or ton.

60 ſolid feet of Newcaſtle coals is a chaldron, or 36 buſhels.

A buſhel of wheat weighs about 60 lb. Averdupoiſe, which is 4 ſtone 4 lb; but ſome weighs more.

A load of hay is 36 truſſes, and a truſs four ſtone, or half a hundred.

The ſeveral ways of meaſuring different ſorts of Work.

Different work is computed by different meaſures. In meaſuring boards, timber, glaſs, ſtone; the dimenſions are taken in feet and inches; and the content caſt up in feet.

In caſks, the dimenſions are taken in inches, and the content caſt up in ſolid inches, or elſe in gallons.

In painting, plaiſtering, paving, flooring, wainſcot, the dimenſions are taken in feet or yards; and the content caſt up in yards.

In roofing, tyling, ſlating, raftering, partitioning, flooring; the dimenſions are taken in feet, and the content given in ſquares of 100 ſquare feet.

Walling is meaſured in feet or yards, and the content given in rods, containing 272 ſquare feet; or, in the North country, the rod contains 7 ſquare yards.

Land is meaſured by Gunter's chain, and caſt up in acres, at 10 chains an acre.

Earth works, as cellars, vaults, &c. are meaſured by the yard ſolid.

In any rule, &c. to meaſure with, it is the beſt way to have it divided into decimal parts; for the content of any thing is ſooneſt caſt up, when the dimenſions are taken in decimals. And the ſhort-

eſt way is to work by logarithms; adding the logarithms, inſtead of multiplying the numbers; and ſubtracting inſtead of dividing.

The Practice of Workmen.

Glaziers take dimenſions to a quarter of an inch, and never make any allowance for round or oval windows; but meaſure the circumſcribing parallelograms.

In plaiſtering, deductions muſt be made for doors and windows; but ſome make no deductions.

Painters, in taking the height, gird the ſtring into all the hollows, and round all the ſwellings of the pannels, &c. And in taking the height of a door, or the breadth, they add the thickneſs. Their price is according to the number of times the colour is laid on. Deductions are made for chimnies, caſements, &c.

Joiners, in meaſuring the height of a room, put the ſtring into all the ſwellings and mouldings. But in taking the length, they meaſure in a ſtrait line. Deductions are made for all vacancies, as windows, chimneys, &c. In partitioning, deductions muſt be made for doors and windows.

In flooring, the hearth-ſtone is deducted, except there be a border round it. Window ſhutters and doors are commonly reckoned meaſure and half; becauſe they are worked on both ſides.

In roofing, tiling, ſlating, it is cuſtomary to reckon the flat and half of building within the walls, for the meaſure of the roof, when it is a true pitch; that is, when the rafters are $\frac{3}{4}$ the breadth of the building. For workmanſhip alone, ſky-lights, chimney ſhafts, &c. are deducted. But finding materials and work, takes in all, except places of 9 or 10 feet area. Some never deduct for

for window ſhafts and ſky-lights at all; they are ſo troubleſome to the workmen.

In tiling and ſlating, ſky-lights and chimney ſhafts are deducted. The angle of the roof which bends inwards is called a *Valley*, and the angle bending outwards is called a *Hip*.

In walling a houſe, deductions muſt be made for doors and windows.

In meaſuring chimnies, gird round the middle for the breadth, and the height of the ſtory is the length.

In meaſuring timber, it is cuſtomary for the buyer to take the girt any where he pleaſes, between the greater end and the middle of the tree. Branches of two feet compaſs are reckoned timber; any thing leſs is not timber. When the bark is on, deduct $\frac{1}{10}$ or $\frac{1}{12}$ the circumference.

PART I.

Computing and Weighing.

PROB. I.

To reduce Guineas into Pounds.

1 RULE.

TAKE the tenth part of the Guineas, and add the half thereof to the guineas, for the pounds.

What remains is ſhillings.

Examp.

In 674 Guineas, how many Pounds?

The tenth of 674 (dropping 4) is 67, half of 67 (dropping 1) is 33. Then 33 added to 674, gives 707 pounds, to which put the 14 ſhillings remaining.

2 RULE.

Call the guineas ſhillings, which reduce into pounds, and add to the guineas.

Example.

How many Pounds in 168 Guineas?

Here 168 ſhillings is 8l. 8s. which added to 168, gives 176l. 8s.

Cor.

Cor. *To reduce pounds to guineas, ſubtract the 21ſt part thereof.*

PROB. II.

Having the price of 1, *to know what* 100 *comes to?*

1 RULE.

For every farthing in the price of one, reckon twice as many ſhillings and once as many pence.

Examp.

If 1 *coſts* $9\frac{1}{2}$ *pence, what will* 100 *come to?*

9 pence halfpenny is 38 farthings.

Then twice 38 is	76 s.	0 d.	
And 38 pence	3	2	
	79 s.	2 d.	= 3 l. 19 s. 2 d.

2 RULE.

For every ſhilling of the price reckon 5 pounds.
And for every 3d. beſides reckon 25 ſhillings.
And for a penny 8 s. 4 d.

Examp.

What comes 100 *to, at* 7 s. 10 d. *a piece?*

The ſhillings	—	35	0	0
The 3 pences	—	3	15	0
A penny	—		8	4
		39	3	4

PROB. III.

