COCKER, E

Ingenious COCKER! (Now to Rest thou'rt Gone
Noe Art can Show the fully but thine own.
Thy rare Arithmetick alone can show
Th'vast Sums of Thanks wee for thy Laboure owe.

Cocker's ARITHMETICK:

BEING

A Plain and familiar Method, ſuitable to the meaneſt Capacity for the full underſtanding of that Incomparable Art, as it is now taught by the ableſt School-maſters in City and Country.

COMPOS'D

By *Edward Cocker*, late Practitioner in The Arts of Writing, Arithmetick, and Engraving. Being that ſo long ſince promiſed to the World.

PERUSED and PUBLISHED

By *John Hawkins*, Writing Maſter near St. *George's* Church in *Southwork*, by the Author's correct Copy, and commended to the World by many eminent Mathematicians and Writing Maſters in and near *London*.

The Six and Twentieth Edition carefully Corrected, with Additions.

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LONDON:
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TO his much Honoured Friend, *Manwarning Davies* of the *Inner Temple*, Esquire, and Mr. *Humphry Davies* of St. *Mary Newington Butts*, in the County of *Surry*;

John Hawkens, As an Acknowledgment of Unmerited Favours; humbly Dedicateth this *Manuel of Arithmetick.*

To the READER.

Courteous Reader,

I Having the Happineſs of an Intimate Acquaintance with Mr. *Cocker* in his Life-time, often ſolicited him to remember his Promiſe to the World, of Publiſhing his *Arithmetick*, but (for Reaſons beſt known to himſelf he refuſed it; and (after his Death) the Copy falling accidentally into my Hands, I thought it not convenient to ſmother a Work of ſo conſiderable a moment, not queſtioning but it might be as kindly accepted, as if it had been preſented by his own Hand. The Method is familiar and eaſie, diſcovering as well the Theorick as the Practick of that Neceſſary Art of *Vulgar Arithmetick*: And in this new Edition there are many remarkable alterations for the benefit of the Teacher or Learner, which I hope will be very acceptable to the World: I have alſo performed my Promiſe in publiſhing the *Decimal Arithmetick*, which finds Encouragement to my Expectation, and the Bookſellers too, I am

Thine to ſerve thee,

John Hawkins.

Mr.

Mr. *Edward Cocker's*

PROEME or PREFACE.

BY *the ſacred Influence of Divine Provi-dence, I have been Inſtrumental to the benefit of many, by vertue of thoſe uſeful Arts,* Writing *and* Engraving: *And do now with the ſame wonted alacrity caſt this my Arith-metical Mite into the Publick Treaſury, be-ſeeching the Almighty to grant the like Bleſ-ſing to theſe as to my former Labours.*

Seven Sciences ſupremely excellent.
Are the chief Stars in Wiſdoms Firmament.
Whereof Arithmetick is one, whoſe worth
The Beams of Profit and Delight ſhines forth;
This crowns the reſt; this makes Man's mind com-pleat;
This treats of Numbers, and of this we treat.

I have been often deſired by my intimate Friends to publiſh ſomething on this Subject; who in a pleaſing Freedom have ſignified to me that they expected it would be extraordinary. How far I have anſwered their Expectation, I know not; but this I know, that I have de-ſigned this Work not extraordinary abſtruſe or profound,

profound, but have by all means possible within the Circumference of my Capacity, endeavoured to render it extraordinary useful to all those, whose Occasions shall induce them to make use of Numbers. If it be objected that the Books already published, treating of Numbers, are innumerable, I Answer, that's but a small wonder, since the Art is infinite. But that there should be so many excellent Tracts of Practical Arithmatick extant, and so little practised, is to me a greater wonder; knowing that as Merchandise is the Life of the Weal-Publick, so Practical Arithmatick is the Soul of Merchandize. Therefore I do ingeniously profess, that in the beginning of this Undertaking, the numerous Concerns of the honoured Merchants first possessed my Consideration: And how far I have accommodated this Composure for his most worthy Service, let his own profitable Experience be judge.

Secondly, *For your Service, most excellent Professors, whose Understandings soar to the Sublimity of the Theory and Practice of this Noble Science, was this Arithmatical Tractate composed; which you may please to imploy as a Monitor to instruct your young* Tyroes, *and thereby take occasion to reserve your precious Moments, which might be exhausted that way, for your more important Affairs.*

Thirdly,

Thirdly, *For you, the ingenious Off-spring of happy Parents, who will willingly pay the full Price of Industry and Exercise for those Arts and choice Accomplishments which may contribute to the Felicity of your future State. For you, I say, (ingenious Practitioners) was this Work composed, which may prove the Pleasure of your Youth, and the Glory of your Age.*

Lastly, *For you the pretended Numerists of this vapouring Age, who are more disingeniously witty to propound unnecessary Questions, than ingeniously judicious to resolve such as are necessary. For you was this Book composed and published, if you will deny your selves so much as to invert the streams of your Ingenuity, and by studiously conferring with the Notes, Names, Orders, Progress, Species, Properties, Proprieties, Proportions, Powers, Affections and Applications of Numbers delivered herein, become such Artists indeed, as you now only seem to be. This Arithmetick ingeniously observed, and diligently practised, will turn to good account to all that shall be concerned in Accompts. All whose Rules are grounded on Verity and delivered with Sincerity. The Examples are built up gradually from the smallest Consideration to the greatest. All the Problems or Propositions are well weighed,*

weighed, pertinent, and clear, and not one of them throughout the Tract taken upon trust; therefore now,

Zoilus and *Momus* lie you down and die,
For these Inventions your whole force defie.

Edward Cocker.

Courteous

urteous Reader,

Being well Acquainted with the deceased Author, and finding him knowing and studious in the Mysteries of Numbers and Algebra, of which he had some choice Manuscripts, and a great Collection of Printed Authors in several Languages, I doubt not but he hath writ his Arithmetick suitable to his own Preface, and worthy Acceptation; which I thought to certify on a Request to that purpose made to him that wisheth thy Welfare, and the progress of Arts.

John Collens.

November 27th, 1677.

This Manuel of Arithmetick is recommended to the World by Us whose Names are Subscribed, viz.

Mr. *John Collens* } Matth.	Mr. *William Mason*
Mr. *James Atkinson* } Matth.	Mr. *Steph. Thomas*
Mr. *Peter Perkins* } Matth.	Mr. *Peter Storey*
Mr. *Rich. Lawrence*, Senior	Mr. *Benj. Tichbourn*
Mr. *Eleazer Wigan*	Mr. *Joseph Symmonds*
Mr. *Rich. Noble of* Guilford	Mr. *Jerem. Miles*
Mr. *William Norgate*	Mr. *Josiah Cuffley*
	Mr. *John Hawkens*

And generally Approved by all Ingenious Artists.

A Table

A Table of the Contents of this BOOK.

CHAP

CHAP. I.

Notation of Numbers.

1. A*Rithmetick* is an Art of Numbring or Knowledge, which teacheth to Number well, (*viz.*) the Doctrine of Accounting by Numbers. And there are divers Species and Kinds of *Arithmetick* and *Geometry*, the which we do intend to treat of in order; applying the Principles of the one to the Definitions of the other: For as Magnitude or Greatneſs is the Subject of *Geometry*, ſo Multitude or Number is the Subject of *Arithmetick*; and if ſo, then their firſt Principles and chief Fundamentals, muſt have like Definitions; or at leaſt, a Semblable Congruency.

2. Number is that by which the Quantity of any thing is expreſſed or numbred; as the Unit is the Number by which the quantity of one thing is expreſſed or ſaid to be one, and two by which it is named two, and $\frac{1}{2}$ half, by which it is named or called half, and the Root of 3, by which it is called the Root of 3, the like of any other.

3. Hence it is that Unit is number; for the part is of the ſame matter that is his whole, the Unit is part of the multitude of Units, therefore the Unit is of the ſame matter that is the multitude of Units; but the matter of the multitude of Units is Number, therefore the matter of Unit is Number; for elſe if from a given number, no number be ſubtracted, the Number given remaineth; let three be the number given; from which number ſubtract or take away one, (which as ſome conceive, is no number) therefore the

number given remaineth, that is to say, there remaineth three, which is absurd.

4. Hence it will be convenient to examine from whence Number hath its rise or beginning: Most Authors maintain, that Unit is the beginning of Number, and it self no Number; but looking upon the Principles and Definitions in the first Rudiments of Geometry, we shall find, that the Definition of a Point is in no way congruous with the Definition of an Unit in Arithmetick; and therefore One, or Unit must be in the bounds or limits of Number, and consequently the beginning of Number is not to be found in the number One; wherefore to make Number and Magnitude congruent in Principles, and like in Definitions, we make and constitute a Cypher to be the beginning of Number, or rather the Medium between encreasing and decreasing Numbers, commonly called absolute or whole Numbers, and Negative or Fractional Numbers, between which nothing can be imagined more agreeable to the Definition of a Point in Geometry; for as a Point is an adjunct number, and it self no Line, so is (o) Cypher an adjunct of number, and it self no number: And as a Point in Geometry cannot be divided or increased into parts; so likewise (o) cannot be divided or increased into parts; for as many Points though in number infinite do make no Line, so many (o) Cyphers, though in number infinite do make no Number. For the line A B cannot be increased by the addition of the Point C, neither can the number D be increased by the addition of the (o) Cypher E: for if you add nothing to 6, the Sum will be 6, (o) neither increasing nor diminishing the number 6, but if it be granted that A B be extended or prolonged to the Point C, so that A C be made a continued line, then A B is increased by the addition of the Point C: in like maner

A———— ——B
C

D 6
E o
sum

A———B———C

C E
6 o } 60

if

if we grant D (6) be prolonged to E (o) so that D E (60) be a continued number making 60, then 6 is augmented by the aid of (o) as to the constituting the number (60) sixty; and furthermore that One or Unit is material and a number, and that (o) is the beginning of number is proved by all Authors, altho' indirectly, for the Tables of Sines and Tangents prove one Degree to be a number, because the Sine of 1 Degree is 174524 (the Radius being 1000000) and the beginning of that Table is (o) to it answereth 00000, *&c.*

5. Hence it is that Number is not Quantity discontinu'd, for all that which is but one quantity, is not quantity disjunct, (60) sixty as it is a number, is one quantity, *viz.* one number (60) sixty; therefore as it is number, it is not quantity disjunct; for number is some such thing in Magnitude, as humidity in Water; for as humidity extends it self through all and every part of Water, so number related to magnitude, doth extend it self through all and every part of magnitude. Also as to continued Water doth answer continued Humidity, so to a continued magnitude doth answer a continued number. As the continued humidity of any intire Water, suffereth the same Division and distinction that his Water doth; so the continued Number suffereth the same division and distinction that his magnitude doth. From all which Considerations we might enlarge a further digression concerning number and magnitude, by comparing the definitions of the one with the Principles of the other, for having found a (o) Cypher to be answerable in definition to a Point in magnitude, we may very well conclude that number may be congruent to a line; as also the Figurative Number to be consonant in definition with a Superficies, and Solid, *&c.* in the order of Geometrical Magnitudes.

6. The Characters or Notes by which Numbers are signified, or by which a Number is ordinarily expressed are these following. (*viz.*) o Cypher or nothing, 1 One, 2 two, 3 Three, 4 Four, 5 Five, 6 Six, 7 Seven, 8 Eight, 9 Nine: The Cypher, which though of it

ſelf ſignifieth nothing, (*viz.*) expreſſeth not any certain or known quantity, but is the Beginning, Radix, or Root of Number, and the other nine Figures, or Characters are called ſignificant Figures or Digits.

7. In Numbers of any ſort, two things are to be conſidered, (*viz.*) Notation and Numeration.

8. Notation teacheth how to deſcribe any Number by certain Notes and Characters, and to declare the value thereof being ſo deſcribed, and that is by Degrees and periods.

9. A Degree conſiſts of three Figures, (*viz.*) of three places comprehending Units, Tens, and Hundreds, ſo 365 is a degree, and the firſt figure (5) on the Right-hand, ſtands ſimply for its own value, being Units or ſo many Ones, (*viz.*) five; the ſecond in order from the Right, ſignifies as many times ten, as there are Units contained in it, (*viz.*) ſixty; the third in the ſame order ſignifies ſo many hundreds as it contains Units, ſo will the expreſſion of the Number be three hundred ſixty five; alſo 789, is ſeven hundred eighty nine, &c.

10. A period is when a Number conſiſts of more than three figures, or places, and whoſe proper order is to prick or diſtinguiſh every third place beginning at the Right-hand, and ſo on to the Left; ſo the Number 63452 being given, it will be diſtinguiſhed thus, 63.452, and expreſſed thus, ſixty three thouſand, four hundred fifty two, likewiſe 4.578. 235.782, being diſtinguiſhed as you ſee, will be expreſſed thus, Four thouſand five hundred ſeventy eight millions, two hundred thirty five thouſand, ſeven hundred eighty two.

11. Number is either Abſolute or Negative.

12. An abſolute, or intire, whole, increaſing Number, is that which by annexing of another Figure or Cypher, it becomes ten times as much as it ſtood for before; and if two Figures or Cyphers be annexed, it makes it an hundred times more than it ſtood for before, &c. as if you annex to the Figure 6 a Cypher, then it will become (60) ſixty: ſo if two Cyphers are annexed,

annexed, then it will be (600) ſix hundred, and if you do annex to it a (4) four, then it will be (64) ſixty four; and if you annex (78) ſeventy eight, it will be then (678) ſix hundred ſeventy eight, and ſo on: By annexing more Figures or Cyphers, it will increaſe in a decuple proportion *ad Infinitum.*

13. A Negative, or Broken, Fractional Decreaſing Number, is that which by prefixing a Point or Prick towards the Left-hand its value is decreaſed from ſo many Units, to ſo many tenth parts of any thing, and if a Point and (0) Cypher, or a Digit be prefixed, it will be then ſo many hundred parts, and if a Point and two Cyphers or Digits be prefixed, its value is decreaſed to be ſo many thouſand parts; as if you would prefix before the Figure 3 a Point (.) or Prick thus (.3) it is then decreaſed from 3 Units or 3 Integers, to (3) three tenth parts of an Unit or 3 Integer: and if you prefix a Point and Cypher thus (.03) it is decreaſed from 3 Integers to 3 hundred parts of an Integer, and by this means 5 *l.* Abſolute, by prefixing of a Point will be decreaſed to 5 *l.* Negative, which is 5 tenth parts of a Pound, equal in value to ten Shillings, and ſo by prefixing of more Cyphers or Digits, its value is decreaſed in a decuple proportion *ad Infinitum.* As in the following Scheme, or rather order of Numbers, we have placed (0) Cypher in its due place and order, as it is both the beginning and medium of Number; for going from (0) towards the Left-hand you deal with intire, abſolute, whole, increaſing Numbers.

Increaſing	*Numbers.*				*Decreaſing*	*Numbers.*		
29	876	543	256	2 1 0 1 2	345	678	976	3
mm	mmm	mmm	mmm	CXUXC	mmm	mmm	mmm	m
mm	mmm	mmm	CX		XC	mmm	mmm	m
mm	mmm	CX				XC	mmm	m
mm	CX						XC	
X								

But going from (0) the place of Units towards the Right-hand, you meet with broken, negative, fractional and decreaſing Numbers. And hence it follows that

Multiplication encreaseth the Product in absolute Numbers, but decreaseth the Product in negative Numbers. Also Division decreaseth the Quotient in whole Numbers, and increaseth it in negative or Fractional Numbers.

14. An absolute, entire, whole, increasing *Number*, hath always a Point annexed towards the Right-hand; and therefore,

15. A negative, broken, decimal, decreasing *Number*, hath always a Point prefixed before it towards the Left-hand. When we express Integers or whole *Numbers*, as 5 *Pounds*, 5 *Feet*, 26 *Men*, we usually annex a Point or prick after the *Number* thus, 5. 5. 26. 347. *l. feet. men. inch.* But when we express *Decimals*, or *Numbers* that are denied to be entire, as decreasing *Numbers*, we do commonly prefix a point or prick before the said Decimal or decreasing *Number*, thus (.3), that is 3 tenths, or 3 primes .03. that is 3 hundredths, or 3 seconds.

16. A whole or absolute *Number* is an Unit, or a composed multitude of Units, and it is either a prime or else a compounded *Number*.

17. Prime *Numbers* amongst themselves are those which have no multitude of Units for a common measurer, as 8 and 7, or 18 and 13, because not any multitude of Units can equally measure or divide them without a Remainder.

18. Compound *Numbers* amongst themselves are those which have a multitude of Units for a common measurer, as 9 and 12, because 3 measures them exactly, and abbreviates them to 3, and

19. A broken *Number* commonly called a Fraction, is a part or parts of a whole *Number viz.* a part of an Integer, as $\frac{1}{3}$ one third, is one third part of an Unit.

20. A broken *Number* or Fraction, consists of 2 parts, *viz.* the Numerator and Denominator.

21. The Numerator and Denominator of a Fraction, are set one over the other, with a line between them; and the Numerator is set above the line, and expresseth the parts therein contained.

22. The

22. The Denominator of a Fraction is the inferiour *Number* placed below the line, and expresseth the number of parts into which the Unit or Integer is divided; as let $\frac{3}{4}$ be the Fraction given, so shall 3 be the Numerator, and doth express or *number* the multitude of parts contained in this Fraction; for $\frac{3}{4}$ is a Fraction composed of Fourths or Quarters; and the figure 3 in *numbring* shews us, that in that Fraction there are three of those fourth parts or quarters; also in the same Fraction $\frac{3}{4}$, 4 is the *Denominator*, and doth express the quality of the Fraction, *viz.* that the whole, or Integer, is here divided into 4 equal parts.

23. A broken *Number* is either proper or improper, *viz.* proper, when the *Numerator* is lesser than the *Denominator*; for $\frac{3}{4}$ is a perfect proper Fraction, but an improper Fraction hath its *Numerator* greater, or at least equal to the *Denominator*; thus $\frac{13}{1}$ is an improper Fraction, the reason is given in the definition.

24. A proper broken *Number* is either *Simple* or *Compound*, *viz.* *Simple*, when it hath one *denomination*; and *Compound* when it consisteth of divers *Denominations*, If $\frac{3}{4}$ *l.* $\frac{6}{12}$, $\frac{25}{100}$ *l.* were given, we say they are either of them single or *simple Fractions*, because they consist but of one *Numerator* and one *Denominator*; but if $\frac{3}{4}$ of $\frac{6}{32}$ of $\frac{25}{100}$ of a Pound *Sterling* were given, we say, that is a *compound broken Number*, or *Fraction*, because the expression and representation consisteth of more *Denominations* than one; and such by some are called *Fractions of Fractions*, and they have always this Particle (of) between them.

25. When a single *broken number* or *Fraction* hath for his *Denominator* a *Number* consisting of a Unit in the first place towards the Left-hand, and nothing but Cyphers from the Unit towards the Right-hand, it is then the more aptly and rightly called a *Decimal Fraction*; under this Head are all our decreasing *Numbers* placed, and in our 13th. *Definition* called Negative, and by that order there prescribed, we order them to be *Decimals*, by signing a point or prick before them, or the *Numerator* rejecting the *Denominator*: Therefore ac-

cording to our last Rule, $\frac{5}{10}$, $\frac{5}{100}$, $\frac{25}{100}$, $\frac{25}{1000}$, are said to be *Decimals*; and a *Decimal Fraction* may be expressed without its *Denominator* (as before) by prefixing a point or prick before the *Numerator* of the said *Fraction*, and then shall the former *Fraction* $\frac{5}{10}$ and $\frac{25}{100}$, stand thus 5, and .25.

But oftentimes, as in the second and fourth *Fractions* $\frac{5}{100}$ and $\frac{25}{1000}$, a prick or point will not do without the help of a Cypher or Cyphers prefixed before the significant Figures of the *Numerator*, and therefore when the *Numerator* of a *Decimal Fraction*, consisteth not of so many places as the *Denominator* hath Cyphers, fill up the void places of the *Numerator*, with prefixing Cyphers before the significant Figures of the *Numerator*, and then sign it for a *Decimal*, so shall $\frac{5}{100}$ be .05, and $\frac{25}{1000}$ will be .025, and $\frac{72}{10000}$ will be .0072. Now by this we may easily discover the *Denominator* having the *Numerator*; for always the *Denominator* of any *Decimal Fraction* consists of so many Cyphers, as the *Numerator* hath places, with an Unit prefixed before the said Cyphers, *viz.* under the point or prick.

26. A *Decimal Number* or *Fraction*, is that which is expressed by *Primes*, *Seconds*, *Thirds*, *Fourths*, &c. and is number decreasing. Here instead of *Natural* and *Common Fractions*, as $\frac{3}{4}$ of a thing, we order the thing or Integer into *Primes*, *Seconds*, *Thirds*, *Fourths*, *Fifths*, &c. that our expression may be consonant to our former order.

27. In *Decimal Arithmetick* we always imagine (and it would be very commodious if it were really so) that all intire Units, Integers, and things are divided first into ten equal parts, and these parts so divided we call *Primes*: and secondly, we divide also each of the former *Primes* into other ten equal parts, and every of these divisions we call *Seconds*; and thirdly, we divide each of the said *Seconds* into ten other equal parts, and those so divided we call *Thirds*; and so by decimating the former, and subdecimating these latter, we run on *ad Infinitum*.

28. Let a Pound *Sterling*, *Troy-weight*, *Averdupois-weight*,

weight, *Liquid-Meaſure*, *Dry-Meaſure*, *Long-Meaſure*, *Time*, *Dozen*, or any other thing, or Integer be given to be *decimally* divided ; in this notion premiſed we ought to let the firſt Diviſion be *Primes*, the next diviſion *Seconds*, the next *Thirds*, &c. So one Pound *Sterling* being 20 Shillings, which divided into ten equal parts, the value of each part will be 2 Shillings ; therefore one *Prime* of a Pound Sterling will ſtand thus, (.1) which is in value 2 Shillings, three *Primes* will ſtand thus (.3) and that is in value 6 Shillings. Again, a *Prime* or .1 being divided into ten equal parts, each of thoſe parts will be one *Second*, and is thus expreſſed, (.01) and its value will be found to be 2*d.* Farthing, and $\frac{6}{10}$ of a Farthing ; and ſo will .05 ſignifie one Shilling, or five *Seconds*. And if .01 be divided into ten other equal parts, each of thoſe parts ſo divided will be *Thirds*, and will ſtand thus .001, and its value will be found to be .96 of a Farthing, or $\frac{96}{100}$ of a Farthing ; and .009 *Thirds* will be 2*d.* and .64 of a Farthing, or $\frac{64}{100}$ of a Farthing, *&c.* So that .375 *l.* will be found to repreſent 7 *s.* 6 *d.* ; for the 3 *Primes* are 6 Shillings, and the 7 *Seconds* are 1 *s.* 4 *d.* and $\frac{8}{10}$ of a Penny, and the 5 *Thirds* are 1 Penny, and $\frac{2}{10}$ of a Penny, both which added together make 7 *s.* 6 *d.*

29. If you put any bulk or body, repreſenting an Integer if it be *decimally divided*, then the parts in the firſt decimation are *Primes*, the next *Seconds*, and the next decimation is *Thirds*, the next *Fourths*, &c. As let there be given a Bullet of Lead, or ſuch like, whoſe weight let it be 50 *l. Troy*, this call an Unit, Integer, or thing, then with the like weight and matter, make 10 other, the which together will be equal to 50 *l.* and will weigh each of them 5 *l.* a-piece, take of the ſame matter, and equal to 5 *l.* make 10 more, then each of thoſe will weigh 6 Ounces a-piece ; alſo, if again you take 6 Ounces, and thereof make 10 other ſmall Bullets, each of them will weigh 12 penny weight *Troy* ; and thus have you made *Primes*, *Seconds*, and *Thirds*, in reſpect of the Integer containing 50 *l. Troy* ; and that 5 *Primes* is equal to the half Maſs, and 2 *Primes*, and 5 *Se-*

B 5 *conds*

conds is a quarter of the maſs; and therefore 1 of the firſt diviſion, 2 of the ſecond diviſion, and 5 of the third diviſion, will be equal in weight to $\frac{1}{2}$ a quarter of the maſs, and contain 6 *l.* and 4 Ounces.

30. When a *Decimal Fraction* followeth a whole *Number*, you are to ſeparate or part the *Decimal* from the *whole Number* by a point or prick; ſo if .75 followed the *whole Number* 32, ſet them thus 32.75. You ſhall find that divers Authors have divers ways in expreſſing mixt *Numbers*, as thus, 32|75, or $32\frac{75}{100}$ or 32.75, or $32|\underline{75}$, or 32;75, but you will find that 32.75 thus placed and expreſſed is fitteſt for Calculation.

31. A mixt *Number* hath 2 parts, the whole and the broken; the whole is that which is compoſed of Integers, and the broken is a *Fraction* annexed thereunto. So the mixt *Number* $36\frac{8}{12}$ being given, we ſay that 36 is the whole *Number*, which is compoſed of Integers, and the $\frac{8}{12}$ is the broken *Number* annexed, which ſheweth that one of the former Integers (of that 36) being divided into 12 parts, this $\frac{8}{12}$ doth expreſs 8 of thoſe 12 parts more belonging to the ſaid 36 Integers.

32. *Denominative Numbers* are of one, or of many, and thoſe are of divers ſorts and kinds, *viz.* *Singular*, called Unit, as 1; and *Plural*, called multitude, as 2, 3, 4, 5; *Single* of one kind only, called *Digits*, as 1, 2, 3, 4, 5, 6, 7, 8, 9, and *Compounds* of many, 10, 11, 12. &c. 102, 367, &c.

Proportional, as Single, Multiple, Double, Triple, Quadruple, &c. Denominate, as Pounds, Shillings, Pence; Undenominate, as 1, 2, 3, &c. Perfect, as 6, 28, 496, 8128, 130816, 2099128; &c. whoſe parts are equal to the Numbers; Imperfect, unequal and more than the Sum, as 12 to 1, 2, 3, 4, 6, Imperfect, unequal and leſs than the Sum, as 8 to 1, 2, 4. Numbers Commenſurable and Incommenſurable, as 12 and 9 are Commenſurable, becauſe 3 meaſures them both; but 6 and 17 are Incommenſurable, becauſe no one common *number* or *meaſure* can meaſure them. Linear, in form of a Line, as .... Superficial in form of a Superficies or Plane, as : : : ., or ⋮ ⋮, &c. and number

ber cubical or solid in form of a Cube. These two latter are otherwise called figurative Numbers: There are also other Numbers called Tabular, as Sines, Tangents, Secants, *&c.* Others that be called Logarithms or borrowed Numbers, fitted to proportion for ease and speedy Calculation of all manner of Questions.

CHAP. II.

Of the Natural Division of Integers, and the several Denominations of the Parts.

1. BEfore we come to calculation or the ordering of *Numbers* to operate any Arithmetical Question proposed, we will lay down Tables of the Denomination of several Integers; and after that (having mentioned the several species and kinds of Arithmetick) we shall immediately handle the species of Numeration; which are the main Pillars upon which the whole Fabrick of this Art is built.

Of Money, Weights, &c.

2. The least Denomination or Fraction of Money used in *England* is a Farthing, from whence is produced the following Table, called the *Table of Coyn*, *viz.*

1 *Farth.*	make	1 *Farthing*
4 *Farth.*	make	1 *Penny*
12 *Pence*	make	1 *Shilling*
20 *Shill.*	make	1 *Pound*

And therefore

l.	*s.*	*d.*	*qrs.*
1	20	12 ——	4
1	20	240 —	960
	1	12	48
		1 ——	4

The first of these Tables, *viz.* that on the Left-hand, is plain and easy to be understood, and therefore wants no no directions. In the second Table above the line you have 1 *l.* 20 *s.* 12 *d.* 4 *qrs.* whereby is meant that 1 Pound is equal to 20 Shillings, and one Shilling is equal to 12 Pence, and one Penny is equal to 4 Farthings; under the line is 1 *l.* 20 *s.* 240 *d.* 960 *qrs.* which signifie, one Pound to contain 20 Shillings, or 240 Pence, or 960 Farthings; in the second line below that 1 *s.* 12 *d.* 48 *qrs.* the first standing under the denomination of Shillings, whereby is to be noted that one Shilling is equal to 22 Pence, or 48 Farthings, and likewise that below that, one Penny is equal in value to four Farthings; understand the like reason in all the following Table of Weight, Measure, Time, Motion and Dozen.

Of Troy Weight.

3. The least Fraction or Denomination of Weight used in *England*, is a Grain of Wheat gathered out of the middle of the Ear, and well dried; from whence are produced these following Tables of Weight called *Troy weight.*

32 *Grains of Wheat*	make	24 *Artificial Grains*
24 *Artificial Grains*	make	1 *Penny-weight*
20 *Penny-weight*	make	1 *Ounce*
12 *Ounces*	make	1 *Pound Troy-weight*

And therefore

l.	*oun.*	*p.w.*	*grains.*
1	12	20	24
1	12	240	5760
	1	20	480
		1	24

Troy weight serveth only to weigh Bread, Gold, Silver, and Electuaries; it also regulateth and prescribeth a Form how to keep the Money of *England* at a certain Standard

Standard. The *Goldsmiths* have divided the Ounce *Troy-weight* into other parts, which they generally call Mark-weight; the denominative parts thereof are as followeth, *viz.* A Mark (being an Ounce *Troy*) is divided into 24 equal parts called Carects and each Carect into 4 Grains, so that in a Mark are 96 Grains; by this Weight they distinguish the different fineness of their Gold; for if to the fineness of Gold be put 2 Carects of Alloy (which is of Silver, Copper, or other baser Metal, with which they use to mix their Gold or Silver to abate the fineness thereof) both making when cold but an Ounce, or 24 Carects, then this Gold is said to be 22 Carects fine, for if it come to be refined the 2 Carects of Alloy will fly away, and leave only 22 Carects of pure Gold, the like to be considered of a greater or lesser quantity; and as the fineness of Gold is estimated by Carects, so the fineness of Silver is distinguish'd by Ounces; for if a Pound of it be pure, and loseth nothing in the Refining, such Silver is said to be twelve Ounces fine; but if it loseth any thing, it is said to contain so much fineness as the loss wanteth of 12 Ounces, as if it lose an Ounce, it is said to be 11 Ounces fine, and if it lose one Ounce 14 Penny-weight, then it is said to be 10 Ounces 6 Penny-weight fine, and that which loseth 2 Ounces 4 Penny-weight 16 Grains, is said to be 9 Ounces 15 Penny-weight 8 Grains fine, *&c.* the like of a greater or lesser quantity.

Of Apothecaries Weights.

4. The *Apothecaries* have their Weights deduc'd from *Troy-weight*, a Pound *Troy* being the greatest Integer, a Table of whose Division and Sub-division followeth, *viz.*

			And therefore				
			l.	*oun.*	*drams*	*scrup.*	*gr.*
1 *pound*	make	12 *ounces*	1	12	8	3	20
1 *ounce*		8 *drams*	1	12	96	288	5760
1 *dram*		3 *scruples*		1	8	24	480
1 *scrup.*		20 *geains*			1	3	60
						1	20

5. Thus much concerning *Troy-weight*, and its derivative Weights (which as was ſaid before) ſerveth to weigh Bread, Gold, Silver, and Electuaries; now beſides *Troy-weight* there is another kind of Weight uſed in *England*, commonly known by the name of *Averdupois-weight* (a Pound of which is equal to 14 Ounces 12 Penny-weight *Troy weight*) and it ſerveth to weigh all kinds of Grocery wares, as alſo Butter, Cheeſe, Fleſh, Wax, Tallow, Roſin, Pitch, Lead, and all ſuch kind of Garble, the Table of which Weight is as followeth.

The Table of Averdupois-weight.

4 *quarters of a dram*	make	1 *dram*
16 *drams*		1 *ounce*
16 *ounces*		1 *pound*
28 *pounds*		1 *quarter of a hundred*
4 *quarters*		1 *hundred weight at* 112 *l.*
20 *hundred*		1 *tun*

And therefore,

Tun	*C.*	*qrs.*	*l.*	*oun.*	*drams*	*qrs.*
1	20	4	28	16	16	4
1	20	80	2240	35843	573440	2293760
	1	4	112	1792	28672	114688
		1	28	448	7168	28672
			1	16	256	1024
				1	16	64
					1	4

Wool is weighed with this Weight, but only the Diviſions are not the ſame; A Table whereof followeth.

A Table of the denominative parts of Wool-weight.

7 *pounds*	make	1 *clove*
2 *cloves*		1 *ſtone*
2 *ſtones*		1 *todd*
6 *todd* 1 *ſtone*		1 *wey*
2 *weys*		1 *ſack*
12 *ſacks*		1 *laſt*

And

And therefore,

Last	*Sack*	*Wey*	*Todd*	*Stone*	*Cloves*	*l.*
1	12	2	$6\frac{1}{2}$	2	2	7
1	12	24	156	312	624	4368
	1	2	13	26	52	364
		1	$6\frac{1}{2}$	13	26	182
			1	2	4	28
				1	2	14
					1	7

Note, That in some Counties, the *Wey* is 256 *l. Averdupois*, as in the *Suffolk Wey*; but in *Essex* there is 336 *l.* in a Wey.

6. The least denominative part of *Liquid Measure* is a Pint, which was formerly taken from *Troy-weight*, (a Pound of Wheat *Troy-weight* making a Pint of *liquid Measure*) but in regard of the difference between the Brewers and the Farmers of Her Majesty's Excise concerning the Gauging of Vessels occasioned by the different Opinions of Artists, concerning the solid Inches in a Gallon; it was lately decided by Act of Parliament, the Statute making 282 solid Inches in a Beer Gallon, and 231 in a Wine-measure, and consequently the Pint Beer-measure to contain $35\frac{1}{4}$ solid Inches, and the Pint Wine-measure to contain $28\frac{7}{8}$ cubical or solid Inches, from whence is drawn the following Table.

The Table of Liquid Measure.

$35\frac{1}{4}$ *cubical Inches*	make	1 *pint beer-measure*
$28\frac{7}{8}$ *cubical Inches*		1 *pint wine-measure*
2 *pints*		1 *quart*
2 *quarts*		1 *pottle*
2 *pottles*		1 *gallon*
8 *gallons*		1 *firk. of ale, soap or beer.*
9 *gallons*		1 *firkin of beer*
10 *gallons and a half*		1 *firk. of Salmon or Eels*
2 *firkins*		1 *kilderkin*
2 *kilderkins*		1 *barrel*
42 *gallons*		1 *tierce of wine*
63 *gallons*		1 *hogshead*
2 *hogsheads*		1 *pipe or but*
2 *pipes or buts*		1 *tun of wine*

And

And therefore

tun	*pipes*	*hhds*	*gall.*	*pints*
1	2	2	63	8
1	2	4	252	2016
	1	2	126	1008
		1	63	504
			1	8

7. The least denominative part of Dry Measure is also a Pint, and this is likewise taken from *Troy-weight*. The Table of whole Division followeth.

The Table of Dry Measure.

1 *pound Troy*	make	1 *pint*
2 *pints*	make	1 *quart*
2 *quarts*	make	1 *pottle*
2 *pottles*	make	1 *gallon*
2 *gallons*	make	1 *peck*
4 *pecks*	make	1 *bushel*
4 *bushels*	make	1 *comb*
2 *combs*	make	1 *quarter*
4 *quarters*	make	1 *chaldron*
5 *quarters*	make	1 *Wey*
2 *Weys*	make	1 *last*

And therefore,

last	*wey*	*qrs*	*com.*	*bush.*	*pecks*	*gall.*	*pints*
1	2	5	2	4	4	2	8
1	2	10	20	80	320	640	5120
	1	2	10	40	160	320	2560
		1	5	8	32	64	512
			1	4	16	32	256
				1	4	8	64
					1	2	16
						1	8

8. The

8. The least denominative part of *Long Measure* is a Barly-corn well dried, and taken out of the middle of the Ear; whose Table of parts followeth.

The Table of Long Measure.

3 *Barly-corns*	make	1 *inch*
12 *inches*		1 *foot*
3 *feet*		1 *yard*
3 *feet 9 inches, or a yard and quarter*		1 *ell English*
6 *feet*		1 *fathom*
5 *yards and a half*		1 *pole, perch or rod*
40 *poles or perches*		1 *furlong*
8 *furlongs*		1 *English mile*

And therefore,

mile	*furl.*	*poles*	*yards*	*feet*	*inches*	*barly corns*
1	8	40	5½	3	12	3
1	8	320	1760	5280	63360	190080
	1	40	220	660	7920	23760
		1	5½	16½	198	594
			1	3	36	108
				1	12	36
					1	3

And note, that the Yard, as also the Ell, is usually divided into 4 quarters, and each quarter into 4 Nails.

Note also that a Geometrical Pace is 5 Feet; and there are 1056 such Paces in an *English* Mile.

9. The parts of the Superficial Measures of Land are such as are mention'd in the following Table, *viz.*

The Table of Land Measure.

40 *square Poles or Perches*	make	1 *Rood, or quarter of an Acre*
4 *Roods*		1 *Acre*

By the foregoing *Table of Long Measure*, you are inform'd what a Pole, or (which is all one) Perch is; and by this that 40 square Perches are 1 Rood. Now a square Perch is a Superficies very happily resembled by a square Trencher, every side thereof being a Perch, or 5 Yards and a half in length, 40 of them is a Rood, and 4 Roods an Acre. So that a Superficies that is 40 Perches long and broad is an Acre of Land, the Acre containing in all 160 square Perches.

10. The least denominative part of Time is a *Minute*, the greatest Integer being a *Year*; from whence is produced this following Table.

The Table of Time.

1 *Minute*	make	1 *Minute*
60 *Minutes*		1 *Hour*
24 *Hours*		1 *Day natural*
7 *Days*		1 *Week*
4 *Weeks*		1 *Month*
13 *Months*, 1 *day 6 hou.*		1 *Year*

But the Year is usually divided into 12 unequal *Kalendar Months*, whose Names and the number of Days they contain, follow, *viz.*

	Days
January	31
February	28
March	31
April	30
May	31
June	30
July	31
Agust	31
September	30
October	31
November	30
December	31

So that the Year containeth 365 Days, and 6 Hours; but the 6 Hours are not reckoned but only every 4th Year, and then there is a Day added to the latter end of *February*, and then it containeth 29 Days, and that Year is called Leap-year, and containeth 366 Days.

And here note, that as the Hour is divided into 60 Minutes, so each Minute is subdivided into 60 Seconds, and each Second into 60 Thirds, and each Third into 60 Fourths, *&c.*

The Tropical Year by the exactest observations of the most accurate *Astronomers* is found to be 365 Days 5 Hours, 49 Minutes, 4 Seconds, and 21 Thirds.

CHAP. III.

Of the Species or Kinds of Arithmetick.

1. ARithmetick is either Natural, Artificial, Analytical, Algebraical, Lineal or Instrumental.

2. Natural Arithmetick is that which is performed by the Numbers themselves; and this is either positive or Negative. Positive which is wrought by certain infallible Numbers propounded, and this either Single or Comparative; Single which considereth the nature of *Numbers* simply by themselves; and Comparative, which is wrought by *Numbers* as they have relation one to another. And the Negative part relates to the Rule of *False*.

3. Artificial (by some the Logarithmical) Arithmetick is that which is performed by artificial or borrowed Numbers invented for that purpose, and are called Logarithms.