Having the price of 100 *given, to find the price of* 1.

RULE.

Take half as many farthings as there are ſhillings in the price; abating the 50th part of the whole number of farthings.

Examp.

If 100 *coſt* 33 l. *what is that a piece?*

Whole num. farthings	660	
Half the number	330	
$\frac{1}{50}$ the whole, ſub.	13	
	317	farthings.
	$79\frac{1}{4}$	pence.
Anſ.	6 s. $7\,d\frac{1}{4}$.	

PROB. IV.

Having the price of 1, *to know what the long hundred will coſt.*

1 RULE.

How many pence you give for each one thing,
So many angels the long hundreds bring.

Examp.

If one thing coſt $3\frac{1}{4}$ d. *what will* 120 *be?*

$3\frac{1}{4}$ angels $32\frac{1}{2}$ s. = 1 l. 12 s. 6 d.

2 RULE.

2 RULE.

Take half as many pounds as 1 coſts pence; adding 2 s. 6 d. for every odd farthing.

Ex.

If 1 *coſts* $13\frac{3}{4}$ d. *what is the charge of* 120?

Half of 13 is $6\frac{1}{2}$	61.	10 s.	0 d.
3 half crowns for $\frac{3}{4}$		7	6
Anſ.	6	17	6

PROB. V.

By knowing the price of the long hundred, to know what 1 *coſts.*

1 RULE.

For every pound reckon 2 pence, and for every half crown more a farthing.

Ex.

If the long hundred (120) *coſts* 7 l. 15 s. *what does* 1 *coſt?*

7 two pences	1 s.	2 d.
6 farthings		$1\frac{1}{2}$
Anſ.	1	$3\frac{1}{2}$

2 RULE.

Double the price, then the number of pounds call pence, and the number of crowns over, call farthings.

Ex.

Ex.

If deals be 18 l. 16 s. 3 d. *for the long hundred, what does* 1 *coſt?*

double, 37 l. 12 6 = 3 s.—1½ d. Anſ.

PROB. VI.

Having the price of 1, *to know what the thouſand comes to.*

1 RULE.

For every 6 pence of the price, reckon 25 pounds; and for every penny more, 4 l. 3 s. 4 d. or 4⅙ pounds.

Or ten times the price of 100, is the price of a thouſand.

Ex.

Suppoſe 1 *coſts* 13 s. 4 d. *what does* 1000 *coſt?*

26 ſix pences	650
4 times 4 l. 3 s. 4 d.	16 13 4
Anſ.	666 13 4

2 RULE.

Take as many pounds as there are farthings in the whole price. Then add as many pounds as there are ſix pences in the price. Alſo for every 1½ d. above, add 5 ſhillings, and 10 d. for each farthing.

Examp.

If 1 *coſts* 14¾ *pence, what will* 1000 *coſt?*

59 farthings	59 l.	s.	d.
2 ſix pences	2		
1½ d.	0	5	0
5 farthings		4	2
Anſ.	61	9	2

PROB.

PROB. VII.

Having the price of a thouſand, to find the price of one.

RULE.

Take as many farthings as pounds in the price, abating the 25th part thereof.

Ex.

At 564 l. 18 s. 9 d. *per thouſand, what does* 1 *coſt?*

565 farthings
$2\frac{1}{25}$ part ſub.

565
22

Anſ. 543 farthings = 11 s. $3\frac{3}{4}$ d.

PROB. VIII.

Having the price of 1, *to find that of a dozen.*

RULE.

For every penny in the price reckon a ſhilling, and 3 pence for each odd farthing.

Ex.

If 1 *coſts* $16\frac{1}{2}$ *pence, what will* 12 *be?*

Anſ. 16 s. 6 d.

Cor. *The price of a dozen being given; the price of* 1 *is found, by reckoning ſo many pence as there are ſhillings; or by taking* $\frac{1}{12}$ *the price.*

PROB.

PROB. IX.

Having the price of 1 *thing; to find the price of a groſs.*

RULE.

Find the price in pence, and take $\frac{6}{10}$ of it, for the pounds.

Ex.

If one coſts 3 s. 11$\frac{1}{2}$d. *what is a groſs?*

3 s. 11$\frac{1}{2}$ 47$\frac{1}{2}$ pence
.6

Anſ. 28.50 or 28 l. 10 s.

PROB. X.

Having the price of a groſs, to find the price of one.

RULE.

Take the third part of the price in ſhillings, for the price of 1 in farthings.

Ex.

At 7 l. 9 s. 6 d. *the groſs, what is the price of* 1 *?*

7 l. 9 s. 6 d. is 149$\frac{1}{2}$ ſhillings, or 150 s.
3)150(50 far. = 12$\frac{1}{2}$ d. Anſ.

PROB. XI.

Having the price of a gallon of liquors; to find the price of a ton.

RULE.

Put the price into pence, and call them ſo many guineas; adding quarter guineas for farthings.

Ex

Ex.

If brandy be ſold for 6 s. 10¾ d. *a gallon, what is that a ton?*

6 s. 10¾ d. is		82¾ d.
82 guin.	{	82 0 0
	{	4 2 0
¾ d.		15 9
Anſ.		86 17 9

Cor. *The price of a hogſhead is had, by taking a quarter of this ſum.*

PROB. XII.