4. Analytical Arithmetick, is that which shews from a thing unknown to find truly that which is sought, always keeping the Species without Change.

5. Algebraical Arithmetick, is an obscure and hidden Art of Accompting by Numbers in resolving of hard Questions.

6. Lineal Arithmetick, is that which is performed by lines fitted to proportions, as Geometrical Projections.

7. Instrumental Arithmetick, is that which is performed by Instruments fitted with Circular and Right Lines of Proportion, by the motion of an Index, or otherwise.

8. The

8. The Parts of Single Arithmetick are Numeration and the Extraction of Roots.

9. Numeration, is that by which certain known Numbers propounded, we discover another Number unknown.

10. Numeration hath four Species, *viz. Addition Subtraction*, *Multiplication* and *Division*.

CHAP. IV.

Of Addition of Whole Numbers.

1. ADdition, is the Reduction of two or more *Numbers* of like kind together into one Sum or Total. Or it is that by which divers Numbers are added together, to the end that the Sum or Total Value of them all may be discovered.

The first Number in every *Addition* is called the *addible-Number*, the other, the *number* or *numbers* added, and the *number* invented by the *Addition* is called the *Aggregate* or *Sum* containing the value of the *Addition*.

The Collation of the Numbers, is the right placing of the numbers given respectively to each denomination, and the Operation, is the Artificial adding of the numbers given together in order to the finding out of the *Aggregate* or *Sum*.

2. In *Addition*, place the numbers given respectively the one above the other, in such sort, that the like degree, place or denomination, may stand in the same Series, *viz.* Units under Units, Tens under Tens, Hundreds under Hundreds, *&c.* Pounds under Pounds, Shillings under Shillings, Pence under Pence, *&c.* Yards under Yards, Feet under Feet, &c.

3. Having thus placed the numbers given (as before) and drawn a line under them, add them together, beginning with the lesser denomination, *viz.* at the Right-hand, and so on, subscribing the Sum under the line respectively; as for Example.

Let there be given 3352 and 213 and 133 to be added together, I ſet the Units in each particular number under each other, and ſo likewiſe the Tens under the Tens, *&c.* and draw a line under them, as in the Margent; then I begin at the place of Units, and add them together upwards, ſaying, 3 and 3 are 6 and 2 make 8, which I ſet under the Line, and under the ſame Figures added together; then I proceed in the next place, being the place of Tens, and add them up in the ſame manner as I did the place of Units, ſaying, 3 and 1 are 4, and 5 are 9, which I likewiſe ſet under the line reſpectively; then I go to the place of Hundreds, and add them up as I did the other, ſaying, 1 and 2 are 3 and 3 are 6, which I alſo ſet under the line; and laſtly, I go to the place of Thouſands, and becauſe there are no other Figures to add to the 3, I ſet it under the line in its reſpective place, and ſo the Work is finiſhed; and I find the Sum of the three given numbers to be 3698.

3352
213
133
3698

4. But if the Sum of the Figures of any Series exceeds Ten, or any number of Tens, ſubſcribe under the ſame the Exceſs above the Tens, and for every Ten carry one to be added to the next Series towards the Left-hand, and ſo go on till you have finiſhed your addition; always remembring, that how great ſoever the Sum of the Figures of the laſt Series is, it muſt all be ſet down under the line reſpectively. So 3678 being given to be added to 2357, I ſet them down as is before directed, and as you ſee in the Margent, with a line drawn under them, then I begin and add them together, ſaying, 7 and 8 are 15, which is 5 above 10, wherefore I ſet 5 under the line, and carry 1 for the 10 to be added to the next Series, ſaying, 1 that I carried and 5 is 6, and 7 are 13, wherefore I ſet down 3 and carry 1 (for the Ten) to the next Series, then I ſay, 1 that I carried and 3 are 4, and 6 are ten, now becauſe it comes to juſt ten and no more, I ſet 0 under the line and carry 1 for the 10 to the next, and ſay, 1 that

3678
2357
6035

that I carried and 2 are 3, and 3 are 6, which I set down in its respective place, thus the addition is ended, and the total Sum of these *Numbers* is found to be 6035; several Examples of this kind follow.

Numbers to be added	354897
	573846
	785946
	347205
Sum	2061864

Numbers to be added	748647
	465834
	76483
	648300
	1939264

Numbers to be added	45346
	38074
	8437
	923
	76
Sum	92856

5. If the Numbers given to be added, are contained under diverse denominations; as of *Pounds, Shillings, Pence and Farthings*; or of *Tuns, Hundreds, Quarters, Pounds*, &c. Then in this case having disposed of the *Numbers*, each denomination under other of like kind; beginning at the least denomination, (minding how many of one denomination do make an Integer of the next) and having added them up, for every Integer of the next greater denomination that you find therein contained, bear an Unit in mind to be added to the said next greater denomination, expressing the Excess respectively under the line, proceed in this manner until your Addition be finished; the following Examples will make the Rule plain to the Learner. Thus these several Sums being given to be added, *viz.* 136 *l.* 13 *s.* 4 *d.* 2 *qrs.* and 79 *l.* 07 *s.* 10 *d.* 3 *qrs.* and 33 *l.* 18 *s.* 90 *d.* 1 *qs.* also 15 *l.* 09 *s.* 05 *d.* 0 *qrs.* The Numbers being disposed according to order will stand as in the Margent. Then I begin at the denomination of Farthings,

and

l.	s.	d.	qrs.
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2

and add them up, saying, 1 and 3 are 4 and 2 make 6. now I consider that 6 Farthings are 1 Penny and 2 Farthings, wherefore I set down the 2 Farthings in their place under the line, and keep 1 in mind to be added to the next denomination of Pence; then I go on saying, 1 that I carried and 5 are 6, and 9 are 15 and 10 are 25, and 4 are 29, now I consider that 29 Pence are 2 Shillings and 5 Pence, wherefore I set the 5 Pence in order under the line, and keep 2 in mind for the 2 Shillings, to be added to the Shillings; then I go on, saying, that 2 I carried and 9 are 11, and 18 are 29, and 7 are 36, and 13 are 49; then I consider that 49 Shillings are 2 Pounds and 9 Shillings, whereof I set the 9 Shillings under the line, and carry 2 for the 2 Pounds, to the next and last denomination of Pounds, and proceed, saying, 2 that I carried and 5 make 7, and 3 are 10, and 9 are 19, and 6 are 25; then I set down 5, and carry 2 for the terms, and proceed, saying, 2 that I carry and 1 is 3, and 3 are 6, and 7 are 13, and 3 make 16; and I set down 6 and carry 1 for the 10, and go on, saying, 1 that I carried and 1 are 2, which I set in its place under the line, and the Work is finished; and thus I find the Sum of the foresaid *Numbers* to be 265 *l.* 9 *s.* 5 *d.* 2 *qrs.* This to the Ingenious Practitioner is sufficient; but I shall (for the further Illuminating of weaker Apprehensions) explain the Operation of another Example in *Troy-weight*; and here the Learner must take notice of the Table of *Troy-weight* mentioned or set down in the third Section of the Second Chapter. The *Numbers* given in this Example are 38 *l.* 7 *oz.* 13 *p.w.* 18 *gr.* and 50 *l.* 10 *oz.* 10 *p.w.* 12 *gr.* and 42 *l.* 08 *oz.* 05 *p.w.* 16 *gr.* and in order to the Addition thereof, I place them as you see, and proceed to Operation; saying, 16 and 12 are 28, and 18 are 46; now because 24 *Grains* make

1 *Penny*

1 *Penny-weight*, 46 *Grains* are 1 *Penny-weight* and 22 *Grains*; wherefore I set down 22 and carry 1 for the *Penny-weight*, and going on I say, 1 that I carry and 5 make 6, and 10 are 16, and 13 are 29, which is one Ounce and 9 Penny-weight, I set down 9 in its place under the line, and carry one to the Ounces, saying, 1 that I carry and 8 are 9, and 10 are 19, and 7 are 26, and because 26 Ounces makes 2 Pounds 2 Ounces, I set down 2 for the Ounces, and carry 2 to the Pounds: going on, 2 that I carry and 2 are 4, and 8 make 12, that is 2 and go 1; then 1 I carry and 4 are 5, and 5 are 10, and 3 are 13, which I set down as in the Margent, and the Work is finished, and I find the Sum of the said *numbers* to amount to 132 *l* 2 *oz.* 9 *p.w.* 22 *gr.* This is sufficient for the understanding of the following Examples, or any other that shall come to thy view. The way of proving these, or any Sums in this Rule, is shewed immediately after the ensuing Examples.

l.	*oz.*	*p.w.*	*gr.*
38	07	13	18
40	10	10	12
42	08	05	16
132	02	09	22

Addition of English Money.

l.	s.	d.	qrs.
436	12	07	1
184	00	10	3
768	17	04	2
564	11	11	0
1954	02	09	2

l.	s.	d.	qrs.
48	15	11	1
76	10	07	3
18	00	05	3
24	18	09	2
168	06	09	1

Addition of Troy-weight.

l.	oz.	p.w.	gr.
15	07	13	12
18	06	04	20
11	20	16	18
09	04	10	22
19	11	11	04
22	00	00	00
97	04	17	04

l.	oz.	p.w.	gr.
145	09	12	18
726	08	14	13
380	07	06	10
83	10	16	20
130	00	10	12
74	07	15	00
1541	08	16	01

Addition of Apothecaries Weights.

l.	oz.	dr.	sc.	gr	l.	oz.	dr.	sc.	gr.
48	07	1	0	14	60	03	4	0	10
74	05	5	2	10	48	10	6	0	34
64	10	7	1	16	34	08	2	1	15
17	08	1	0	11	18	11	2	2	11
34	09	6	1	09	160	07	1	2	15
					35	02	5	1	07
240	05	6	1	00	358	07	7	0	12

Addition of Averdupois-weight.

Tun	C.	qrs.	l.	l.	oun.	dr.
75	13	1	15	36	10	12
48	07	3	21	22	11	13
60	11	1	17	11	07	04
21	07	0	25	15	04	10
12	15	0	11	20	00	09
218	16	0	05	106	03	00

Addition of Liquid Measure.

Tun	pipe	hhd.	gal.	Tun	hhd.	gall.	pts.
45	1	1	48	30	3	40	4
15	0	1	17	12	0	28	6
38	0	0	47	47	5	60	5
12	1	0	56	57	3	22	3
21	1	1	18	17	0	00	0
133	1	1	60	166	1	26	2

Addition of Dry-Measure.

Chald.	*qrs.*	*bush.*	*pec.*
48	3	7	3
13	1	4	0
54	0	6	2
16	3	6	1
40	1	9	1
173	3	0	3

qrs.	*bush.*	*pec.*	*gall.*
17	3	1	1
50	1	3	0
14	5	3	1
40	2	0	1
23	3	3	0
152	5	3	1

Addition of Long-Measure.

yards	*qrs.*	*na.*
35	3	3
14	1	2
74	2	3
38	0	1
30	1	0
15	0	0
208	1	1

ells	*qrs.*	*na.*
56	1	3
13	3	2
48	2	1
50	1	0
74	0	2
17	1	0
260	2	0

Addition of Land-Measure.

Acre	*rood*	*perc.*
12	3	18
14	0	24
30	2	19
48	3	30
28	1	38
50	3	26
185	3	35

Acre	*rood*	*perc.*
86	1	36
47	3	24
73	2	18
60	0	07
04	2	08
14	1	14
286	3	27

The

The Proof of Addition.

6. *Addition* is proved after this manner, when you have found out the Sum of the Numbers given, then ſeparate the uppermoſt line from the reſt, with a ſtroke or daſh of the Pen, and then add them all up again as you did before, leaving out the uppermoſt line, and having ſo done add this new invented Sum to the uppermoſt line you ſeparated, and if the Sum of thoſe two lines be equal to the Sum firſt found out, then the Work was performed true, otherwiſe not. As for Example, Let us prove the firſt Example of Addition of Money, whoſe Sum we found to be 265 *l.* 9 *s.* 5 *d.* 2 *qrs.* and which we prove thus, having ſeparated the uppermoſt number from the reſt, by a line as you ſee in the Margent, then I add the ſame together again, leaving out the ſaid uppermoſt line, and the Sum thereof I ſet under the firſt Sum or true Sum, which doth amount to 128 *l.* 16 *s.* 01 *d.* 0 *qrs.* then again I add this new Sum to the uppermoſt line that before was ſeparated from the reſt, and the Sum of theſe two is 265 *l.* 09 *s.* 05 *d.* 2 *qrs.* the ſame with the firſt Sum, and therefore I conclude that the Operation was rightly performed.

l.	*s:*	*d.*	*qrs.*
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2
128	16	01	0
265	09	05	2

7. The main End of *Addition* in Queſtions Reſolvable thereby, is to know the Sum of ſeveral Debts, Parcels, Integers, *&c.* Some Queſtions may be theſe that follow.

Queſt. 1. There was an Old Man whoſe Age was required; to which he replied, I have ſeven Sons, each having two Years between the Birth of each other, and in the 44th Year of my Age my eldeſt Son was born which is now the Age of my youngeſt; I demand what was the Old Man's Age?

Now to resolve this Question, first set down the Father's Age at the birth of his first Child, which was 44, then the difference between the eldest and the youngest, which is 12 years, and then the Age of the youngest which is 44 and then add them all together, and their Sum is 100 the compleat Age of the Father.

44
12
44
100

Quest. 2. A Man lent his Friend, at several times, these several Sums; (*viz.*) at one time 63 *l.* at another time 50 *l.* at another time 48 *l.* at another time 156 *l.* now I desire to know how much was lent him in all.

Set the Sums lent one under another, as you see in the Margent, and then add them together, and you will find their Sum to amount to 317 *l.* which is the Total of all the several Sums lent, and so much is due to the Creditor.

l.
63
50
48
156
317

Quest. 3. From *London* to *Ware* is 20 Miles, thence to *Huntington* 29 Miles, thence to *Stamford* 21 Miles, thence to *Tuxford* 36 Miles, thence to *Wentbridge* 25 Miles, from thence to *York* 20 Miles. Now I desire to know how many Miles it is from *London* to *York* according to this reckoning.

Now to answer this Question, set down the several distances given, as you see in the Margent, and add them together, and you will find their Sum to amount to 151, which is the true distance in Miles between *London* and *York*.

20
29
21
36
25
20
151

Quest. 4. There are two Numbers, the least whereof is 40, and their difference is 14. I desire to know what is the greater Number, and also what is the Sum of them both? First, set down the least, *viz.* 40 and 14 the difference, and add them together, and their Sum is 54 for the greatest Number, then I

	40
	14
greatest	54
least	40
Sum	94

set

set 40 (the least) under 54 (the greatest) and add them together; and their Sum is 94 equal to the greatest and least *Numbers.*

CHAP. V.

Of Subtraction of whole Numbers.

1. SUbtraction is the taking of a lesser *Number* out of a greater of like kind, whereby to find out a third *Number*, being or declaring the inequality, excess, or difference between the *Numbers* given; or *Subtraction* is that by which one *Number* is taken out of another *Number* given, to the end that the Residue or Remainder may be known, which Remainder is also called the *Rest*, *Remainder*, or *Difference* of the *Numbers* given.

2. The *Number* out of which *Subtraction* is to be made, must be greater, or at least equal with the other *Number* given; the higher or superior *Number* is called the major *Number*, and the lower or inferior is called the minor *Number*; and the Operation of *Subtraction* being finished, the Rest or Remainder is called the Difference of the *Numbers* given.

3. In *Subtraction* place the *Numbers* given respectively, the one under the other, in such sort as like degrees places or Denominations, may stand in the same Series, *viz.* Units under Units, Tens under Tens, *&c.* Pounds under Pounds, *&c.* Feet under Feet, and Parts under Parts, *&c.* This being done, draw a Line underneath, as in *Addition.*

4. Having placed the *Numbers* given as is before directed, and drawn the Line under them, subtract the lower *Number* (which in this case must always be less than the uppermost) out of the higher *Number*, and subscribe the difference or remainder respectively below the Line; and when the Work is finished, the

 number

number below the line will give you the Remainder; As for Example, let 364521 be given to be ſubſtracted from 795836, I ſet the leſſer under the greater as in the Margent, and draw a line under them, then beginning at the Right-hand, I ſay, 1 out of 6 and there remains 5, which I ſet in order under the Line; then I proceed to the next, ſaying, 2 from 3 reſts 1, which I note alſo under the Line; and thus I go on till I have finiſhed the Work, and then I find the Remainder or Difference to be 431315.

795836
364521
———
431315

5. But if it ſo happen (as commonly it doth) that the lowermoſt Number or Figure is greater than the uppermoſt; then in this caſe add Ten to the uppermoſt number, and Subſtract the ſaid lowermoſt number from their Sum, and the Remainder place under the Line, and when you go to the next Figure below, pay an Unit by adding it thereto for the Ten you borrowed before, and Subſtract that from the higher number of Figures: And thus go on until your Subſtraction be finiſhed. As for Example; Let 437503 be given from whence it is required to Subſtract 153827, I diſpoſe of the numbers as is before directed, and as you ſee in the Margent; then I begin, ſaying, 7 from 3 I cannot, but (adding 10 thereto I ſay) 7 from 13 and there remains 6, which I ſet under the Line in order; then I proceed to the next Figure, ſaying, 1 that I borrowed and 2 is 3 from 0 I cannot, but 3 from 10 and there remains 7, which I likewiſe ſet down as before; then 1 that I borrowed and 8 is nine from 5 I cannot, but 9 from 15 and there remains 6; then 1 borrowed and 3 is 4 from 7 and there remains 3; then 5 from 3 I cannot, but 5 from 13 and there remains 8; then 1 I borrowed and 1 are two from 4 and there reſts 2; and thus the Work is finiſhed: And after theſe numbers are Subſtracted one from another, the Inequality, Remainder, Exceſs or Difference, is found to be 283676.

437503
153827
———
283676
———

283676. Examples for thy further Experience may be these that follow.

From	3475016	From	3615746
Take	738642	Take	5864
Rests	2736374	Rests	3609882

6. If the *Sum* or *Numbers* to be Substracted, are of several Denominations, place the lesser Sum below the greater, and in the same rank and order as is shewed in *Addition* of the same Numbers; then begin at the Right-hand and take the lower *Number* out of the uppermost if it be lesser; but if it be bigger than the uppermost, then borrow an Unit from the next greater Denomination, and turn it into the Parts of the less Denomination, and add those parts to the uppermost *Number*, and from their Sum Substract the lowermost, noting the Remainder below the Line; then proceed and pay 1 to the next Denomination for that which you borrow'd before, and proceed in this order until the Work be finished. An Example of this Rule may be this that followeth; Let 375 *l.* 13 *s.* 7 *d.* 1 *qr.* be given, from whence let it be required to Substract 57 *l.* 16 *s.* 03 *d.* 2 *qrs.* In order whereunto I place the Numbers as you see in the Margent; and thus I begin at the least Denomination, saying, two from one I cannot, therefore I borrow one Penny from the next Denomination, and turn it into Farthings, which is 4, and adding 4 to 1 which is 5, I say, but 2 from 5 and there remains 3, which I put under the Line; then going on, I say, 1 that I borrowed and 3 is 4 from 7 and there rests 3; then going on, I say, 16 from 13 I cannot, (but borrowing 1 Pound and turning it into 20 Shillings, I add it to 13, and that is 33) wherefore I say, sixteen from 33, and there remains 17, which I set under the Line and go on, saying, 1 that I borrowed and 7 is 8 from 5 I cannot, but 8 from 15 and there remains 7; the one that I bor-

l.	*s.*	*d.*	*qrs.*
375	13	07	1
57	16	03	2
317	17	03	3

borrowed and 5 is 6 from 7 there rests 1, and 0 from 3 rests 3, and the Work is done: And I find the Remainder or difference to be 317 *l.* 17 *s.* 03 *d.* 2 *qrs.*

Another Example of *Troy-weight*, may be this, I would subtract 17 *l.* 10 *oz.* 11 *p.w.* 20 *gr.* from 24 *l.* 05 *oz.* 00 *p.w.* 08 *gr.* I place the Numbers according to the Rule, and begin, saying 20 from 8 I cannot, but borrow 1 *Peny-weight*, which is 24 *Grains*, and add them to 8, and they are 32, wherefore I say, 20 from 32 rest 12; then 1 that I borrowed and 11 is 12 from 00 I cannot, but 12 from 20 (borrowing an Ounce which is 20 *Penny-weight.*) and there remains 8; then 1 that I borrowed and 10 is 11 from 5 I cannot, but 11 from 17 and there rests 6; then one that I borrowed, and 7 is 8 from 4 I cannot, but 8 from 14 and there rests 6; then 1 that I borrowed and 1 is 2 from 2 and there rests nothing; so that I find the remainder or difference to be 6 *l.* 6 *oz.* 8 *p.w.* 12 *gr.*

l.	*oz.*	*p.w.*	*gr.*
24	05	00	08
17	10	11	20
06	06	08	12

7. It many times happeneth that you have many *Sums* or *Numbers* to be *subtracted* from one *Number*; as suppose a Man should lend his Friend a certain Sum of Money, and his Friend hath paid him part of his Debt at several times, then before you can conveniently know what is still owing, you are to add the several *Numbers* or *Sums* of Payment together, and *subtract* their *Sum* from the whole Debt, and the remainder is the *Sum* due to the Creditor: As suppose *A* lendeth to *B* 564 *l.* 13 *s.* 10 *d.* and *B* hath repaid him 79 *l.* 16 *s.* 8 *d.* at one time, and 163 *l.* 18 *s.* 11 *d.* at another time, and 241 *l.* 15 *s.* 08 *d.* at another time; and you would know how the *Accompt* standeth between them, or what is more due to *A*. In order whereunto

	l.	*s.*	*d.*
Lent	564	13	10
Paid at several Payments	79	16	08
	163	18	11
	241	15	08
Paid in all	485	11	03
Remains	79	02	07

I first

I first set down the *Sum* which *A* lent, and draw a Line underneath it; then under that Line set the several *Sums* of Payment as you see in the Margent; and having brought the several Sums of Payment into one total by the fifth Rule of the fourth Chapter foregoing, I find their Sum amounteth to 485*l.* 11*s.* 3*d.* which I subtract from the Sum first lent by *A*, by the sixth Rule of this Chapter, and I find the remainder to be 79*l.* 2*s.* 7*d.* and so much is still due to *A*.

When the Learner hath good knowledge of what hath been already delivered in this and the foregoing Chapter: he will with ease understand the manner of working the following Examples.

Subtraction of Whole Money.

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	374	10	03	700	10	11	2
Paid	69	15	11	9	03	11	3
Remains	304	14	04	691	06	11	3

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	1000	00	00	711	03	00	1
Paid	19	00	06	11	13	00	0
Remains	980	19	06	699	09	11	3

	l.	*s.*	*d.*	*qrs.*
Borrowed	3300	00	00	0
Paid at several Payments	170	10	00	0
	361	13	10	1
	590	03	04	3
	73	04	11	3
Paid in all	1195	12	02	3
Remains due	2104	07	10	1

Subtraction of Troy-weight.

	l.	oz.	p.w.	gr.
Bought	173	00	13	00
Sold	78	04	16	15
Remains	95	07	16	09

	l.	oz.	p.w.	gr.
Bought	470	10	13	00
Sold at several times	60	00	00	00
	35	10	18	00
	16	07	09	08
	48	04	00	00
	61	11	19	23
	23	00	00	00
Sold in all	245	10	07	07
Remains unsold	225	00	05	17

Subtraction of Apothecaries Weights.

	l.	oz.	dr.	sc.	gr.	l.	oz.	dr.	sc.	gr.
Bought	12	04	3	0	00	20	00	1	0	07
Sold	8	05	1	1	15	10	00	1	2	12
Remains	3	11	1	1	05	9	11	7	0	15

Subtraction of Averdupois weight.

	C.	qrs.	l.	Tun.	C.	qrs.	l.	oz.	dr.
Bought	25	0	15	15	07	1	10	10	05
Sold	16	2	20	3	17	1	16	09	13
Remains	08	1	23	11	9	3	22	09	08

Subtraction of Liquid Measure.

	Tuns	hhd.	gall.	Tuns	hhd.	gall.	pin.
Bought	40	1	30	60	3	42	4
Sold	16	1	40	15	3	46	6
Remains	23	3	53	44	3	58	6

Subtraction of Dry Measure.

	Chald.	qrs.	bush.	pec.	Chald.	qrs.	bush.	pec.
Bought	100	0	00	0	73	2	3	2
Sold	54	1	04	3	46	2	3	3
Remains	45	2	03	1	26	3	7	3

Subtraction of Long Measure.

	Yards	qrs.	nails	Yards	qrs.	nails
Bought	160	1	0	344	0	1
Sold	64	1	2	177	1	3
Remains	95	3	2	166	2	2

Subtraction of Land Measure.

	Acres	roods	perc.	Acres	roods	perc
Bought	140	2	13	600	0	00
Sold	70	3	22	54	0	16
Remains	69	2	31	545	3	24

The Proof of Subtraction.

8. When your Subtraction is ended, if you desire

to prove your Work, whether it be true or no, then add the Remainder to the minor Number, and if the Aggregate of these two be equal to the major Number, then is your Operation true, otherwise false; thus let us prove the first Example of the fifth Rule of this Chapter, where after Subtraction is ended, the Numbers stand as in the Margent; the remainder or difference being 283676. Now to prove the Work, I add the said Remainder 283676 to the minor Number 153827, by the fourth Rule of the foregoing Chapter, and I find the Sum or Aggregate to be 437503 equal to the major Number, or Number from whence the lesser is subtracted. Behold the Work in the Margent.

437503
153827
283676
437503

The Proof of another Example may be of the first Example of the sixth Rule of this Chapter, where it is required to subtract 57 *l.* 16 *s.* 03 *d.* 3 *qrs.* from 375 *l.* 13 *s.* 07 *d.* 1 *qr.* and by the *Rule* I find the Remainder to be 317 *l.* 17 *s.* 03 *d.* 2 *qrs.* now to prove it, I add the said Remainder 317 *l.* 17 *s.* 03 *d.* 2 *qrs.* to the minor Number 57 *l.* 16 *s.* 03 *d.* 2 *qrs.* and their Sum is 375 *l.* 13 *s.* 07 *d.* 1 *qr.* equal to the major number, which proves the Work to be true; but if it had happened to have been either more or less than the said major number, then the Operation had been false.

l.	*s.*	*d.*	*qrs.*
375	13	07	1
57	16	03	3
317	17	03	2
375	13	07	1

9. The general effect of *Substraction*, is to find the difference or excess between two numbers, and the Rest when a Payment is made in part of a greater Sum, the Date of Books Printed, the Age of any thing by knowing the present Year, and the Year wherein they were made, created, or built, and such like.

The Questions appropriated to this Rule are such as follow.

Quest. 1.

Quest. 1. What difference is there between one thing of 125 foot long and another of 66 foot long?

To resolve this Question, I first set down the major or greater number 125, and under it the minor or lesser number 66, as is directed in the third *Rule* of this Chapter, and according to the fourth *Rule* of the same, I Subtract the minor from the major, and the Remainder, Excess or Difference I find to be 59. See the Work in the Margent.

125
66
59

Quest. 2. A Gentleman oweth a Merchant 365 *l.* whereof he hath paid 278 *l.* what more doth he owe?

To give an *Answer* to this *Question*, I first set down the major number 365 *l.* and under it I place 278 the minor, and subtract the one from the other, and thereby I discover the Excess, Difference or Remainder to be 87, and so much is still due to the Creditor; as *per* Margent.

365
278
87

Quest. 3. An Obligation was written, a Book printed, a Child born, a Church built, or any other thing, made in the Year of our Lord 1575, and now we account the Year of our Lord 1706, the Question is to know the Age of the said things, that is, how many Years are passed since the said things were made? I say, if you Subtract the lesser number 1575, from the greater 1706, the remainder will be 131, and so many Years are past since the making of the said things; as by the Work in the Margent.

1706
1575
131

Quest. 4. There are three Towns lie in a straight Line, viz. *London*, *Huntington*, and *York*, now the distance between the farthest of these Towns, *viz.* *London* and *York* is 151 Miles, and from *London* to *Huntington* is 49 Miles, I demand how far it is from *Huntington* to *York*?

To resolve this Question, Subtract 49 the distance between *London* and *Huntington*, from 151 the distance between *London* and *York*, and the Remainder is 102, for the true distance between *Huntington* and *York*. See the Work in the Margent.

151
49
———
102

CHAP. VI.

Of Multiplication of Whole Numbers.

1. MUltiplication is performed by two Numbers of like kind for the production of a third, which shall have such reason to the one, as the other hath to a Unit, and in effect is a most brief and artificial compound *Addition* of many equal Numbers of like kind into one Sum. Or *Multiplication* is that by which we multiply two or more Numbers, the one into the other, to the end that their Product may come forth, or be discovered.

Or, *Multiplication* is the increasing of any one *Number* by another, so often as there are Units in that Number, by which the other is increased, or by having two Numbers given to find a third, which shall contain one of the Numbers as many times as there are Units in the other.

2. *Multiplication* hath three parts. First, the *Multiplicand* or Number to be *Multiplied*. Secondly, the *Multiplier*, or Number given, by which the *Multiplicand* is to be *Multiplied*. And thirdly, the *Product* or Number produced by the other two, the one being multiplied by the other, as if 8 were given to be Multiplied by 4, I say, 4 times 8 is 32, here 8 is the *Multiplicand*, and 4 is the *Multiplier*, and 32 is the *Product*.

8
4
—
32

3. *Multiplication* is either single by one Figure; or compound, that consists of many.

Single Multiplication is said consist of one Figure, because the Multiplicand and Multiplier consist each of them of a Digit, and no more, so that the greatest Product that can arise by single *Multiplication* is 81, being the square of 9; and Compound Multiplication is said to consist of many Figures, because the Multiplicand or Multiplier consists of more places than one; as if I were to multiply 436 by 6, it is called Compound, because the Multiplicand 436 is of more places than one, (*viz.*) 3 places.

4. The Learner ought to have all the varieties of single Multiplication by heart before he can well proceed any further in this Art, it being of most Excellent Use, and none of the following Rules in Arithmetick but what have their principal dependance thereupon, which may be learnt by the following Table.

Multiplication Table.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The Use of the precedent Table is this. In the uppermost Line or Column you have expressed all the Digits from 1 to 9; and likewise beginning at 1 and going downwards in the side Column you have the same; so that if you would know the Product of any two single numbers multiplied by one another, look for one of them (which you please) in the uppermost Column, and for the other in the side Column, and running your Eye from each Figure along the respective Column, in the common Angle (or place) where these two Columns meet, there is the Product required. As for Example, I would know how much is 8 times 7; First, I look for 8 in the uppermost Column, and 7 in the side Column; then do *I* cast my Eye from 8 along the Column downwards from the same, and likewise from 7 in the side Column, *I* cast my Eye from thence towards the Right-hand, and find it to meet with the first Column at 56, so that I conclude 56 to be the Product required; it would have been the same if you had looked for 7 in the top, and 8 on the side; the like is to be understood of any other such numbers. The Learner being perfect herein, it will be necessary to proceed.

5. In Compound *Multiplication*, if the *Multiplicand* consists of many places, and the *Multiplier* of but one Figure; first set down the *Multiplicand*, and under it place the *Multiplier* in the place of Units, and draw a Line underneath them; then begin and multiply the *Multiplier* into every particular Figure of the *Multiplicand*, beginning at the place of Units, and so proceed towards the Left-hand, setting each particular Product under the Line, in order as you proceed; but if any of the Products exceed 10, or any number of Tens, set down the Excess, and for every 10 carry a Unit to be added to the next Product, always remembring to set down the total Product of the last Figure; which Work being finished, the Sum or number placed under the Line shall be the true and Total Product required. As for Example, I would multiply 478 by 6, first I set down 478, and underneath it 6 in the place of Units, and draw a Line underneath them, as in the Margent; then I begin, saying, 6 times 8 is 48, which is 8 above 4 Tens, therefore I set down 8 (the Excess) and bear 4 in mind for the

```
 478
   6
----
2868
```

4 Tens;

4 Tens; then I proceed, saying, 6 times 7 is 42 and 4 that I carried is 46, I then set down 6 and carry 4, and go on, saying, 6 times 4 is 24, and 4 that I carried is 28, and because it is the last Figure, I set it all down, and so the Work is finished, and the Product is found to be 2868, as was required.

6. When in Compound *Multiplication*, the Multiplier consisteth of divers Places, then begin with the Figure in the place of Units in the Multiplier, and multiply it into all the Figures in the Multiplicand, placing the Product below the Line, as was directed in the last Example; then begin with the Figure of the second place of the Multiplier, (*viz.*) the place of Tens, and multiply it likewise into the whole Multiplicand (as you did the first Figure) placing its Product under the Product of the first Figure; do in the same manner by the third, fourth and fifth, *&c.* until you have multiplied all the Figures of the Multiplier particularly into the whole Multiplicand, still Placing the Product of each particular Figure under the Product of its precedent Figure; herein observing the following Caution.

A Caution.

In the placing of the Product of each particular Figure of the Multiplier, you are not to follow the 2d Rule of the 4th Chapter, *viz.* not to place Units under Units, and Tens under Tens, *&c.* but to put the Figure or Cypher in the place of Units of the second Line under the second Figure or place of the Tens in the Line above it, and the Figure or Cypher in the place of Units of the third Line under the place of Tens in the second Line, *&c.* Observing this order till you have finished the Work, *viz.* still placing the first Figure of every Line or Product under the second Figure or place of Tens in that which was above it, and having so done, draw a Line under all these particular Products, and add them together; so shall the Sum of all these Products be the Total Product required.

As if it were required to multiply 764 by 27, I set them down the one under the other, with a Line drawn under-

underneath them; then I begin, ſaying, 7 times 4 is 28, then I ſet down 8, and carry 2, then I ſay 7 times 6 is 42, and 2 that I carried is 44, that is 4 and go 4; then 7 times 7 is 49, and 4 that I carry is 53, which I ſet down becauſe I have not another Figure to multiply; thus I have done with the 7, then I begin with the 2, ſaying, 2 times 4 is 8, which I ſet down under (4) the ſecond Figure or place of Tens in the Line above it, as you may ſee in the Margent: Then I proceed, ſaying, 2 times 6 is 12, that is two and carry one, then two times 7 is 14, and 1 that I carry is 15, which I ſet down becauſe 'tis the product of the laſt Figure; ſo that the product of 764 by 27 is 5348, and by 2 is 1528, which being placed the one under the other, as is before directed, and as you ſee in the Margent, and a Line drawn under them, and they added together reſpectively, make 20628 the true Product required, being equal to 27 times 764.

```
  764
   27
-----
 5348
1528
-----
20628
```

Another Example may be this; Let it be required to multiply 5486 by 465. I diſpoſe of the Mutiplicand and Multiplier, according to the Rule, and begin multiplying the firſt Figure of the Multiplyer, which is (5) into the whole Multiplicand, and the Product is 27430; then I proceed and multiply the ſecond Figure (6) of the Multiplier into the Multiplicand, and find the Product to amount to 32916, which is ſubſcrib'd under the other Product reſpectively; then do I multiply the third and laſt figure (4) of the Multiplier into the Multiplicand, and the Product is 21944, which is likewiſe placed under the ſecond Line reſpectively; then I draw a Line under the ſaid Products (being placed the one under the other accordin to this Rule) and add them together, and the Sum is 2550990, the true Product ſought, being equal to 5486 times 465, or 465 times 5486.

```
   5486
    465
-------
  27430
 32916
21944
-------
2550990
```

More

More Examples in this Rule are these following.

430865	6400758
4739	37496
3877785	38404548
1292595	57606822
3016055	25603032
1723460	44805306
	19202274
2041869235	240002821968

Compendiums in Multiplication.

7. Although the former Rules are sufficient for all Cases in *Multiplication*, yet because in the work of *Multiplication* many times great labour may be saved, I shall acquaint the Learner with some Compendiums in order thereto, viz. If the *Multiplicand* or *Multiplier*, or both of them end with Cyphers, then in your multiplying you may neglect the Cyphers, and multiply only the significant Figures, and to the Product of those significant Figures, add so many Cyphers as the Numbers given to be multiplied did end with; that is, annex them on the Right-hand of the said Product, so shall that give you the true Product required. As if I were to multiply 32000 by 4300, I set them down in order to be multiplied as you see in the Margent, but neglecting the Cyphers in both numbers, I only multiply 32 by 43, and the Product I find to be 1376, to which I annex the 5 Cyphers that are in the Multiplicand and Multiplier, and then it makes 137600000 for the true Product of 32000 by 4300,

Si e numeris propositis unus vel uterque adjunctos habeat ad dextram circulos; omissis circulis fiat ipsorum numerorum multiplicatio, & facto demum tot insuper integrorum loci accenseantur quot sunt omissi circuli in utroque factore, Clavis Mat. c. 4, 3.

32000
4300
96
128
137600000

8. If

8. If in the Multiplier, Cyphers are placed between significant Figures, then multiply only by the significant Figures, neglecting the Cyphers; but here special notice is to be taken of the true placing of the first Figure after the neglect of such Cypher or Cyphers; and therefore you must observe in what place of the Multiplier the Figure you multiply by standeth, and set the first Figure of that Product under the same place of the Product of the first Figure of your Multiplier: As for Example, let it be required to multiply 371568 by 40007, first I multiply the Multiplicand by 7, and the Product is 2600976, then neglecting the Cyphers I multiply by 4, and that Product is 1486272; now I consider that 4 is the fifth Figure in the Multiplier, therefore I place two (the first Figure of the Product by 4) under the fifth place of the first Product by 7, and the rest in order, and having added them together, the Total Product is found to be 14865320976. Other Examples in this Rule are these following:

Si intermedio multiplicantis loco circulus fuerit, ille negligetur. Alsted. cap. 59. de Arithm.

```
     371568
      40007
 ----------
    2600976
1486272
 ----------
14865320976
```

```
    327586
      6030
----------
   9827520
1965516
----------
1975343580
```

```
     7864371
       20604
------------
    31457484
  47186226
 15728742
------------
162037500084
```

2. If you are to multiply any number by an Unit with Cyphers, (*viz.*) by 10, 100, 1000, *&c.* then annex so many Cyphers before the Multiplicand, and that number when the Cyphers are annexed is the Product required; as if you would multiply 428 by 100, annex two Cyphers to 428 and it is 42800: If it were

required

required to multiply 102 by 10000, annex 4 Cyphers and it gives 1020000 for the Product required.

The Proof of Multiplication.

10. *Multiplication* is proved by *Division*, and to ſpeak truth all other ways are falſe; and therefore it will be moſt convenient in the firſt place to learn Diviſion, and by that to prove Multiplication. There is a Way (at this Day generally uſed in Schools) to prove Multiplication, which is this, Firſt add all the Figures in the Multiplicand together, as if they were Simple Numbers, caſting away the Nines as often as it comes to ſo much, and noting the Remainder at laſt, which in this caſe cannot be ſo much as 9: Caſt likewiſe the Nines out of the Multiplier as you did out of the Multiplicand, and note that Remainder; then multiply the Remainders, the one by the other, and caſt the Nines out of the Product, obſerving the Remainder; and laſtly, caſt the Nines out of the Total Product, and if this Remainder be equal to the Remainder laſt found, then they conclude the Work to be rightly performed; but there may be given a thouſand (nay infinite) falſe Products in Multiplication, which after this manner may be proved to be true, and therefore this way of proving doth not deſerve any Example; but we ſhall defer the Proof of this Rule till we come to prove Diviſion, and then we ſhall prove them both together.