Having the price of a ton of liquors; to find that of a gallon.

RULE.

Reduce the price to guineas; then for every guinea reckon a penny, and a farthing for a quarter guinea.

Ex.

At 97 l. *per ton, what is that a gallon?*

97 l. is	92 g.	8 s.
92 pence	—	7 8
8 ſhillings	—	0¼
Anſ.		7 8¼

PROB.

PROB. XIII.

Knowing the price of 1 *pound, to find what the hundred weight coſts.*

1 RULE.

For every penny which a pound denotes,
Count once the angels, 'bating twice the groats.

Ex.

If a pound be $7\frac{1}{2}$ d. *what is the hundred weight?*

$7\frac{1}{2}$ angels	3 l. 15 s.
15 groats, ſub.	5
Anſ.	3 10

2 RULE.

Number the farthings that each pound denotes,
Take twice the ſhillings, once as many groats.

Ex.

If 1 *coſt* 3 s. $6\frac{3}{4}$ d. *what will* 100 *weight coſt?*

3 s. $6\frac{3}{4}$ d. is 171 farthings.

twice 171 ſhillings	17 2 0
171 groats, add	2 17 0
	19 19 0

3 RULE.

Find the pence for 1; take 9 times as many ſhillings, and once as many groats.

Ex.

At 10 d. *per pound, what is the hundred weight?*

9 ten pences	90
ten groats	3 4
	93 4
Anſ.	4 13 4

PROB.

PROB. XIV.

The price of a hundred weight being given, to find that of a pound?

1 RULE.

For every 7 ſhillings in the price of a hundred weight, reckon 3 farthings for a pound.

Ex.

At 8 l. a hundred weight, what will one coſt?

8 pounds are 160 ſhillings
the 7th part 23
3 times 23 farth^{s}. 69 = 17$\frac{1}{4}$ pence, Anſw.

2 RULE.

Take the tenth part of the price in ſhillings, and the fourteenth part of that; the ſum is the pence for a pound.

Ex.

At 29 l. 17 s. 6 d. the hundred, how much is a pound?

29 l. 17 s. 6 d. is 597$\frac{1}{2}$ ſhillings.
the tenth part 59·7
$\frac{1}{14}$ of this — 4·2

ſum 64 pence.
Anſ. 5 s. 4 d.

PROB. XV.

In Troy weight, having the price of a grain, to find the price of an ounce, or a pound?

RULE.

Multiply the farthings in the price, by 6; gives the price of a pound, in pounds.

Or

Or double the pence in the price; gives the price of an ounce in pounds ſterling.

Ex. 1.

At $1\frac{1}{4}$ d. *a grain, how much is a pound?*

$1\frac{1}{4}$ or $5^{f} \times 6 = 30$ l. Anſ.

Ex. 2.

At 2 *d. a grain, how much is an ounce of gold?*

2 d. doubled is 4 pounds: Anſ.

PROB. XVI.

In Troy weight, the price of a penny weight being given, to find that of a pound.

RULE.

The number of pence in the price, call pounds.

Ex.

And $10\frac{1}{2}$ *d. the penny weight, how much is a pound?*

$10\frac{1}{2}$ pounds 10 l. 10 s. Anſw.

PROB. XVII.

The price of a buſhel of coals being given, to find that of a chaldron, or 36 *buſhels.*

RULE.

Thrice the number of pence in the price, call ſhillings.

Ex.

At $4\frac{1}{2}$ *d. the buſhel, how much is a chaldron of coals?*

Thrice $4\frac{1}{2}$ is $13\frac{1}{2}$ ſhillings, or 13 s. 6 d. Anſ.

PROB. XVIII.

Given the price of a ſtone, to find the price of a ton.

RULE.

Find the pence, and take $\frac{2}{3}$ that number of pounds.

Ex.

At 3 *s.* $4\frac{1}{4}$ *d. a ſtone, what is that a ton?*

3 *s.* $4\frac{1}{4}$ *d.* is $40\frac{1}{4}$.

and $\frac{2}{3}$ of $40\frac{1}{4}$ is $\frac{80}{3} + \frac{1}{6}$ or $26\ \frac{5}{6}$ l.

and $26\ \frac{5}{6}$ l. is 26 l. 16 s. 8 d. Anſ.

PROB. XIX.

The price of one thing being given in pence, to find what any number will come to.

1 RULE.

For 6 pence reckon half ſo many ſhillings;
For 3 pence, half of the laſt ſum; and
For a penny, $\frac{1}{3}$ of the laſt.

Example.

What will 57 *coſt at* 8 d. *a piece?*

	s.	d.	l.	s.	d.
half of 57	28	6	1	8	6
half of this	14	3		0	0
a third of that	4	9		4	9
ditto —	4	9		4	9
		Anſ.	1	18	0

2 RULE. *By a Table.*

Againſt the quantity on the ſide, and under the price of 1 at top, you have the price of your quantity. This is to be taken out at ſeveral times as occaſion requires.

num	1 farth.			2 farth.			3 farth.			1 pen.	2 pen.	3 pen.	4 pen.
	l.	s.	d.	l.	s.	d.	l.	s.	d.				
1			0¼			0½			0¾	1	2	3	4
2			0½			1			1½	2	4	6	8
3			0¾			1½			2¼	3	6	9	1 0
4			1			2			3	4	8	1 0	1 4
5			1¼			2½			3¾	5	10	1 3	1 8
6			1½			3			4½	6	1 0	1 6	2 0
7			1¾			3½			5¼	7	1 2	1 9	2 4
8			2			4			6	8	1 4	2 0	2 8
9			2¼			4½			6¾	9	1 6	2 3	3 0
10			2½			5			7½	10	1 8	2 6	3 4
20			5			10		1	3	1 8	3 4	5 0	6 8
30			7½		1	3		1	10½	2 6	5 0	7 6	10 0
40			10		1	8		2	6	3 4	6 8	10 0	13 4
50		1	0½		2	1		3	1½	4 2	8 4	12 6	16 8
60		1	3		2	6		3	9	5 0	10 0	15 0	1 0 0
70		1	5½		2	11		4	4½	5 10	11 8	17 6	1 3 4
80		1	8		3	4		5	0	6 8	13 4	1 0 0	1 6 8
90		1	10½		3	9		5	7½	7 6	15 0	1 2 6	1 10 0
100		2	1		4	2		6	3	8 4	16 8	1 5 0	1 13 4
200		4	2		8	4		12	6	16 8	1 13 4	2 10 0	3 6 8
300		6	3		12	6		18	9	1 5 0	2 10 0	3 15 0	5 0 0
400		8	4		16	8	1	5	0	1 13 4	3 6 8	5 0 0	6 13 4
500		10	5	1	0	10	1	11	3	2 1 8	4 3 4	6 5 0	8 6 8
600		12	6	1	5	0	1	17	6	2 10 0	5 0 0	7 10 0	10 0 0
700		14	7	1	9	2	2	3	9	2 18 4	5 16 8	8 15 0	11 13 4
800		16	8	1	13	4	2	10	0	3 6 8	6 13 4	10 0 0	13 6 8
900		18	9	1	17	6	2	16	3	3 15 0	7 10 0	11 5 0	15 0 0
1000	1	0	10	2	1	8	3	2	6	4 3 4	8 6 8	12 10 0	16 13 4

Examp.

	5 per.		6 per.		
1		5			6
2		10		1	0
3	1	3		1	6
4	1	8		2	0
5	2	1		2	6
6	2	6		3	0
7	2	11		3	6
8	3	4		4	0
9	3	9		4	6
10	4	2		5	0
20	8	4		10	0
30	12	6		15	0
40	16	8	1	0	0
50	1 0	10	1	5	0
60	1 5	0	1	10	0
70	1 9	2	1	15	0
80	1 13	4	2	0	0
90	1 17	6	2	5	0
100	2 1	8	2	10	0
200	4 3	4	5	0	0
300	6 5	0	7	10	0
400	8 6	8	10	0	0
500	10 8	4	12	10	0
600	12 10	0	15	0	0
700	14 11	8	17	10	0
800	16 13	4	20	0	0
900	18 15	0	22	10	0
1000	20 16	8	25	0	0

Examp.

What comes 1453 *to, at* $9\frac{1}{2}$ *d. a piece?*

	l.	*s.*	*d.*
1000 (at 6d.)	25	0	0
at 3d.	12	10	0
at $\frac{1}{2}$	2	1	8
400 (at 6 d.)	10	0	0
at 3 d.	5	0	0
at $\frac{1}{2}$		16	8
50 (at 6 d.)	1	5	0
at 3 d.		12	6
at $\frac{1}{2}$		2	1
3 (at 6 d.)		1	6
at 3 d.			9
at $\frac{1}{2}$.			$1\frac{1}{2}$
Anſ.	57	10	$3\frac{1}{2}$

PROB. XX.

The price of 1 *being given in ſhillings, to find what any number will come to.*

1 RULE.

In the number of things propoſed, double the right hand figure for ſhillings, and reckon the reſt of it pounds. Then take this ſum of pounds and ſhillings as oft as 2 is contained in the price; and if there is an odd ſhilling, take half the ſaid ſum.

Examp.

What is 2344 *ounces at* 13 *ſhillings an ounce?*

234 l. 8 s. taken 6 times	is	1406 l.	8 s.
half of it	—	117	4
Anſ.		1523	12

2 RULE.

Multiply the number of things by half the price; then double the right hand figure for ſhillings, and the reſt is pounds.

In the former Example.

2344 × by $6\frac{1}{2}$ is as follows,

6 × 2344	is	14064
half of it	is	1172
		15236
Anſ.		1523 l. 12 s.

PROB.

PROB. XXI.

Having the price of 1 *in pounds; to find the price of any number of them.*

RULE.

Multiply the price ſeparately by every figure of the propoſed number; putting each product in its proper place.

Examp.

What comes 5307 *to at* 57 l. *a piece?*

5000 × 57	—	285000
300 × 57	—	17100
7 × 57	—	399
	Anſ.	302499 l.

PROB. XXII.

To caſt up ſums of money by Counters.

RULE.

Make four ſeparate partitions upon a table, and mark them with chalk, pounds, ſhillings, pence, farthings; then write down the ſeveral ſums, or elſe put as many counters into each partition as there are pounds, ſhillings, &c. in each ſum. Then begin to reckon at the loweſt denomination, and proceed till you amount to 1 of the next greater; then throw away that number of counters in the leſſer, and inſtead of them, put 1 counter in the place of the greater. Proceed thus throughout, leaving only ſo many counters in each partition, as is the overplus at laſt.