Non eſt quod aliam expectes examinandi viam; nam aliæ vulgares, & falſæ ſunt, & nullo innixæ fundamento.
Gemma Friſius.

11. The general effect of *Multiplication* is contained in the Definition of the ſame, which is to find out a third Number, ſo often containing one of the two given Numbers, as the other containeth Units.

The ſecond effect is by having the length and breadth of any thing (as a Parallelogram, or long place) to find the ſuperficial Content of the ſame, and by having the ſuperficial Content of the Baſe, and the Length to find out the ſolidity of any Parallelopipedon, Cylinder, or other ſolid Figures.

The

The third Effect is by the Contents, Price, Value, Buying, Selling, Expence, Wages, Exchange, simple Interest, Gain or Loss of any one thing, be it Money, Merchandize, &c. to find out the Value, Price, Expence, Buying, Selling, Exchange, or Interest of any number of things of like Name, Nature and Kind.

The fourth Effect is (not much unlike the other) by the Contents, Value, or Price of one part of any thing denominated, to find out the Content, Value, or Price of the whole thing, all the parts into which the whole is divided, multiplying the price of one of those parts.

The fifth Effect is, to aid, to compound, and to make other Rules, as chiefly the Rule of Proportion, called the Golden Rule, or Rule of Three; also by it, things of one denomination are reduced to another.

If you multiply any number of Integers or the price of the Integer, the Product will discover the Price of the Quantity or Number of Integers given.

In a Rectangular Solid, if you multiply the breadth of the Base by the depth, and that Product by the length, this last Product will discover the Solidity or Content of the same solid.

Some Questions proper to this Rule may be these following.

Quest. 1. What is the Content of a square Piece of Ground, whose length is 28 *Perches*, and breadth 13 *Perches?*

Answer, 364 square *Perches*, for multiplying 28 the length by 13 the breadth, the Product is so much.

Quest. 2. There is a square Battel whose Flank is 47 Men, and the Files 19 deep, what number of Men doth that Battel contain? *Facit* 893; for multiplying 47 by 19, the Product is 893.

Quest. 3. If any one thing cost 4 Shillings, what shall 9 such things cost? *Answ.* 36 Shillings; for multiplying 4 by 9, the Product is 36.

Quest. 4. If a piece of Money or Merchandize be worth or cost 17 Shillings, what shall 19 such Pieces of Money or Merchandize coſt? *Facit* 323 Shillings which is equal to 16 *l.* 3 *s.*

Queſt. 5. If a Soldier or Servant get or ſpend 14 *s.* per Month, what is the Wages or Charges of 49 Soldiers or Servants for the ſame time? Multiply 49 by 14, the Product is 686 *s.* or 34 *l.* 6 *s.* for the *Anſwer.*

Queſt. 6. If in a Day there are 24 Hours, how many Hours are there in a Year, accounting 365 Days to conſtitute the Year? *Facit* 8760 Hours; to which if you add the 6 Hours over and above 365 Days, as there is in a Year, then it will be 8766 Hours; now if you multiply this 8766 by 60, the number of Minutes in an Hour, it will produce 525960 for the number of Minutes in a Year.

CHAP. VII.

Of Diviſion of Whole Numbers.

DIVISION is the ſeparating or parting of any Number or Quantity given into any parts aſſigned, or to find how often one Number is contained in another: or from any two Numbers given to find a third that ſhall conſiſt of ſo many Units, as the one of thoſe two given Numbers is comprehended or contained in the other.

2. *Diviſion* hath three Parts or Numbers remarkable, viz. Firſt, the *Dividend*. Secondly, the *Diviſor*. Thirdly, the *Quotient*. The *Dividend* is the Number given to be parted or divided. The *Diviſor* is the Number given, by which the *Dividend* is divided: Or it is the Number which ſheweth how many parts the *Dividend* is to be divided into: and the *Quotient* is the Number produced by the *Diviſion* of the two given Numbers, the one by the other.

So 12 being given to be divided by 3, or into three equal parts, the *Quotient* will be 4, for 3 is contained in 12 four tims, where 12 is the *Dividend*, and 3 is the *Diviſor*, and 4 is the *Quotient.*

3. In *Division* set down your Dividend, and draw crooked Line at each end of it, and before the Line at the Left-hand, place the Divisor, and behind that on the Right-hand, place the Figures of the Quotient, as in the Margent, where it is required to divide 12 by 3: First I set down 12 the Dividend, and on each side of it do I draw a crooked Line, and before that on the Left hand do I place 3 the Divisor; then do I seek how often 3 is contained in 12, and because I find it 4 times, I put 4 behind the crooked Line on the Right-hand of the Dividend, denoting the Quotient.

3) 12 ((4

4. But if when the Divisor is a single Figure, the Dividend consisteth of two or more places, then (having placed them for the Work as is before directed) put a Point under the first Figure on the Left-hand of the Dividend, provided it be bigger than (or equal to) the Divisor, but if it be lesser than the Divisor, then put a Point under the second Figure from the Left-hand of the Dividend, which Figures as far as the Point goeth from the Left-hand are to be reckoned by themselves, as if they had no dependance upon the other part of the Dividend, and for distinction sake may be called the Dividual; then ask how often the Divisor is contained in the Dividual; placing the Answer in the Quotient; then multiply the Divisor by the Figure that you placed in the Quotient, and set the Product thereof under the Dividual; then draw a Line under that Product, and subtract the said Product from the Dividual, placing the Remainder under the said Line, then put a Point under the next Figure in the Dividend on the Right-hand of that to which you put the Point before, and draw it down, placing it on the Right-hand of the Remainder, which you found by Subtraction; which Remainder with the said Figure annexed before it, shall be a new Dividual; then seek again how often the Divisor is contained in this new Dividual; and put the Answer in the Quotient on the Right-hand of the Figure which you put there before; then multiply the Divisor by the last Figure that you

pu-

put in the *Quotient*, and ſubſcribe the Product under the Dividual, and make Subtraction, and to the Remainder draw down the next Figure from the grand Dividend, having firſt put a Point under it, and put it on the Right-hand of the Remainder for a new Dividual as before, *&c.* and proceed thus till the Work is finiſhed.

• Obſerving this general Rule in all kinds of Diviſion, Firſt to ſeek how often the Diviſor is contained in the Dividual; then (having put the Anſwer in the *Quotient*) multiply the Diviſor thereby, and ſubtract the Product from the Dividual. An Example or two will make the Rule plain. Let it be required to divide 2184 by 6. I diſpoſe of the Numbers given as is before directed, and as you ſee in the Margent, in order to the Work, then (becauſe 6 the Diviſor is more than 2 the firſt Figure of the Dividend) I put a Point under 1 the ſecond Figure, which makes the 21 for the Dividual, then do I aſk how often 6 the Diviſor is contained in 21, and becauſe I cannot have it more than 3 times, I put 3 in the *Quotient*, and thereby do I multiply the Diviſor (6) and the Product is 18, which I ſet in order under the Dividual, and ſubtract it therefrom, and the Remainder (3) I place in order under the Line, as you ſee in the Margent.

```
6) 2184 (3
    .
```

```
6) 2184 (3
    .
   18
   --
    3
```

Then do I make a Point under the next Figure of the Dividend being 8, and draw it down placing it before the Remainder 3, ſo have I 38 for a new Dividual, then do I ſeek how often 6 is contained in 38, and becauſe I cannot have more than 6 times, I put 6 in the *Quotient*, and thereby do I multiply the Diviſor 6, and the Product (36) I put under the Dividual (38) and ſubtract it therefrom, and the Remainder 2 I put under the Line, as you ſee in the Margent.

```
6) 2184 (36
    ..
   18
   --
    38
    36
    --
     2
```

Then do I put a Point under the next (and last) Figure of the Dividend (being 4) and draw it down to the Remainder 2, and putting it on the Right-hand thereof, it maketh 24 for a new Dividual; then I seek how often 6 is contained in 24, and the Answer is 4, which I put in the Quotient, and multiply the Divisor (6) thereby; and the Product (24) I put under the Dividual (24) and substract it therefrom, and the Remainder is (0); and thus the Work is finished, and I find the Quotient to be 364, that is, 6 is contained in 2184 just 364 times, or 3184 being divided into 6 equal parts, 364 is one of those parts.

```
6)2184(364
  ...
  18
  ——
   38
   36
   ——
    24
    24
    ——
    (0)
```

Again, if it were required to divide 2646 by 7, or into equal parts, the Quotient would be found to be 378, as by the following Operation appeareth.

```
7) 2646 (378
    ...
   21
  ————
    54
    49
   ————
     56
     56
    ————
     (0)
```

So if it were required to divide 946 by 8, the Quotient will be found to be 118, and 2 remaining after Division is ended. The Work followeth,

Many

8) 946 (118
...
8

14
8

66
64
---
(2)

Many times the Dividend cannot exactly be divided by the Divisor, but something will remain, as in the last Example, where 946 was given to be divided by 8, the Quotient was 118 and there remaineth 2 after the Division is ended: Now what is to be done in this Case with the Remainder, the Learner shall be taught when we come to treat of reducing (or Reduction) of Fractions.

And here Note, that if after your Division is ended, any thing do remain, it must be lesser than your Divisor, for otherwise your Work is not rightly performed.

Other Examples are such as follow.

) 73464 (9183	9) 13758 (1528
....	....
72	9
14	47
8	45
66	25
64	18
24	78
24	72
(0)	(6)

5. But if the Divisor consisteth of more places than one, than chuse so many Figures from the left side of the Dividend for a Dividual as there are Figures in the Divisor, and put a point under the farthest Figure of that Dividual to the Right-hand, and seek how often the first Figure on the left side of the Divisor, is contained in the first Figure on the left side of the Dividual, and place the Answer in the *Quotient*, and thereby multiply your Divisor, placing your Product under your Dividual, and subtract it therefrom, placing the remainder below the Line; then put a point under the next Figure in the Dividend, and draw it down to the said remainder, and annex it on the right side thereof, which makes a new Dividual, and proceed as before, till the Work is finished.

And if it so happen that after you have chosen your first Dividual (as is before directed) you find it to be lesser than the Divisor, then put a point under Figure more near to the Right-hand, and seek how often the first Figure on the left side of the Divisor is contain'd in the two first Figures on the left side of the Dividual, and place the Answer in the *Quotient*, by which multiply the Divisor, and place the Product thereof in order under the Dividual, and subtract it therefrom, and proceed as before.

Always remembring, that (in all cases of Division) if after you have multiplied the Divisor by the Figure last placed in the *Quotient*, the Product be greater than the Dividual, then you must cancel that Figure in the *Quotient*, and instead thereof put a Figure lesser by an Unit (or one) and multiply the Divisor thereby, and if still the Product be greater than the Dividual, make the Figure in the *Quotient* yet lesser by an Unit, and thus do until your Product be lesser than the Dividual, or at the most equal thereto, and then make Subtraction, *&c.*

So if you would divide 9464 by 24, the *Quotient* will be found to be 394; I first put down the given Numbers, as is before directed in the third Rule: Now because

because my Divisor consisteth of two Figures, I therefore put a Point under the second Figure from the Left-hand of my Dividend, which here is 4, wherefore I seek how often 2 the first Figure (on the left side of the Divisor) is contained in 9 (the like first in the Dividual) the answer is 4, which I put in the *Quotient*, and thereby multiply all the Divisors and find the product to be 96, which is greater than the Dividual 94, wherefore I cancel the 4 in the *Quotient*, and instead thereof I put 3 (an Unit lesser) and by it multiply the Divisor 34 and the Product is 72, which I subtract from 94 the Dividual, and the remainder is 22, then do I make a point under the next Figure 6 in the Dividend, and draw it down and place it on the right side of the remainder 22, and it makes 226 for a new Dividual, now because the Dividual 226 consisteth of a Figure more than the Divisor, therefore I seek how often 2 (the first Figure of the Divisor) is contained in 22, the two first of the Dividual, I say 9 times, where I put the 9 in the *Quotient*, and thereby multiply the Divisor 24, the Product (216) I place under the Dividual 226, and subtract it from it, and there remaineth 10.

```
            (3
24) 9464 (4
     .
    72
    ——
    22
```

```
24) 9464 (39
      ..
    27
    ——
    226
    216
    ——
     10
```

Then I go on and make a point under the next and last Figure (4) in the Dividend, and draw it down to the remainder 10, and it maketh 104, for a new Dividual, which is also a Figure more than the Divisor, and therefore I seek how often two is contained in 10, I answer 5 times, but multiplying my Divisor, by 5, the Product is 120, which is greater than the Dividual, and therefore I make it but 4, and by it multiply the Divisor, and the Product is 96, which being placed under, and subtracted from the Dividual, there remaineth 8, and thus the whole Work of this Division is ended, and I find that 9464 being divided by 24 or into 24 equal parts, is found to be 394, as was said before, and the Remainder is 8, as you see in the Work following.

```
24) 9464 (394
    ...
    72
    ———
    226
    216
    ———
     104
      96
    ———
     (8)
```

Another Example may be this, Let there be required the Quotient of 1183653 divided by 385; first I dispose of the Numbers in order to their dividing, and because 118 the three first Figures of the Dividend is lesser than the Divisor 385, I therefore make a Point under the fourth Figure, which is 3, and seek how often 3 (the first Figure of the Divisor) is contained in 11? The Answer is 3; which I put in the Quotient, and thereby multiply the Divisor 385, and the Product is 1155, which I subtract from the Dividual 1183, and there remains 28. Then (as before) I draw down the next Figure, which is 6, and place it after the Remainder 28 so have I 286 for a new dividual, and because it hath no more Figures than the divisor, I seek how often 3 (the first Figure in the divisor) is contained in 2 (the first Figure of the Dividual) and the Answer is 0; for a greater Number cannot be contained in a lesser, wherefore I put 0 in the Quotient; and thereby (according to the 5th Rule) I should multiply my Divisor, but if I do the Product will be 0, and

```
385) 1183653 (3
        .
     1155
     ————
       28
```

```
385) 1183653 (30
        ..
     1155
     ————
      286
```

and o ſubtracted from the Dividual 286, the Remainder is the ſame; wherefore I draw down the next Figure (5) from the Dividend, and put it after the ſaid Remainder 286, ſo have I 2865 for a new Dividual, and becauſe it conſiſteth of four places, *viz.* a place more than the Diviſor, I ſeek how often 3 (the firſt figure of the Diviſor) is contained in 28 (the two firſt of the

385 (1183653 (307

1155

2865
2695

170

Dividual) and I ſay, there is 9 times 3 in 28, but multiplying my whole Diviſor (385) thereby I find the Product to be 3465, which is greater than the Dividual 2865, wherefore I chuſe 8, which is leſſer by an Unit than 9, and thereby I multiply my Diviſor 385, and the Product is 3080, which ſtill is greater than the ſaid Dividual, wherefore I chuſe another Number yet an Unit leſſer, *viz.* 7, and having multiplied my Diviſor thereby, the Product is 2695, which is leſſer than the Dividual 2865, wherefore I put 7 in the Quotient, and ſubtract 2695 from the Dividual 2865, and there remains 170; then I draw down the laſt Figure (3) in the Dividend, and place it after the ſaid Remainder 170, and it makes 1703 for a new Dividual, then (for the Reaſon aboveſaid) I ſeek how often 3 is contain'd in 17, the Anſwer is 5, but multiplying the Diviſor thereby, the Product is (1925) greater than the Dividual, wherefore I ſay, it will bear 4 (an Unit leſſer) and by it I multiply the Diviſor 385 and the Product is 1540, which is leſſer than the Dividual, and therefore I put 4 in the Quotient, and ſubtract the ſaid Product from the Dividual, and there remaineth 163, and thus the Work is finiſhed, and I find that 1183653 being divided by 385,

385) 1183653 (3074

1155

2865
2695

1703
1540

(163)

or into 385 equal ſhares or parts, the Quotient (or one of thoſe parts) is 3074, and beſides there is 163 remaining.

And thus the Learner being well verſed in the Method of the foregoing Examples, he may be ſufficiently qualify'd for the dividing of any greater Sum or Number into as many parts as he pleaſeth, that is, he may underſtand the Method of dividing by a Diviſor, which conſiſteth of 4 or 5, or 6, or any greater number of places, the Method being the ſame with the foregoing Examples in every reſpect.

Other Examples in Diviſion.

27986) 835684790 (29806

55972

275964
251874

240907
223888

170199
167916

Remains (22830)

126374) 473986018 (2413

392748

812380
785496

268841
196374

724678
589122

Remains (135556)

So if you divide 47386473 by 58736, you will find the *Quotient* to be 806, and 45257 will remain after the Work is ended.

In like manner if you would divide 3846739204 by 483064, the *Quotient* will be 7963, and the Remainder after Division will be 100572.

Compendiums in Division.

1. IF any given Number be to be divided by another Number that hath Cyphers annexed on the Right-side thereof, (omitting the Cyphers) you may cut off so many Figures from the Right-hand of the Dividend, as there are Cyphers before the Divisor, and let the remaining Numbers in the Dividend, be divided by the remaining Number or Numbers of the Divisor, observing this Caution, that if after your Division is ended any thing remain, you are to annex hereto the Number or Numbers that were cut off from the Dividend; and such new found Number shall be the Remainder. As for Example: Let it be required to divide 46658 by 400; now because there are two Cyphers before the Divisor, I cut off as many Figures from before the Dividend, *viz.* 58, so that then there will remain only 466 to be divided by 4, and the *Quotient* will be 116, and there will remain 2, to which I annex the two Figures (58) which were cut off from the Dividend, and it makes 258 for the true Remainder, so that I conclude 46658 being divided by 400, the *Quotient* will be 116, and 251 remaineth after the Work is ended; as by the Work in the Margent.

Et si Divisor adjunctos sibi habeat Circulos ad dextram, omissis circulis & abscissis totidem ultimis Figuris dividendi, in numeris reliquis fiat divisio, in fine autem divisionis restituendi sunt tum omissi circuli tum figuræ abscissæ, *Ough. Cla. Math.* cap. 5. 3.

```
4|00) 466|58 (116
      ...
      4
      —
      6
      4
      —
      26
      24
      ——
      (258)
```

2. And hence it followeth that if the Divisor be (1) or a Unit with Cyphers annexed, you may cut off so many Figures from the end of the Dividend, as there are Ciphers in the Divisor, and then the Figure or Figures that are on the Left-hand, will be the Quotient, and those that are on the Right-hand will be the Remainder after the Division is ended: As thus, if 45783 were to be divided by 10, I cut off the last Figure (3) with a dash thus (4578|3) and the Work is done, and the Quotient is 4578 (the Number on the Left-hand of the dash) and the Remainder is 3 (on the Right-hand); in like manner if the same Number 45783 were to be divided by 100, I cut off two Figures from the end thus (457|83) and the Quotient is 457, and the Remainder is 83. And if I were to divide the same by 1000, I cut off 3 Figures from the end thus, (45|783) and the Quotient is 45, and 783 the Remainder, &c.

Divisurus quemcunque numerum per 10, Aufer ex dextra parte unicam, eamque primam figuram; Reliquæ enim figuræ productum ostendunt. Ablatum Residuum, &c. Gem. Fris. Arith. Part. 1.

6. The general Effect of Division is contained in the Definition of the same, (that is) by having two unequal Numbers given, to find a third Number in such proportion to the Dividend, as the Divisor hath to Unit or 1; it also discovers what reason or proportion there is between Numbers; so if you divide 12 by 4, it quotes 3, which shews the reason or proportion of 4 to 12 is triple.