Note, pieces of paper may ſerve inſtead of counters, and brown paper may ſerve for pence, and white for ſhillings.

Example.

Suppoſe you have the following ſums,

l.	*s.*	*d.*
3	7	8
105	12	$2\frac{1}{2}$
17	11	$6\frac{3}{4}$
9	0	11

	poun.	ſhill.	penc.	far.
	0	0	0	
		0		
tot.	135	0000	00	0
	000	0000	00	
	00	0000		
	00			
	0			
	0			

Firſt, I ſay, 3 farthings and a halfpenny are 5 farthings, leave 1 counter in the place of farthings; and carry 1 to the place of pence. Then 1 and 11 is 12, which throw away, and put 1 counter in the place of ſhillings; then 6 and 2 is 8 and 8 is 16, throw away 12, and put 1 in the place of ſhillings, and put in 4 counters at pence. Then 2 and 11 is 13 and 12 is 25, throw away 20, and but 1 in the place of pounds. Then 5 and 7 is 12, ſo put 12 counters in the place of ſhillings. Laſtly, 1 and 9 is 10 and 7 is 17, and 5 is 22, and 3 is 25, and 10 is 35, and 100 is 135; ſo put 135 counters in the place of pounds. So examining each partition, you will find 135 l. 12 s. $4\frac{1}{4}$ d. to be the ſum required.

PROB. XXIII.

To find the intereſt of a ſum of money for any number of days, at any rate per cent.

RULE.

Multiply the rate per cent. and the principal together, and take the third part of it, from which

cut

cut off 3 places to the right hand. From this ſubtract the 73d part of itſelf (or for ſhortneſs the 70th part); and the remainder is the intereſt for 12 days.

Then 2, 5, 10 times this, &c. gives the intereſt for 24, 60, 120 days, &c. Alſo $\frac{1}{12}$, $\frac{1}{6}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$ the ſaid intereſt gives the intereſt for 1, 2, 3, 4, 6 days, and conſequently it will be had for any number of days.

Examp.

What is the intereſt of 311 l. 13 s. 4 d. for 315 days, at $4\frac{1}{2}$ per cent.

311 l. 13 s. 4 d. $= 311\frac{1}{3} = 311.66666$

$4\frac{1}{2} \times 311.666$ is	—	1402.5
the third part is	—	467.5
three places cut off	—	.4675
the 70th part, ſubſt.		66
the intereſt for 12 days		.4609
Intereſt for 120 days	—	4.609
—— for 120 days more		4.609
—— for 60 days more		2.3045
—— for 12 days more		.461
—— for 3 days more		.1152
315		12.0987
		20
		1.9740
		12
		11.6880

Anſ. 12 l. 1 s. $11\frac{3}{4}$ d.

PROB. XXIV.

Having your weekly expences; to know what it coſts you in the year.

1 RULE.

Each ſix-pence in the week does make appear,
The guineas with the crowns ſpent in a year.

Examp.

At 5 s. 6 d. *per week, or* 11 *ſix-pences per week.*

		l.	s.	d.
11 guineas	—	11	11	0
11 crowns	—	2	15	0
Anſ.		14	6	0

2 RULE.

The farthings in each week do make appear,
The ſhillings with the pence ſpent in a year.
Add one day's expence.

Ex.

At $15\frac{1}{4}$*d. in a week, what is it in a year?*
$15\frac{1}{4}$ is 61 farthings.

		l.	s.	d.
61 ſhillings		3	1	0
61 pence			5	1
One day	—			$2\frac{1}{4}$
		3	6	$3\frac{1}{4}$

PROB. XXV.

Knowing your daily expences; to find what it coſts in a year.

RULE.

Number the pennies of each day's expence;
So many pounds, and angels, groats, and pence,
You ſpend within the year's circumference.

Examp.

At 9d. *per day, what for the year?*

		l.	s.	d.
9 pounds	—	9	0	0
9 angels	—	4	10	0
9 groats	—		3	0
9 pence	— —			9
Anſw.		13	13	9

PROB. XXVI.

By knowing your yearly income; to find what you can ſpend a day.

RULE.

The third part of the pounds you yearly have,
So many two-pences afford to ſpend or ſave. nearly.

Examp.

At 40 l. *a year, quere what a day?*

$\frac{1}{3}$ of 40 is $13\frac{1}{3}$
and $13\frac{1}{3}$ two-pences is $26\frac{2}{3}$ pence, or 2 s. $2\frac{1}{2}$ d.

PROB. XXVII.

The money gained in an hour being given; to find the produce in a week.

RULE.

Reduce the price to pence, and take $\frac{7}{10}$ thereof for the pounds.

Examp.

If an hour produces $9\frac{1}{2}$*d. what will be the product in a week?*

Here $9\frac{1}{2} \times \frac{7}{10}$ is $6.65 = 6$ l. 13 s. Anſw.

PROB. XXVIII.

Having the product of any thing for a minute, to find it for a day.

RULE.

Take ſo many pounds, and ſo many angels as there are farthings in the product of one minute.

Examp.

At $5\frac{1}{4}$ d. *a minute, what will a day come to?*

$5\frac{1}{4}$ d. is 21 farthings.

		l.	s.	d.
21 pounds		21	0	0
21 angels	—	10	10	0
	Anſ.	31	10	0

PROB. XXIX.

To diſcover a deceitful Ballance.

RULE.

After the weights are made even in the two ſcales, change them into the oppoſite ones, Then if they ſtill

ſtill remain equal, the ballance is true; if not, 'tis falſe.

But a ſteelyard cannot be tried this way; yet it may be tried, by weighing any thing with it, and then weighing that thing in a true pair of ſcales.

Cor. *If one arm of a ballance be longer than the other it is a deceitful ballance; though the ſcales, when empty, may be in equilibrio.*

PROB. XXX.

To weigh all things with the feweſt weights.

RULE.

Take any number of pound weights in this progreſſion 1, 3, 9, 27, 81, &c. and they will weigh any number of pounds, not exceeding the ſum of them all. But ſometimes ſome of the weights muſt be put in the contrary ſcale, to be ſubtracted.

The ſame thing may alſo be done with the weights in this progreſſion, 1, 2, 4, 8, 16, 32, &c. where none need be put in the oppoſite ſcale, which is better.

PROB. XXXI.

To find the content of any plane figure by weighing it.

RULE.

Having the figure drawn upon paper, cut it out in paſteboard, which is eaſily done, by laying the paper ſcheme upon it; and weigh your paſteboard figure in grains. Then mark upon it any ſquare you can meaſure, and cut it all away to that ſquare; and then weigh the ſquare. And ſay, as the weight of the ſquare, to its meaſure; ſo is the weight of the figure, to its content in the ſame meaſure.

PROB.

PROB. XXXII.

The ſolid content of a body being known, to find its weight.

RULE.

Find what an inch or a foot of that ſort of body weighs, either by trial, or by the tables of ſpecific gravity. Then multiply the content of the body, by this weight, and you have the weight of the whole.

Ex.

How much does a piece of elm weigh, which contains 20 *feet?*

By the table of ſpecific gravities, a foot of elm weighs 49 l. 1 oz. This multiplied by 20, produces 981 $\frac{1}{4}$ lb. that is, 70 ſt. 1 $\frac{1}{4}$ lb. or 8 hundred 6 ſtone, 1 $\frac{1}{4}$ lb.

PART II.

Geometrical Problems, and the Meaſuring of Lines.

SINCE meaſuring the contents of ſuperficies and ſolids by the Sliding rule, is very eaſy and expeditious; and we ſhall have occaſion to make frequent uſe of it, in what follows; therefore I ſhall begin with a ſhort deſcription thereof.

The deſcription and uſe of the Sliding rule.

This Rule (commonly called *Cogſhal*'s Sliding rule) has four lines upon it, adapted to meaſuring; they are marked A, B, C, D. Three of theſe, A, B, C, are double lines, becauſe they proceed from 1 to 10 twice over. The fourth line D is a ſingle line, proceeding from 4 to 40, and is called the *Girt line.*

Two of theſe lines B, C, are upon the ſlider, and the other two A, D, upon the rule. The three ſingle lines are all exactly alike, and alike numbered, and divided; the diviſions being numbered 1, 2, 3, 4, to 1 again, from the beginning to the middle; and again, 1, 2, 3, 4, to 10, from the middle to the end. The fourth line D, is numbered 4, 5, 6, 7 to 40; but figures are not ſet to all the diviſions, for towards the end they grow very ſmall. The number 4 in the ſingle line ſtands againſt 1 in the double lines, and the number 40 againſt 10. In all the lines the diviſions are large

at

at the beginning, and continually decreaſe to the laſt.

For the numeration upon the lines; 1 at the beginning may be counted 1, then the 1 in the middle will be 10, and 10 at the end 100. If 1 at the beginning be called 10, 1 in the middle is 100, and 10 at the end 1000. Or if the firſt 1 be reckoned 100, the ſecond 1 will be 1000, and the laſt 1 or the 10 will be 10,000; and ſo on. And as the grand diviſions are numbered or altered, ſo are all the ſmaller diviſions altered in value accordingly.

The uſe of the double lines A and B, is for working the rule of proportion; as alſo for finding the areas of plain figures. And the uſe of the girt line D, and the other double line C, is for meaſuring ſolids.

Beſides theſe lines, there are ſeveral other lines and ſcales, as a line of inches with halves, quarters, and half quarters. A line of inches, each divided into ten parts; this is alſo a foot divided decimally, and ſerves to turn inches into decimal parts of a foot. The backſide of the ſliding piece is divided into inches, halves, quarters, and half quarters; and ſerves to meaſure any length, by ſliding it out.

There are upon ſome of theſe rules other ſcales and tables, as a table of board meaſure, one of timber meaſure. A line ſhewing what length, for any breadth, will make a foot ſquare: this is for compleating the table of board meaſure. Alſo a line, ſhewing what length will make a ſolid foot, for any thickneſs. This alſo compleats the table of ſolid meaſure.

If 1 on A be ſet to any number on B, theſe two lines will be a table of multiplication. For the numbers in A, will be the ſeveral multiplicands, and the correſponding numbers in B, the products.