The second Effect is, by the superficial measure or content, and the length of any Oblong, Rectangular, Parallelogram, or square Plane known, to find out the breadth thereby, or contrariwise, by having the superficies and breadth of the said Figure, to find out the length thereof. Also by having the solidity and length of a Solid, to find the superficies of the Base, *& e contra.*

The third Effect is, by the Contents, Reason, Price, Value, Buying, Selling, Expences, Wages, Exchange, Interest, Profit or Loss of any number of Things (be it Money, Merchandize, or what else) to find out the

Contents, Reaſon, Price, Value, Buying, Selling, Expence, Wages, Exchange, Intereſt, Profit or Loſs, of any one thing of like kind.

The fourth Effect is, to aid, to compoſe, and to make other Rules, but principally the Rule of Proportion, called the Golden Rule, or Rule of Three, and the Reduction of Moneys, Weights, and Meaſures, of one Denomination into another; by it alſo Fractions are abbreviated by finding a Common Meaſurer, unto the Numerator and Denominator, thereby diſcovering commenſurable Numbers.

If you divide the Value of any certain Quantity by the ſame Quantity, the Quotient diſcovers the Rate or Value of the Integer; as, if 8 Yards of Cloth coſt 96 Shillings, if you divide (96) the Value or Price of the given Quantity, by (8) the ſame Quantity, the Quotient will be 12, which is the Price or Value of 1 of thoſe Yards, *& e contra.*

If you divide the Value or Price of any unknown Quantity, by the Value of the Integer, it gives you in the Quotient that unknown Quantity, whoſe Price is thus divided; as if 12 Shillings were the Value of 1 Yard, I would know how many Yards are worth 29 Shillings: Here if you divide (96) the Price or Value of the unknown Quantity, by (12) the Rate of the Integer, or one Yard, the Quotient will be 8, which is the number of Yards worth 96 Shillings.

Some Queſtions anſwered by Diviſion may be theſe following.

Queſt. 1. If 22 things coſt 66 Shillings, what will 1 ſuch thing coſt? *Facit,* 3 Shillings; for if you divide 66 by 22, the Quotient is 3 for the Anſwer; ſo if 36 Yards or Ells of any thing be bought or ſold for 108 *l.* how much ſhall 1 Yard or Ell be bought or ſold for? *Facit,* 3 *l.* for if you divide 108 *l.* by 36 Yards, the Quotient will be 3 *l.* the Price of the Integer.

Queſt. 2. If the Expence, Charges, or Wages of 7 Years amount to 868 *l.* what is the Expence, Charges, or Wages of one Year? *Facit,* 124 *l.* for if you divide

868

868 (the Wages of 7 Years) by 7 (the number of Years) the *Quotient* will be 124 *l.* for the Anſwer. See the Work,

```
7) 868 (124
   ...
   7
   --
   16
   14
   --
    28
    28
    --
   (0)
```

Queſt. 3. If the content of one ſuperficial Foot be 144 Inches, and the breadth of a Board be 9 Inches, how many Inches of that Board in length will make ſuch a Foot? *Facit,* 16 Inches; for by dividing 144 (the number of ſquare Inches in a ſquare Foot) by 9 (the Inches in the breadth of the Board) the Quotient is 16 for the number of Inches in length of that Board to make a ſuperficial Foot.

```
9) 144 (16 Inches
   ...
   9
   --
   54
   54
   --
   (0)
```

Queſt. 4. If the Content of an Acre of Ground be 160 ſquare Perches, and the length of a Furlong (propounded) be 80 Perches, how many Perches will there go in breadth to make an Acre? *Facit,* 2 Perches; for if you divide 160 (the number of Perches in an Acre) by 80 (the length of the Furlong in Perches) the Quotient is 2 Perches; and ſo many in breadth of that Furlong will make an Acre.

80) 160 (2 *Perches*

160

(0)

Quest. 5. If there be 893 Men to be made up into a Battel, the Front consists of 47 Men, what number must there be in the File? *Facit*, 19 deep in the File: For if you divide 893 (the number of Men) by 47 (the number in Front) the Quotient will be 19 File in depth; the Work followeth.

47) 893 (19 *deep in File*

47

423
423

(0)

Quest. 6. There is a Table whose superficial content is 72 Feet, and the breadth of it at the end is 3 Feet, now I demand what is the length of this Table? *Facit*, 24 Feet long; for if you divide 72 (the content of the Table in Feet) by 3 (the breadth of it) the Quotient is 24 Feet for the length thereof, which was required. See the Operation as followeth:

3) 72 (24

6

12
12

(0)

The Proof of Multiplication and Division.

Multiplication and *Division* interchangeably prove each other; for if you would prove a Sum in *Division*, whether the Operation be right or no, multiply

the

the *Quotient* by the Divisor ; and if any thing remain after the *Division* is ended, add it to the Product, which Product (if your Sum was rightly divided) will be equal to the Dividend: And contrariwise, if you would prove a *Sum* in *Multiplication*, divide the Product by the Multiplier, and if the Work was rightly performed, the *Quotient* will be equal to the Multiplicand. See the Example where the Work is done and undone. Let 7654 be given to be multiplied by 3242, the Product will be 24814268, as by the Work appeareth.

```
     7654
     3242
   ------
    15308
   30616
  15308
 22962
---------
 24814268
```

And then if you divide the said Product 24814268 by 3242 the Multiplier, the *Quotient* will be 7654, equal to the given Multiplicand.

```
3242) 24814268 (7654
         ....
      22694
      -----
       21202
       19452
       -----
        17506
        16210
         12968
         12968
         -----
          (0)
```

In

In like manner (to prove a Sum or Number in *Division*) if 24814268 were divided by 3242 the *Quotient* will be found to be 7654; then for Proof, if you multiply 7654 the *Quotient* by 3242 the Divisor, the Product will amount 24814268, equal to the Dividend.

Or you may prove the last, or any other Example in *Multiplication* thus, *viz.* divide the Product by the Multiplicand, and the *Quotient* will be equal to the Multiplier. See the Work.

```
       7654
       3242
     ------
      15308
     30616
    15308
   22962
  ---------
7654 (24814268 (3242
      ....
     22962
     -----
      18522
      15308
      -----
       32146
       30616
       -----
        15308
        15308
        -----
         (0)
```

From whence there ariseth this Corollary, that any Operation in *Division* may be proved by *Division*; for if after your *Division* is ended, you divide the Dividend by the *Quotient*, the new *Quotient* thence arising, will be equal to the Divisor of the first Operation; for trial whereof let the last Example be again repeated.

```
3242) 24814268 (7654
      ....
      22694
      -----
      21202
      19452
      -----
      17506
      16210
      -----
      12968
      12968
      -----
       (o)
```

For Proof whereof divide again 24814268 by the *Quotient* 7654, and the *Quotient* hence will be equall to the first Divisor 3242. See the Work.

```
7654) 24814268 (3242
      ....
      22962
      -----
       18522
       15308
       -----
       32146
       30616
       -----
        15308
        15308
        -----
         (o)
```

But in proving *Division* by *Division*, the Learner is to observe the following Caution, That if after his *Division* is ended there be any Remainder, before you go about to prove your Work, subtract that Remainder out of your Dividend, and then work as before, as in the following Example, where it is required to divide 43876 by 765, the *Quotient* here is 57, and the Remainder is 271. See the Work following.

(765

765) 43876 (57
3825
5626
5355
(271)

Now to prove this Work ſubtract the Remainder 271 out of the Dividend 42876, and there remaineth 43605 for a new Dividend to be divided by the former *Quotient* 57, and the *Quotient* thence ariſing is 765 equal to the given Diviſor, which proveth the Operation to be right.

43876
271
57) 43605 (765
399
370
342
285
285
(0)

Thus have we gone through the four Species of Arithmetick, *viz. Addition, Subtraction, Multiplication,* and *Diviſion*, upon which all the following Rules, and all other Operations whatſoever that are poſſible to be wrought by Numbers have their immediate dependance, and by them are reſolved. Therefore before the Learner make a further ſtep in this Art, let him be well acquainted with what hath been delivered in the foregoing Chapters.

Hæ ſunt igitur quatuor illæ ſpecies Arithmetices per quas omnia quæcunque deinceps dicenda ſunt, vel quæ per numeros fieri poſſibile eſt, abſolvuntur. Quare eas quiſquis es ante omnia perdiſces. Gem. Friſ. Arith. p.tr.1.

CHAP.

CHAP. VIII.

Of Reduction.

1. Reduction is that which brings together two or more Numbers of different denominations into one denomination, or it serveth to change or alter Numbers, Mony, Weight, Measure of Time, from one denomination to another; and likewise to abridge Fractions to their lowest Terms. All which it doth so precisely, that the first proportion remaineth without the least jot of Error or Wrong committed; so that it belongeth as well to Fractions as Integers, of which in its proper place. *Reduction* is generally performed, either by *Multiplication* or *Division*; from whence we may gather, that,

Hill's Arith. c.13. p. 152.

2. *Reduction* is either descending or ascending.

3. *Reduction* descending, is when it is required to reduce a Sum or Number of a greater denomination into a lesser; which Number, when it is so reduced, shall be equal in value to the Number first given in the greater denomination; as if it were required to know how many *Shillings*, *Pence*, or *Farthings*, are equal in value to an *Hundred Pounds*? or how many *Ounces* are contained in 45 *Hundred weight*? or how many *Days*, *Hours*, or *Minutes* there are in 240 *Years*, &c. And this kind of *Reduction* is generally performed by *Multiplication*.

Wing Arith. ch. 7. 23, 4.

4. *Reduction* ascending, is when it is required to reduce or bring a Sum or Number of a smaller denomination into a greater, which shall be equivalent to the given number; as suppose it were required to find out how many Pence, Shillings or Pounds are equal in value to 43785 Farthings; or how many hundreds are equal to (or in) 3748 Pounds, &c. and this kind of *Reduction* is always performed by *Division*.

5. When a Sum or Number is given to be reduced into another denomination, you are to consider whether

ther it ought to be resolved by the Rule descending or ascending, *viz.* by *Multiplication* or *Division*: if it be to be performed by *Multiplication*, consider how many parts of the Denomination into which you would reduce it, are contained in an Unit or Integer of the given number, and multiply the said given number thereby, and the Product thereof will be the Answer to the *Question*. As if the question were, in 38 *Pounds*, how many *Shillings*? Here I consider, that in one Pound are 20 Shillings, and that the number of *Shillings* in 38 *Pounds* will be 20 tims 38, wherefore I multiply 38 *l.* by 20, and the Product is 760, and so many *Shillings* are contained in 38 *Pounds*, as in the Margent.

```
 38
 20
———
760
```

But when there is a Denomination, or Denominations between the number given, and the number required, you may (if you please) reduce it into the next inferior Denomination, and then into the next lower than that, *&c.* until you have brought it into the Denomination required: As for Example, Let it be demanded, in 132 *Pounds* how many *Farthings*? First, I multiply 132 (the number of *Pounds* given) by 20, to bring it into *Shillings*, and it makes 2640 *Shillings*, then do I multiply the *Shillings* (2640) by 12, to bring them into *Pence*, and it produceth 31680, and so many *Pence* are contain'd in 2640 *Shillings*, or 132 *Pounds*; then do I multiply the *Pence*, *viz.* 31680 by 4 to bring them into *Farthings* (because 4 *Farthings* is a *Penny*) and I find the *Product* thereof to be 126720, and so many *Farthings* are equal in value to 132 *pounds*, the Work is manifest in the Margent.

```
   132 Pounds
    20
  ——————
  2640 Shill.
    12
  ——————
  5280
 2640
  ——————
 31680 pence
     4
 ———————
126720 farth.
```

6. And if the number propounded to be reduced is to be divided, or wrought by the Rule Ascending,

con-

consider how many of the given numbers are equal to an Unit or Integer, in that Denomination to which you would reduce your given number, and make that your Divisor, and the given number your Dividend; and the Quotient thence arising will be the number sought or required: As for Example, Let it be required to reduce 2640 Shillings into Pounds. Here I consider that 20 Shillings are equal to one Pound; wherefore I divide 2640 (the given Number) by 20, and the *Quotient* is 132, and so many Pounds are contained in 2640 Shillings. In Reduction descending and ascending the Learner is advised to take particular notice of the Tables delivered in the second Chapter of this Book, where he may be informed what Multipliers or Divisors to make use of in the reduction of any Number to any other Denomination whatsoever especially *English* Moneys, Weights, Measures, Time and Motion; but in this place it is not convenient to meddle with Foreign Coins, Weights or Measures.

```
2|0) 264|0 (13
      ...
     2
     —
      6
      6
      —
       4
       4
       —
      (0)
```

But if in Reduction ascending it happen that there is a Denomination or Denominations between the Number given, and the Number required, then you may reduce your Number given into the next superior Denomination, and when it is reduced, bring it into the next above that, and so on until you have brought it into the Denomination required. As for Example,

Let it be demanded in 126720 *Farthings* how many *Pounds?* First, I divide my given Number (being *Farthings*) by 4, to bring them into *pence* (because 4 *farthings* make one *penny*) and they are 31680 *pence*, then I divide 31680 *pence* by 12, and the *Quotient* giveth 2640 *shillings*, and then I divide 2640 *shillings* by 20 and the *Quotient* giveth 132 *pounds*, which are equal in value to 126720 *farthings*. See the whole Work as it followeth.

```
          (12)     20)   l.
4) 126720 (31680 (264|0 (132
   .....   ....   ..
   12       24     2
   --      --     --
    6      76      6
    4      72      6
   --      --     --
   27      48      4
   24      48      4
   --      --     --
    32    (00)    (0)
    32
    --
   (0)
```

When the Number given to be reduced, consisteth
f divers Denominations, as *Pounds*, *Shillings*, *Pence*,
d *Farthings*, or of *Hundreds*, *Quarters*, *Pounds* and
nces, &c. then you are to reduce the highest (or
eatest) Denomination into the next inferior, and add
ereunto the Number standing in that Denomination
hich your greatest or highest Number is reduced to;
en reduce that Sum into the next inferior Denomi-
tion; adding thereunto the Number standing in that
nomination; do so until you have brought the
umber given into the Denomination proposed. As,
it were required to reduce 48 *l.* 13 *s.* 4 *d.* into Pence;
st I bring 48 *l.* into Shillings, by multiplying it by 20,
d the Product is 960 Shillings, to which I add the
Shillings, and they make 973, then I multiply 973
12, to bring the Shillings into Pence, and they make
676 Pence, to which I add the 10 Pence, and they
ake 11686 Pence for the Answer. See the Work
ne,

l. s. d.
48—13—10
20

960 *Shillings*
Add 13

Sum 973 *Shillings*
12

1946
973

11676 *Pence*
Add 10

Sum 11686 *Pence*

8. If in Reduction Aſcending after Diviſion is ended, any thing remain, ſuch Remainder is of the ſame Denomination with the Dividend.

Example, In 4783 *Farthings*, I demand how many *Pounds* ?

Firſt, I divide the given number of *Farthings*, (*viz.* 4783) by 4 to bring them into *Pence*, and the *Quotient* is 1195 *Pence*, and there maineth 3 after the Work of *Diviſion* is ended, which is 3 *Farthings*.

Again, I divide 1195 *Pence* (the ſaid *Quotient*) by 12, to reduce them into *Shillings*, and the *Quotient* is 99 *Shillings*, and there is a Remainder of 7, which is 7 *Pence*.

And then I divide 99 *Shillings* (the laſt *Quotient*) by 20, to bring it into *Pounds*, and the *Quotient* is 4 *l.* and there remaineth 19 *Shillings*; ſo that I conclude that in 4783 (the propoſed number of *Farthings*) there is 4 *Pounds*, 19 *Shillings*, 7 *Pence*, 3 *Farthings*. View the following Operation.

4)

```
          12)  2|0
4)  4783 (1195 (9|9 (4 Pounds
    ....       ..
    4      108  8
    ———    ———  ———
      7    115  (19) Shillings
      4    108
    ————   ————
      38 rem. (7) Pence
      36
     ———                   l.  s.  d. qrs.
      23          Facit  4—19—7—3
      20
     ———
   Rem. (3) Farthings.
```

More Examples in Reduction of Coyn.

Quest. 1. In 438 *l.* how many *Shillings?* *Facit*, 8760 [Shi]llings; for by multiplying 438 by 20, the Product [am]ounteth to so much. See the Work.

```
   438 Pounds.
    20
  ————
Facit 8760 Shillings.
```

Quest. 2. In 467 *l.* how many *Pence?* First, multi[ply] the given number of *Pounds* (467) by 20 to bring [it i]nto *Shillings*, and it makes 9340 *Shillings*, then mul[tipl]y the *Shillings* by 12, and it produceth 112080 [Pen]ce, thus.

```
   467 Pounds
    20 Shillings
  ————
  9340 Shillings
    12
  ————
 18680
 9340
 ————
Facit 112080 Pence
```

Or it may be resolved thus, *viz.* multiply the given *Number* of *Pounds* (467) by (240) the *Number* of *Pence* in a *Pound*, and the Product is the same, *viz.* 112080 *Pence*, as by the Operation appeareth.

467 *Pounds*
240

18680
934

Facit 112080 *Pence*

Quest. 3. In 5673 *l.* how many *Farthings?* First multiply the given *Number* by 20, to bring it into *Shillings*, and it produceth 113460 *Shillings*, then multiply that *Product* by 12, to bring it into *Pence*, and it produceth 1361520 *Pence*; then lastly, multiply the *Pence* by 4, and it produceth 5446080 *Farthings*. See the Operation.

5673 *Pounds*
20

113460 *Shillings*
12

226920
113460

1361520
4

Facit 5446080 *Farthings*

Or the *Question* might have been thus resolved, *viz.* multiply 5673 (the given *Number* of *Pounds*) by 960 the *Number* of *Farthings* in a *Pound*) and it produceth the same Effect, as you may see by the Work.

l.
5673

5673 *Pounds*	20 *Shillings*
960	12
340380	240 *Pence*
51057	4
Facit 5446080 *Farthings*	960 *Farthings*

Otherwise thus: First, bring the given Number 5673*l.* into Shillings, and multiply the Shillings by 48, the number of Farthings in a Shilling, and the same Effect is thereby likewise produced, *viz.*

5673 *Pounds*	12 *Pence*
20	4
113460 *Shillings*	48 *Farthings*
48	
907680	
453840	
Facit 5446080 *Farthings*	

These various Ways of operating are expressed to inform the Judgment of the Learner, with the Reason of the Rule; more Ways may be shewn, but these are sufficient even for the meanest Capacities.

Quest. 4. In 458 *l.* 16 *s.* 7 *d.* 3 *qrs.* how many Farthings. To resolve this Question, consider the seventh Rule of this Chapter, and work as you are there directed, and you will find the aforesaid given Numbers to amount to 440479 Farthings, *viz.*

l.	s.	d.	qr.
458	16	7	3

```
         20
     ---------
       9160 Shillings
Add      16
     ---------
Sum    9176 Shillings
         12
     ---------
      18352
      9176
     ---------
     110112 Pence
Add       7
     ---------
Sum  110119 Pence
          4
     ---------
     440476 Farthings
Add       3
     ---------
Sum  440479 Farthings
```

This last Quest. (or any other of this kind, *viz.* whe
the Number given to be reduced consisteth of seve
Denominations) may be more concisely resolved th
viz. when you multiply the *Pounds* by 20 to bri
them into *Shillings* to the Product of the first Figu
add the Figure standing in the place of Units in t
Denomination of *Shillings*; but because the first F
gure in the Multiplier is (o) I say o times 8 is nothin
but 6 is 6, which I put down for the first Figure
the Product, then because this Multiplier is o, I go
no further with it, for if I should, the whole Produ
will be o, but proceed, and when I come to multip
the second Figure in the multiplier, and to the Pr
duct of it, I add the Figure standing in the place
Tens in the Denomination of *Shillings* which is ((
sayin

ſaying, 2 times 8 is 16, and (the ſaid Figure) 1 is 17, then I ſet down 7, and carry an Unit to the Product of the next Figure as is directed in the fifth Rule of the ſixth Chapter foregoing; and finiſh the Work. So that now you may have the whole Product and Sum of *Shillings* at one Operation, which is the ſame as before, and when you multiply the *Shillings* by 12, to bring them into *Pence* (after the ſame manner) add to the Product the Number ſtanding in the Denomination of *Pence*, and ſo when you multiply the *Pence* by 4 to bring them into *Farthings*, add to the Product the Number ſtanding under the Denomination of *Farthings*. See the laſt Queſtion thus wrought.

l. s. d. qrs.
458—16—7—3
20

9176 *Shillings*
12

18359
9176

110119 *Pence*
4

Facit 440479 *Farthings*

After the Method laſt preſcribed (which if rightly conſidered, differeth not any thing from the 7th Rule of this Chapter) are all the following Examples that are of the ſame nature wrought and reſolved.