Alſo

Alſo if the lines C, D, be ſet together, 10 againſt 10; they will be a table of ſquares. The line D being the roots, and C the ſquares; the numbers at 10 and 10 being reckoned 10 and 100.

In a Gauger's rule, the line D is numbered from 1 at the beginning to 10 at the end; which is more commodious for extracting roots.

As the ſhorteſt and eaſieſt way of meaſuring all ſuperficies and ſolids, is by the ſliding rule; it will be neceſſary to lay down a few Problems to ſhew the uſe of it.

The Uſe of the SLIDING RULE.

PROB. 1.

To multiply two numbers together, as 7 and 26.

RULE.

Set 1 upon A, to one of the numbers (26) upon B; then againſt the other number (7) on A, is found the product (182) upon B.

Note, If the third term on A runs beyond the end of the line B, ſeek that third term on the other radius (or part) of the line A; then the product will be found on B, which muſt be increaſed ten times as much.

PROB. 2.

To divide one number by another, as 510 by 12.

RULE.

Set the diviſor (12) on A, to 1 on B; then againſt the dividend (510) on A, is the quotient ($42\frac{1}{2}$) on B.

Note, If the dividend runs beyond the end of the line A, diminiſh it 10 or 100 times, to make it

it fall on A; then increaſe the quotient 10 or 100 times, reſpectively.

PROB. 3.

To ſquare any number, as 27.

RULE.

Set 1 (or 10) upon D to 1 upon C, then againſt the number (27) upon D, is the ſquare upon C (729). And to reckon right, obſerve that as the 1 upon D is counted 1, 10, or 100, &c. the 1 upon C (againſt it) will be 1, 100, or 10,000; that is the ſquare of the other.

If you would ſquare 270, reckon the 1 on D to be 100, then that on C will be 10,000, and the product 72,900.

PROB. 4.

To extract the ſquare root of any number, as 4268.

RULE.

Set 1 upon C, to 1 (or 10) upon D; then againſt the number (4268) on C, is the root on D (65.3). Which to value right, you muſt ſuppoſe the 1 on C to be ſome of theſe ſquares 1, 100, 10,000, &c. which is near the given number; and then the root correſponding, will be the value of the 1 on D.

PROB. 5.

To find a mean proportional between any two numbers, as 27 *and* 450.

RULE.

Set one of the numbers (27) on C, to the ſame on D; then againſt the other numbers (450) on C, you have the mean (112) on D.

Note,

Note, if one of the numbers overruns the line, take the 100th part of it, and then take a mean, which multiply by 10.

PROB. 6.

Three numbers being given; to find a fourth proportional: ſuppoſe 12, 28, and 57.

RULE.

Set the firſt (12) upon A, to the ſecond (28) upon B; and againſt the third (57) on A, is the fourth (133) on B.

Note, if one of the middle numbers runs off the line, take the 10th part of it only, and then take 10 times the fourth proportional found. The finding a third proportional is the ſame, the ſecond number being twice repeated.

PROB. 7.

If the breadth of a board be given (8 *inches*); *to find how much in length will make a foot ſquare.*

RULE.

If the board be narrow, you will find it in the table of under board meaſure in the table on the rule; if not, ſhut the rule, and ſeek the breadth (8) in the line of board meaſure running along the rule, from that table; then over againſt it, on the oppoſite ſide, in the ſcale of inches, is 18 inches, the length required.

PROB. 8.

The ſide of the ſquare of a piece of timber being given (16 inches); to find how much in length will make a foot ſolid.

RULE.

If the timber be ſmall, look into the table of under timber meaſure on the rule, and you'll find the feet and inches. Otherwiſe look for the ſide of the ſquare (16) in the line of timber meaſure running along the rule from that table: and againſt it, in the line of inches, is the length $6\frac{3}{4}$ inches.

PROB. 9.

To find the content of any ſurface.

RULE.

Reduce the ſurface to a rectangle, then (by Prob. I.) multiply the length and breadth together, for the area or content of the ſurface, in the ſame ſort of meaſure.

Otherwiſe.

If the length be given in feet, and the breadth in inches. Set 12 on A to the length on B; and againſt the breadth on A, is the content on B, in feet.

Otherwiſe.

If you would have the dimenſions taken in one ſort of meaſure, and the area given in another ſort. See how many ſquares of the firſt, make one of the other; and make it a diviſor.

Then ſet this diviſor on A to the length on B, and againſt the breadth on A, is the area on B.

PROB.

PROB. 10.

To find the content of the ſolid body.

RULE.

Reduce it to a long body, or parallelopipedon, ſquare at the ends; meaſure the length in feet, and the ſide of the ſquare in inches. Then ſet 12 on D, to the length on C; and againſt the ſide of the ſquare on D, is the content on C, in feet.

PROB. 11.

If two fixt numbers are given on the lines D *and* C, *as p and q; to change them to others that will perform the ſame operations.*

RULE.

Inſtead of p and q, take 1 and $\frac{q}{pp}$, or $\sqrt{\frac{pp}{q}}$ and 1, or r and $\frac{qrr}{pp}$; which may be expreſſed thus,

D	C
p	q
1	$\frac{q}{pp}$
$\sqrt{\frac{pp}{q}}$	1
r	$\frac{qrr}{pp}$.

That is, inſtead of ſetting p upon D, to q upon C, one may ſet 1 on D, to $\frac{q}{pp}$ on C; or $\sqrt{\frac{pp}{q}}$ on D, to 1 on C; or r on D to $\frac{qrr}{pp}$ on C.

For p, q, being two fixt numbers, and r take at pleaſure; and ſince the numbers on C are as th ſquares of thoſe on D; therefore we muſt ſquare thoſe on D, and make them proportional, that they may perform the ſame thing; then we ſhall h $pp : q :: rr : s$, and $s = \frac{qrr}{pp}$, and $r = \sqrt{\frac{pps}{q}}$.

PROB. 12.

To find a proper fixt number for the line D, *for meaſuring planes or ſolids.*

RULE.

Here you muſt have given the content of ſome particular plane or ſolid of that ſort, whoſe diameter, circumference, &c. is 1, put this content = S.

Then if the dimenſions be taken in one meaſure, and the content given in another; put n = number of leſſer ſquares or cubes contained in 1 of the greater. x = fixt number. Then $x = \sqrt{\frac{n}{S}}$.

For in areas it will be $x^2 : 1 :: 1 : S$, and $x = \sqrt{\frac{1}{S}}$.

And in ſolids, $x^2 \times$ height : height :: 1 : S. And $x = \sqrt{\frac{1}{S}}$.

Examp.

In ſquares $x = 1$. Or for inches and feet, $x = 12$.

In circles $x = \sqrt{\frac{1}{.7854}}$. Or for inches and feet, $x = \sqrt{\frac{144}{.7854}}$.

In circles, when the circumference is 1, $x = \sqrt{\frac{1}{.079}}$

In cylinders for inches and feet, $x = \sqrt{\frac{144}{.7854}}$.

In a cube, $x = 1$. For inches and feet, $x = \sqrt{\frac{144}{1}} = 12$.

In a ſphere, circumference $= 1$, for inches and feet, $x = \sqrt{\frac{1728}{.0169}}$, &c.

PROB. I.

To draw a right line from one place to another.

RULE.

If it be a ſmall diſtance, apply a ruler, to the two points the line is to paſs through, and by the edge of it draw a line with a pin, or pencil, or with pen and ink.

If the diſtance be great, ſtretch a line from one place to the other. And if it be a plane chalk the line, and cauſe it to ſpring againſt that plane, and it will leave the mark of a right line. If ſtakes be placed all the way between the eye and any diſtant point, they will ſtand in a right line.

PROB. II.

To meaſure the length of any right line.

RULE.

If the diſtance be ſhort, open a pair of compaſſes to the extent of the line, and apply it to a ſcale of equal parts, and you will have the length in the ſame ſort of parts.

If the diſtance be great, apply any meaſure, as a foot, yard, &c. to one end of the line, and extend it as far as it will reach directly forward; do thus as often as you can, till you come to the other end; then

Fig. then ſo many times as you applied that meaſure, ſo many feet or yards your line is of.

Or extend a line from one end to the other; and meaſure the length of that line, by applying any meaſure to it, as oft as you can; and you will ſee how many of theſe meaſures it contains.

In taking the dimenſions of any ſurface or ſolid, they muſt all be taken by one ſort of meaſure; all feet, all yards, &c.

PROB. III.

To draw one line parallel to another, thro' any point.

RULE.

1. Let AB be the line and D the point; from the point D take the neareſt diſtance to the line AB, with a pair of compaſſes, or with a thread. And from ſome other point A in the line AB, ſet off the ſame diſtance to C, and deſcribe a ſmall arch at C. Draw a line from D to touch the arch at C; then CD is parallel to AB.

SCHOLIUM.

Theſe parallels are ſuppoſed both of them to be drawn upon ſome plane ſurface. But if one of them, as CD, be ſuppoſed to be in the air; beſides the equal diſtances, care muſt be taken, that they both be in the ſame plane; and that may be known, by applying the eye to one of them, as CD, for if it cover the other AB, then they are in one plane, otherwiſe not.

PROB.

Fig.

PROB. IV.

To raiſe a perpendicular to a right line, to paſs thro' a given point.

RULE.

Apply a ruler to that line, then apply one ſide of a ſquare to the ruler, ſo that the other ſide may paſs thro' the point; or elſe that another rule applied thereto may paſs thro' the point; then draw a line by the ſide of the ſquare or the ruler.

Or draw a thread from that point, ſo that it may coincide with the ſide of the ſquare, while the other ſide lies upon, or coincides with the given line; and the thread will be a perpendicular.

Otherwiſe.

Make the baſe AB, 4; the height BC, 3, and, 2.
the ſide AC, 5, feet, yards, &c. and then CB is perpendicular to AB.

PROB. V.

To raiſe a perpendicular upon a plane to paſs thro' any point.

RULE.

Extend a thread from the point to the plane, and put it in ſuch a poſition, that it may juſt coincide with one ſide of a ſquare, when the other ſide is laid on the plane, round about the thread on every ſide. Then the thread is a perpendicular to the plane.

Or extend a thread from the point to three diſtinct places on the plane. Find the centre of a circle paſſing thro' thoſe three points, which is ſoon done by a few trials: then a line, paſſing through that center and the given point, is a perpendicular.