Queſt. 5. In 4375866 *Farthings*, I demand how many *Pounds*, *Shillings*, *Pence* and *Farthings*?

To reſolve this Queſtion; Firſt, I divide the given Number of *Farthings* by 4, and the Quotient is 1093966 *Pence*, and there remaineth 2 after the Diviſion is ended (which by the 8th Rule foregoing) is two *Farthings*; then I divide 1093966 *Pence* by 12, and the

Quotient is 91163 Shillings, and there remaineth 10 after Division, which by the said 8th Rule is so many Pence, *viz.* 10 *d.* then I divide 91163 Shillings by 20, and the Quotient is 4558 *l.* and there remaineth 3 Shillings, so the Work is finished, and I find that in 4375866 Farthings there are 4558 *l.* 3 *s.* 10 *d.* 2 *qrs.* See the Operation.

```
                     12)          2|0)       l.
4) 4375866 (1093966 (9116|3 (4558
   .......      .....     ....
   4               108         8
   ——              ———        ——
   37               13         11
   36               12         10
   ——               ——         ——
    15              19         11
    12              12         10
    ——              ——         ——
     38             76         16
     36             72         16
     ——             ——         ——
      26            46         (3) s.
      24            36
      ——            ——
       26          (10) d.
       24
       ——
      (2) qrs.

            l.        s.         d.       qrs.
   Facit 4558———3———10———2
```

Quest. 6. In 4386 *l.* I demand how many Groats?

To resolve this *Question*, I reduce the given Number of Pounds into Shillings, and they are 87720 Shillings, now I consider that in a Shilling are 3 Groats, therefore I multiply the Shillings by 3, and it produceth 263160 Groats. See the Work.

4386

4386 *Pounds*
20
87200 *Shillings.*
3
Facit 263160 *Groats*

This *Question* might have been otherwise resolved thus, *viz.* considering that in a Pound (or 20 Shillings) there are 3 times 20 Groats, which make 60, by which I multiply the number of Pounds given, and it produceth the same Effect at one Operation, as followeth.

	4386 *Pounds*	20
	60 *Groats in* 20 *s.*	3
Facit	263160 *Groats in* 4386 *l.*	60

Quest. 7. In 43758 three-pences, I desire to know how many Pounds?

To resolve this, and many such like *Questions*: First, I divide my given Number of 3 pences by 4, because 4 three-pences are in a Shilling, and the Quotient is 10939 Shillings, and there remaineth 2 after Division is ended, which is 2 three-pences (by the 8th Rule of this Chapter) which are equal in value to 6 *d.* then I divide 10939 shillings by 20, and the Quotient giveth 546 *l.* and 19 *s.* remain; so that I conclude in 43758 pieces of three-pence *per* piece, there are 546 *l.* 19 *s.* 6 *d.* as by the Work appeareth.

```
              2|0       l.    s.  d.
4) 43758 (1093|9 (546—19—6
   .....    ...
   4        10
   ———      ———
   37       9
   36       8
   ———      ———
    15      13
    12      12
    ———     ———
     38    (19) s.
     36
     ———
     (2) three pence or 6 d.
```

This *Question* might have been otherwise resolved thus, *viz.* first multiply the given number of 3 pences 43758, by three the number of pence in 3 pence, and the Product (*viz.* 131274) is the number of pence equal to the given number of 3 pences, which number of pence may be brought into pounds by dividing by 12 and by 20, and the *Quotient* you will find to be equal to the former Works, *viz.* 546 *l.* 19 *s.* 6 *d.*

```
       43758
           3
    ————————— 2|0)    l.   s.   d.
12) 131274 (1093|9  (546—19—6
     .....    ...
     12       10
     ————     ———
     112       9
     108       8
     —————    ———
      47      13
      36      12
      ———     ———
      114 re. (19) shill.
      108
      ————
Remains (6) pence.
```

Or

Or thus, divide the given number of 3 pences by the number of 3 pences in a pound or 20 shillings which you will find to be 80, if you multiply 20 *s.* by 4, the number of 3 pences in a shilling) and you will find the quote to be 546 *l.* as before, and a remainder of 78 three pences, and if you divide those 78 three-pences by 4 (because there are 4 three-pences in a shilling) you will find the quote to be 19 *s.* and 2 three-pences remain, which are equal to 6 *d.* which is the same that was before found.

```
                 l.   s.  d.
8,0) 4375|8 (546—19—6              20
     ...                            4
     40                            ——
     ——                            80
      37
      32
      ——
       55
       48
       ——
   4)  78 (19 s.
       ..
        4
       ——
       38
       36
       ——
      (2) three-pences or 6 d.
```

Quest. 8. In 4785 *l.* 19 *s.* how many pieces of $13\frac{1}{2}$ *l. per piece?*

This *Question* cannot be resolved by Reduction, descending or ascending, absolutely, (because $13\frac{1}{2}$ *d.* is no even part of a pound) but rather by them both jointly, *viz.* by Multiplication and Division; for if you bring the number given into half-pence, and divide the half-pence, by the half-pence, in $13\frac{1}{2}$ *d. viz.* 27, the *Quotient* will be the Answer; for having brought 4785 *l.* 13 *s.* into half-pence, I find it make 2297112, which I divide by 27, (because there are so many half-pence in $13\frac{1}{2}$*d.* and the Quote gives 85078 peces of $13\frac{1}{2}$*d.* and 6 half-pence remain over and above observe the Work following.

l. s.	d.
4785—13	$13\frac{1}{2}$*d.*
20	2
95713 *shillings*	27 *half-pence*
24 *half-pence in a shilling*	
382852	
191426	
2297112 *half-pence in the given number*	

27) 2297112 (85078 *pieces of* $13\frac{1}{2}$d.

216

137
135

211
189

222
216

Rem. (6) *half-pence*

It would have produced the same Answer, if you had reduced your given number into farthings, and divided by the farthings in $13\frac{1}{2}$*d.* *viz.* 54 (for always the Dividend and the Divisor must be of one Denomination) and then you would have had a remainder of 12 farthings, which are equal in value to the former Remainder of 6 half-pence, as you may prove at your leisure.

Quest.

Quest. 7. In 540 Dollars at 4 *s.* 4 *d.* *per* Dollar, how many Pounds *Sterling*?

First, bring your given Number of Dollars into Pence, and then your Pence into Pounds according to the former Directions. Thus in 4 *s.* 4 *d.* (*viz.* a Dollar) you will find 52 Pence, by which multiply 540 Dollars, and it produceth 28080 Pence, which if you divide by 240 (the Pence in one Pound) the Quotient will give you 117 *l.* which are equal in Value to 540 Dollars, at 4 *s.* 4 *d.* *per* Dollar. Observe the Operation.

```
                          s.  d.
     540                  4—4
      52                  12
   ------                -----
    1080                 52 Pence
   2700
   ------    l.
24|0) 2808|0 (117
       ...
      24
     ----
      40
      24
     ----
     168
     168
     ----
     (0)
```

The foregoing Question might have been otherwise wrought, thus, *viz.* multiply (540) your given Number of Dollars, by 13 the number of Groats in a Dollar (or 4 *s.* 4 *d.*) and it produceth 7020 Groats, which divide by 60 (the Groats in 1 Pound or 20 Shillings) and the Quote is 117 *l.* as before. See the Work.

```
                    s.  d.
     544            4—4
      13            3
    ————          ————
    1620           13
     540
6,0) 7021|0 (217 l.
     ...
     6
    ———
     10
      6
    ———
     42
     42
    ———
    (0)
```

Queſt. 10. In 547386 pieces of $4\frac{1}{2}$ *d. per* piece, I demand how many Pounds, Shillings, and Pence?

Firſt, bring your given Number of four pence half-penies all into half-pence, which you will do if you multiply by 9 the number of half-pence in $4\frac{1}{2}$ *d.* and the Product is 4926474 half-pence, which are brought into Pounds, if you divide them by 24 (the half-pence in a Shilling) and 20 (the Shillings in a Pound) it makes 10263 *l.* 9 *s.* 9 *d.* as by the Work.

```
                                              d.
   547386                                     4½
        9                                     2
   ------                                   -----
             2|0)       l.                  9 half-pence
24) 4926474  (2052619  10263
    .......   .....
   48          2
  ----        ---
    126        05
    120        4
   ----       ---                           l.   s.  d.
      64       12                    Facit 10263—9—9
      48       12
    ----      ---
     167        6
     144        6
    ----      ---
      234     (9) s.
      216
    -------
```

Remains (18) *half-pence* or 9 *d.*

Quest. 11. In 4386 *l.* I demand how many pieces of 6 *d.* of 4 *d.* and of 2 *d.* of each an equal Number? that is to say, what number of Six-pences, Groats, and Two-pences, will make up 4386 *l.* and the number of each equal?

The way to resolve Questions of this Nature, is to add the several pieces (into which the given Number is to be brought) into one Sum, and to reduce the given Number into the same Denomination with their Sum, and to divide the said given Number (so reduced) by the said Sum, and the Quotient will give you the exact Number of each piece. And after the same Method will we proceed to resolve the present Question, *viz.*

4386

```
        4386 pounds              6
         240 pence               4
        ———————                  2
        175440                  ——
         8772               Sum 12 pence
        ———————
   12) 1052640 (87720
        .....
         96
        ——
         92
         84
        ——
          86                                     d. d. d.
          84            Facit 87720 pieces of 6—4—2
          ——
           24
           24
           ——
           (0)
```

So that I conclude by the Operation that 87720 sixpences, and 87720 Groats, and 87720 two pences are just as much as (or equal to) 4286 *l.* or if you admit of 5 *s.* to be thus divided, it is equal to 5 six-pences, and 5 four-pences or Groats, and 5 two-pences. *For if two Right Lines (or two Numbers) be given, and one of them be divided into as many Parts, or Segements as you please, the Rectangle (or Product) comprehended under the two wholr right lines (or numbers given shall be equal to all the Rectangles (or Products) contained under the whole line (or number) aud the several Segments (or Parts) into which the other line (or number) is divided.* Eucl. 2.1.

Another Question of the same Nature with the last mey be this following, *viz.*

Quest. 12. A Merchant is desirous to change 148 *l.* into pieces of 13 *d.* $\frac{1}{2}$ of 12 *d.* of 9 *d.* of 6 *d.* and of 4 *d*; and he will have of each sort an equal number of pieces, I desire to know the number?

Do as you were taught in the last Question, *viz.* add the several pieces together, and reduce the Sum into half-

half-pence, then reduce the Sum to be changed, *viz.* 148 *l.* into the ſame Denomination, and divide the greater by the leſſer, and in the Quotient you will find the Anſwer, *viz.* 798, is the Number of each of the pieces required, and 18 remaineth, which is 18 half-pence by the 8th Rule of this Chapter. See the Work as followeth.

```
 l.                                        d.
 148                                       13½
 240 pence in a l.                         12
 ─────                                      9
 5920                                       6
 296                                        4
 ──────                                   ────
 35520 pence in 148 l.               Sum   44
     2                                     2½
 ──────                                   ────
 71040 half-pence                          89 half-pence
          89) 71040 (798 pieces of each sort
                ...
               623
               ───
               874
               801
               ───
                730
                712
                ───
         Rem. (18) half-pence.
```

The truth of the two foregoing Operations will thus be proved, *viz.* multiply the Anſwer by the parts, or pieces into which the given Number was reduced, and having added the ſeveral Products together, if their Sum be equal to the given Number, the Anſwer is right, otherwiſe not.

So the Anſwer to the 11th Queſtion was 87720, which is proved as followeth, *viz.*

87720

		l.
87720	Six-pences make	2193
	Four-pences make	1462
	Two pences make	731

The total Sum of them 4386 which was the Sum given to be changed.

The Anſwer to the 12th Queſtion was 798, and 18 half-pence remained after the Work was ended, now the truth of the Work may be proved as the former was, *viz.*

		l.	s.	d.
798	*Pieces of* $13\frac{1}{2}$ *make*	44	17	09
	Pieces of 12 *make*	39	18	00
	Pieces of 9 *make*	29	18	06
	Pieces of 6 *make*	19	19	00
	Pieces of 4 *make*	13	06	00
	and 18 *half pence*, or 9 d. *remains*	00	00	09
	The Total Sum of them	148	00	00

which total ſum is equal to the number that was firſt given to be changed, and therefore the Operation was rightly performed.

Reduction of Troy-weight.

We come now to give the Learner ſome Examples in *Troy-weight*, wherein we ſhall be brief, having given ſo large a Taſte of Reduction in the foregoing Examples of Coyn, and now the Learner muſt be mindful of the Table of *Troy-weight* delivered in the ſecond Chapter of this Book.

Queſt. 13. In 482 *l.* 07 *oz.* 13 *p.w.* 21 *gr.* how many Grains?

Mulciply by 12 by 20, and by 24, taking in the Figures ſtanding in the ſeveral Denominations, according to the Direction given in the 7th Rule of this Chapter, and you will find the Product to be 2783013 Grains, which is the Number required, or Anſwer to the Queſtion. See the whole as followeth.

l. oz. p.w. gr.
482—7—13—21
12

971
482

5791 *ounces*
20

115833 *penny-weight*
24

463333
231668

Facit 2780013 *grains*

Quest. 14. In 2780013 *grains.* I demand how many pounds, ounces, penny-weights and grains?

This is but the foregoing Question inverted, and is resolved by dividing 24 by 20, and by 12, and the Answer is 482 *l.* 7 *oz.* 13 *p.w.* 21 *gr.*

```
              2|0)        12)      l.
24) 2780013  (115831|3   (5791   (482
     ......     ....       ...
    24          10         48
    ---         ---        ---
    38          15         99
    24          14         96
    ---         ---        ---
    140         18         31
    1?0         18         24
    ---         ---        ---
    200          8 Rem. (7) ounces
    192          2
    ---         ---
     81 Rem. (13) penny-weight
     72
    ---
     93        l.  oz. p.w. gr.
     72  Facit 482—7—15—21
Remains (21) grains
```

Quest. 15. A Merchant ſent in to a Goldſmith 16 Ingots of Silver, each containing in weight 2 *l.* 4 *oz.* and ordered it to be made into Bowls of 2 *l.* 8 *oz. per* Bowl, and Tankards of 1 *l.* 6 *oz. per* piece, and Salts of 10 *oz.* 10 *p.w. per* Salt, and Spoons of 1 *oz.* 18 *p.w. per* Spoon; and of each an equal number, I deſire to know how many of each ſort he muſt make?

This Queſtion is of the ſame nature with the 11 and 12 Queſtions foregoing, and may be anſwered after the ſame Method; *viz.* Firſt, add the weight of the ſeveral Veſſels (into which the Silver is to be made) into one Sum, and reduce it to one Denomination, and they make 1248 penny-weights; then reduce the weight of the Ingot into the ſame denomination, (*viz.* penny-weights, and it makes 560 penny-weights) and multiply them by the number of Ingots, *viz.* 16, and the product will give you the weight of the 16 Ingots, *viz.* 8960, then divide this product by the weight of the Veſſels, *viz.* 1248, and the Quotient giveth you the Anſwer to the Queſtion, *viz.* 7, and 224 *p. w.* remaining over and above.

```
   l.   oz.                         l.  oz. p.w.
   2————4                           2—08—00
  12                                1—06—00
  ————                              0—10—10
  28                                0—10—18
  20                               ————————
  ————                        Sum  5—02—18
  560 penny-weights                 12
   16 Ingots                       ————
 ——————                             62
 3360                               20
 560                               ————
 ——————                           1248 p.w.
1248) 8960 (7 Veſſels of each
      8736
     ——————
Rem. (224) penny-weights
```

The Proof of the Work is as followeth, viz.

		l. oz. p.w.		l. oz. p.w.
7	Bowls of	2—08—00	per Bowl is	18—08—00
7	Tank. of	1—06—00	per Tank. is	10—06—00
7	Salts of	0—10—10	per Salt is	06—01—10
7	Spoons of	0—01—18	per Spoon is	01—10—06
			124 penny-weight remaining is	00—11—04
			Total Sum	37—04—00

So that you ſee the Sum of the Weights of each Veſſel, together with the Remainder is 37 *l.* 4 *oz.* which is equal to the Weight of the 16 Ingots delivered. For if 37 *l.* 4 *oz.* be reduced to penny-weights, it makes 8960.

Reduction of Averdupois Weight.

In Reducing *Averdupois Weight*, the Learner muſt have recourſe to the Table of *Averdupois Weight* delivered in the Second Chapter foregoing.

Queſt. 16. In 47 *C.* 1 *qr.* 20 *l.* how many Ounces? Multiply by 4, by 28, and by 16, and the laſt Product will be the Anſwer, *viz.* 84992 Ounces.

```
      C.  qr.  l.
      47—1—20
       4
     ------
     189 Quarters
      28
     ------
     1512
     380
     ------
     5312 l.
      16
     ------
     31872
     5312
     ------
F. cit  84992 Ounces
```

Quest. 17. In 84992 Ounces I demand how many *C. qrs. l. oz.*

This is the foregoing *Question* inverted and will be resolved if you divide by 16, by 28, and by 4, and the Answer is 47 *C.* 1 *qr.* 20 *l.* equal to the given Numbers in the foregoing *Question.*

```
              28)    4)     C.  qr.  l.
   19) 84992 (5312 (189 (47—1—20
       ....   ...    ..
        80     28    16
       ----   ----  ----
        49    251    29
        48    224    28
       ----   ----  ----
        16    272   (1) qr.
        16    252
       ----   ----
        32    (20) l.
        32
       ----
       (0)
```

Quest. 18. A Chapman buyeth of a Grocer 4 *C.* 1 *qr.* 14 *l.* of Pepper, and ordered it to be made up into Parcels of 14 *l.* of 12 *l.* of 8 *l.* of 6 *l.* and of 2 *l.* and of each parcel an equal number, now I would know the number of each parcel.

This Example is of the same nature with the 11, and 12, and 15 *Questions* foregoing, and after the same manner is resolved. See the Operation as followeth.

4, C.

C.	qr.	l.	l.
4	1	14	14
4			12
17			8
28			6
140			2
35			42 *pounds.*

42) 490 (11
42
70 *Facit* 11 *parcels of each.*
42
Rem. (28 *pounds*

Reduction of Liquid Measure.

Quest. 19. In 45 Tun of Wine, how many gallons? Multiply by 4, and by 63, the product is 11340 Gallons for the Answer.

45
4
180
63
540
1080
Facit 11340 *Gallons*

Quest. 20. In 34 Rundlets of Wine, each containing 18 Gallons, I demand how many Hogsheads?

First, find how many Gallons is in the 34 Rundlets; which you may do if you multiply 34 by 18, the content of a Rundlet, and the product is 612 Gallons, which

which you may reduce into Hogſheads if you divide them by 63, and the Quote will be 9 Hogſheads, and 45 Gallons. See the Work.

```
        34
        18
       ----
       272
       34
      ----
  63) 612 (9 hhds.
        .
      567
     -----
Rem. (45) Gallons
```

Facit 9 hhds. 45 Gallons.

Queſt. 21. In 12 Tuns how many Rundlets of 14 Gallons *per* Rundlet?

Reduce your Tuns into Gallons, and divide them by 14, the Gallons in a Rundlet, and the Quotient (216) is your Anſwer. See the Work following.

```
          12
           4
         ----
          48
          63
         ----
         144
        288
        ----
   14) 3024 (216
        ...
        28
       ----
        22
        14
       ----
         84
         84
       ----  Facit 216 Rundl.
        (0)
```

Reduction of Long Measure.

Quest. 22. I demand how many Furlongs, Poles, Inches and Barley-corns will reach from *London* to *York*, it being accounted 151 Miles?

151	*miles*
8	*furlongs*
1208	*furlongs*
40	*poles in a furlong*
48320	*poles*
11	*half-yard*
48320	
48320	
531520	*half-yards*
18	*inches in half a yard*
4252160	
531520	
9567360	*inches*
3	*barlyey-corns in an inch*
Facit 28702080	*barley-corns in 151 miles*

Quest. 23. The Circumference of the Earth (as all other Circles are) is divided into 360 Degrees, and each Degree into 60 Minutes, which (upon the Superficies of the Earth) are equal to 60 Miles; now I demand how many Miles, Furlongs, Perches, Yards, Feet, and Barley-corns will reach round the Globe of the Earth?

```
          360 degrees
           60 minutes or miles in a degree
       ------
        21600 miles about the Earth
            8 furlongs in a mile
       ------
       172800 furlongs about the Earth
           40 perches in a furlong
       ------
      6912000 poles or perches about the Earth
           11 half yards in a Perch
      -------
      6912000
     6912000
    ---------
 2) 76032000 half yards about the Earth
    ---------
    (38016000 yards, viz. the half yards
            3 divided by 2.
    ---------
    114048000 feet about the Earth
           12 inches in a foot
    ---------
    228096000
   114048000
   ----------
   1368576000 inches about the Earth
            3 barly-corns in an inch
   ----------
Facit 4105728000 barly-corns
```

And so many will reach round the World, the whole being 21600 Miles; so that if any Person were to go round, and go 15 Miles every Day, he would go the whole Circumference in 1440 Days, which is 3 Years 11 Months, and 15 Days.

Reduction of Time.

Queſt. 24. In 28 Years, 24 Weeks, 4 Days, 16 Hours, 30 Minutes, how many Minutes ?

years weeks days hours min.
28——24——4——16——30
52 *weeks in a year*

60
142

1480 *weeks*
7

10364 *days*
24

41562
20729

248752 *hours*
60

14925150

Note, That in reſolving the laſt *Queſtion* after the Method expreſſed, there is loſt in every Year 30 Hours. For the Year conſiſteth of 365 Days and 6 Hours, but by multiplying the Years by 52 Weeks, which is 364 Days, you loſe 1 Day and 6 Hours every Year ; wherefore to find an exact Anſwer, bring the odd Weeks, Days and Hours into Hours, and then multiply the Years by the number of Hours in a Year, *viz.* 8766, and to the Product add the Hours contained in the odd time, and you have the exact time of Hours, which bring into Minutes as before. See the laſt *Queſtion* thus reſolved.

28
8766

172
172
197
228

249592 hours
60

days hou.
365—6
24

1466
730

8766 hours in a year

weeks days
24—4
7

172
24

694
345

4144 hours

14975520 *minutes in* 28 *years and* 4144 *hours*

So you ſee that according to the Method firſt u[ſed] to reſolve this Queſtion, the Hours contained in t[he] given time are 248752, but according to the laſt, be[st] or true Method, they are 249592, which exceeds t[he] former by 840 Hours.

But for moſt Occaſions it will be ſufficient to mu[l]tiply the given Years by 365, and to the Product a[dd] the Days in the odd time, if there be any, and th[en] there will be only a loſs of 6 Hours in every Ye[ar] which may be ſupplied by taking a fourth part of t[he] given Years, and adding it to the contained Days, a[nd] you have your deſire.

Queſt. 25. In 438657540 Minutes, how ma[ny] Years? *Facit*, 834 *Years*, 4 *days*, 19 *hours*.

```
                 8766      years  days  hours
6|0) 43865754|0 (7310959 (834 — 4 — 19
     .........    ...
   42            70128
   ---           -----
   18            29815
   18            26298
   ---           -----
    6             35179
    6             35064
   ---           -----
    57          24) 115 (4 days
    54               .
   ---              96
    35              ---
    30             (19) hours
   ---
     54
     54
   ---
    (0)
```

Quest. 26. I desire to know how many Hours and Minutes it is since the Birth of our Saviour Jesus Christ to this present Year, being accounted 1706 Years?

This Question is of the same nature with the 24th foregoing, and after the same manner is resolved, *viz.* multiply the given number of Years by 8766, the Product is 14954796 Hours, and that by 60, and the Product is 895287560 Minutes. See the Work.

```
        1706 Years
        8766 Hours in a Year
        ----
       10236
      10236
     11942
    13648
    --------
    14954796 Hours in 1706 Year.
          60
    --------
   895287560 Min. in 1706 Year
```

Note that as Multiplication and Division do interchangeably prove each other, so Reduction descending and ascending, prove each other, by inverting the Question, as the 13 and 14, and likewise the 16 and 17 Questions foregoing, by Inversion, do Interchangeably prove each other, the like may be performed for the proof of any Question in Reduction whatsoever.

Thus far have we discoursed concerning single Arithmetick, whose Nature and Parts are defined in the second, eighth, ninth, and tenth Definitions of the third Chapter of this Book, for although Reduction is not reckoned or defined among the parts of single Arithmetick, yet considered abstractly, it is the proper effect of Multiplication and Division; and as for the Extraction of Roots (which ought to be handled in the next place as parts of single Arithmetick) we shall omit it in this place, and refer the Learner to Mr. *Cocker's* Decimal Arithmetick, which is (with great care and pains) now published, together with his Logarithmetical Arithmetick, shewing the Genesis or Fabrick of the Logarithms, and their general uses in Arithmetick, *&c.* As also his Algebraical Arithmetick, containing the Doctrine of composing and resolving an Equation, with all other Rules necessary for the understanding of that Mysterious Art, *&c.*

CHAP. IX.

Of Comparative Arithmetick; viz. The Relation of Numbers one to another.

1. COmparative Arithmetick is that which is wrought by Numbers, as they are considered to have Relation one to another; and this consists either in Quantity, or in Quality.

Boetius Arith. lib. 1. cap. 21.

2.

2. Relation of Numbers in Quantity, is the reference or respect that the Numbers themselves have one to another, where the Terms or Numbers propounded are always two, the first called the Antecedent, and the other the Consequent.

Vide Wing. Arith. cap. 34.

3. The relation of Numbers and Quantity consists in the differences, or in the rate or Reason that is found betwixt the Terms propounded, the difference of two Numbers being the remainder found by Subtraction, but the rate or reason betwixt two numbers is the Quotient of the Antecedent divided by the Consequent. So 21 and 7 being given, the difference betwixt them will be found to be 14, but the rate or reason that is betwixt 21 and 7 will be found to be triple reason, for 21 divided by 7 quotes 3, the reason or rate.

Alsted. Mathemat. lib. 2. cap. 11, & 12.

4. The relation of Numbers in Quality, (otherwise called Proportion) is the reference or respect that the reason of Numbers have one unto another; therefore the Terms given, ought to be more than two. Now this proportion, or reason between Numbers relating one to another, is either Arithmetical, or Geometrical.

Alsted. Mathemat. lib. 2. cap. 21.

5. Arithmetical Proportion (by some called Progression) is when divers Numbers differ one from another by equal Reason, that is, have equal differences.

So this rank of Numbers 3, 5, 7, 9, 11, 13, 15, 17, differ by equal Reason, *viz.* by, 2 as you may prove.

6. In a rank of Numbers that differ by Arithmetical Proportion, the Sum of the first and last Term being multiplied by half the number of Terms, the product is the total sum of all the Terms.

Or if you multiply the number of the Terms by the half sum of the first and last Terms, the product thereof will be the total sum of all the Terms.

So in the former Progression given, 3 and 17 is 20, which multiplied by 4 (*viz.* half the number of Terms) the Product gives 80, the Sum of all the Terms; or Multiply 8 (the Number of Terms) by 10 (half the Sum of the first and last Terms) the Product gives 80 as before.

So also 21, 18, 15, 12, 9, 6, 3, being given, the Sum of all the Terms will be found to be 84; for here the number of Terms is 7, and the Sum of the first and last (*viz.* 21 and 3) is 24, half whereof (*viz.* 12.) Multiplied by 7 produceth 84, the Sum of the Terms sought.

7. Three Numbers that differ by Arithmetical Proportion, the double of the mean (or middle number) is equal to the Sum of the Extreams.

So 9, 12, and 15 being given, the double of the mean 12 (*viz.* 24.) is equal to the Sum of the Extreams 9 and 15.

8. Four Numbers that differ by Arithmetical Proportion (either continued or interrupted) the Sum of the two Means is equal to the Sum of the two Extreams.

Vide Wing. Arith. Cap.35.

So 9, 12, 18, 21, being given, the Sum of 12 and 18 will be equal to the Sum of 9 and 21, *viz.* 30; also 6, 8, 14, 16 being given, the Sum of 8 and 14, is equal to the Sum of 6 and 16, *viz.* 22, &c.

9. Geometrical Proportion (by some called Geometrical Progression) is when divers Numbers differ according to like Reason.

So 1, 2, 4, 8, 16, 32, 64, &c. differ by double Reason. And 3, 9, 27, 81, 243, 729, differ by triple Reason; 4, 16, 64, 256, &c. differ by Quadruple Reason, &c.

10. In any Numbers that increase by Geometrical Proportion, if you Multiply the last Term by the Quotient of any one of the Terms divided by another of the Terms, which being less is next unto it, and having deducted, or subtracted, the first Term out of that product, divide the remainder by a number that is an Unit less than the said Quotient, the last Quote will give the Sum of all the Terms.

So

So, 1, 2, 4, 8, 16, 32, 64, being given, first I take one of the Terms, *viz.* 8, and divide it by the Term which is less and next to it (*viz.* by 4) and the Quotient is 2, by which I multiply the last Term 64, and the product is 128, from whence I Subtract the first Term (*viz.* 1.) the remainder is 127, which divided by the Quotient 2 made less by 1 (*viz.* 1) the Quote is 127, for the Sum of all the given Terms, as by the Work in the Margent.

```
     64
 4) 8 (2
 -------
    128
      1
 -------
1) 127 (127
```

So if, 4, 16, 64, 256, 1024 were given, the Sum of all the Terms will be found to be 1364. For first, I divide 64, one of the Terms, by his next lesser Term, and the Quotient is 4, by which I multiply the last Term 1024, and it produceth 4096; from whence I Substract the first Term 4, and the remainder is 4092, which I divide by the Quote less by 1 (*viz.* 3) and the Quote is 1364, for the total Sum of all the Terms, as *per* Margent.

```
     1024
 16) 64 (4
 ---------
    4096
       4
 ---------
3) 4092 (1364
```

So likewise if 2, 6, 18, 54, 162, 486 were given, the Sum or Total of all the Terms will be found to be 728. See the Work.

```
     486
 6) 18 (3
 ---------
    1458
       2
 ---------
2) 1456 (728
```

11. Three Geometrical Proportionals given, the Square of the Mean is equal to the Rectangle, or Product of the Extreams.

So 8, 16, 32, being given, the Square of the Mean, *viz.* 16, is 256, which is equal to the product of the Extreams 8 and 3, for 8 times 32 is equal to 256.

12. Of 4 Geometrical Proportional Numbers given the Product of the two Means is equal to the Product of the two Extreams.

So 8, 16, 32, 64, being given, I say that the Product of the two Means, *viz.* 16 times 32, which is 512 is equal to 8 times 64, the Product of the Extream.

Also if 3, 9, 21, 63, were given (which are interrupted) I say 9 times 21 is equal to 3 times 63, which is equal to 189.

From hence ariseth that precious Gem in Arithmetick, which for the Excellency thereof is called the *Golden Rule, or Rule of Three.*

CHAP. X.

The Single Rule of Three Direct.

1. THE *Rule of Three* (not undeservedly called the *Golden Rule*) is, that by which we find out a fourth *Number*, in *proportion* unto *three* given *Numbers*; so as this *fourth Number* sought may bear the same Rate, Reason, or proportion to the *third* (given) *Number*, as this *second* doth to the *first*, from whence it is also called the *Rule of Proportion.*

2. Four *Numbers* are said to be *Proportional*, when the first containeth, or is contained by the second, as often as the third containeth or is contained by the fourth. *Vide* Wingate's *Arith. chap.* 8. *Sect.* 4.

So these *Numbers* are said to be *Proportional*, *viz.* 4, 6, 9, 18, for as often as the first *Number* is contained in the second, so often is the third contained in the fourth, *viz.* twice. Also 9, 3, 15, 5, are said to be *Proportional*, for as often as the first *Number* containeth the second, so often the third *Number* containeth the fourth, *viz.* 3 times.

3. The *Rule of Three* is either Simple or Composed.

4. The Simple (or Single) *Rule of Three*, consisteth of 4 *Numbers*; that is to say, it hath 3 *Numbers* given to find out a fourth, and this is either *Direct*, or *Inverse*. *Vide Alsted. Math. lib.* 2. *cap.* 13.

5. The *Single Rule of Three Direct*, is when the *proportion* of the first Term is to the second, as the third is to the fourth; or when it is required that the *Number* sought

fought (*viz.*) the fourth *Number* muſt have the ſame proportion to the ſecond, as the third hath to the firſt.

6. In the *Rule of Three*, the greateſt difficulty is (after the Queſtion is propounded) to diſcover the order of the 3 Terms, *viz.* which is the firſt, which is the ſecond, and which the third, which that you may underſtand, obſerve, That (of the three given *Numbers*) two are always of one kind, and the other is of the ſame kind with the *Proportional Number* that is ſought; as in this Queſtion, *viz.* If 4 Yards of Cloth coſt 12 Shillings, what will 6 Yards coſt at that rate? Here the two Numbers of one kind are 4 and 6. *viz.* they both ſignify ſo many Yards, and 12 Shillings is the ſame kind with the Number ſought, for the price of 6 Yards is ſought.

Again, obſerve, that of the 3 given Numbers, thoſe two that are of the ſame kind, one of them muſt be the firſt, and the other the third, and that which is of the ſame kind with the Number ſought, muſt be the ſecond Number in the *Rule of Three*, and that you may know which of your ſaid Numbers to make your firſt, and which your third, know this; that to one of thoſe two Numbers there is always affixed a Demand, and that Number upon which the Demand lieth muſt always be reckoned the third Number. As in the fore-mentioned Queſtion, the Demand is affixed to the Number 6, for it is demanded what 6 Yards will coſt; and therefore 6 muſt be the third number, and 4 (which is of the ſame denomination (or kind) with it muſt be the firſt, and conſequently the number 12 muſt be the ſecond, and then the numbers being placed in fore-mentioned Order, will ſtand as followeth, *viz.*

yards	*s.*	*yards*
4	12	6

7. In the *Rule of Three Direct* (having placed the *Numbers* as is before directed) the next thing to be done will be to find out the fourth *Number* in proportion, which (that you may do) multiply the ſecond *Number* by

by the third, and divide the Product thereof by the first, (or which is all one) multiply the Third Term (Number) by the second, and divide the Product thereof by the first, and the Quotient thence arising is the 4th Number in a direct Proportion, and is the Number sought or answer to the Question, and is of the same Denomination that the second Number is of. As thus, let the same Question be again repeated, *viz.* If 4 Yards of Cloth cost 12 Shillings, what will 6 Yards cost?

Having placed my Numbers according to the sixth Rule (of this Chapter) foregoing, I multiply (the second Number) 12 by (the third Number) 6, and the Product is 72, which Product I divide by (the first Number) 4, and the Quotient thence arising is 18, which is the fourth Proportional or Number sought, *viz.* 18 Shillings, (because the second Number is Shillings) which is the price of the 6 Yards, as was required by the Question. See the Work following.

yrds *s.* *yds.* *s.*
If 4 —— 12 —— 6 —— 18
6
——
4) 72 (18 *Shillings*
4
——
32
32
——
(0)

Quest. 2. Another Question may be this, *viz.* If 7 *C.* of Pepper cost 21 *l.* how much will 16 *C.* cost at that rate?

To resolve which Question, I consider that (according to the 6th Rule of this Chapter) the Terms or Numbers ought to be placed thus, *viz.* the Demand lying upon 16 C. it must be the third Number, and that of the same kind with it must be the first, *viz.* 7 *C.* and 21 *l.* (being of the same kind with the Number sought) must be the second Number in this Question: then I proceed

according

according to this 7th Rule, and multiply the second number of the third, *viz.* 21 by 16, and the Product is 336, which I divide by the first Number 7, and the Quotient is 48 *l.* which is the value of 16 *C.* of Pepper at the rate of 21 *l.* for 7 *C.* See the Work following.

C.	*l.*	*C.*
If 7 ——	21 ——	16

```
  16
 ----
 126
 21
 ----
7) 336 (48 l.
   ..
  28
 ----
   56
   56   Fac. 48 l.
 ----
  (0)
```

8. If when you have divided the Product of the second and third Numbers by the first, any thing remain after Division is ended, such Remainder may be multiplied by the parts of the next Inferiour Denomination, that are equal to an Unit (or Integer) of the second Number in the Question, and the Product thereof divide by the first Number in the Question, and the Quotient is of the same Denomination with the parts by which you multiplied the Remainder, and is part of the fourth Number which is sought. And furthermore, if any thing remain, after this last Division is ended multiply it by the parts of the next Inferiour Denomination equal to an Unit of the last Quotient, and divide the Product by the same Divisor (*viz.* the first Number in the Question) and the Quote is still of the same Denomination with your Multiplier; follow this Method until you have reduced your Remainder into the lowest Denomination, *&c.* An Example or two

will make this Rule very plain, which may be this following.

Quest. 3. If 13 yards of Velvet (or any other thing) cost 21 *l.* what will 27 yards of the same cost at that rate?

Having ordered and wrought my numbers according to the 6 and 7 Rules of this Chapter, I find the Quotient to be 43 *l.* and there is a remainder of 8, so that I conclude the price of 27 yards to be more than 43 *l.* and to the intent that I may know how much more, I work according to the foregoing Rule, *viz.* I multiply the said Remainder 8 by 20 *s.* (because the second number in the Question was Pounds) and the product is 160, which divided by the first number, *viz.* 13, it quotes 12, which are 12 shillings, and there is yet a remainder of 4, which I multiply by 12 pence, (because the last Quotient was shillings) and the product is 48 which I divide by 13 (the first number) and the Quotient is 3 *d.* and yet there remaineth 9, which I multiply by 4 Farthings, and the product is 36, which divided by 13 again, it quotes 2 Farthings, and there is yet a remainder of 10, which (because it cometh not to the value of a Farthing) may be neglected, or rather set (after the 2 Farthings) over the divisor, with a Line between them, and then (by the 21 and 22 Definitions of the first Chapter of this Book) it will be $\frac{10}{13}$ of a Farthing; so that I conclude, that if 13 *yards* of Velvet cost 21 *l.* 27 *yards* of the same will cost 43 *l.* 12 *s.* 3 *d.* 2$\frac{10}{13}$*qrs.* which Fraction is 10 thirteenths of a Farthing. See the Operation as followeth.

```
            yds.    l.     yds.
         If 13 —— 21 —— 27
                    27
                   ———
                   147
                   42
                   ———
         13)       567  (43 l.
                   ..
                   52
                   ———
                    47
                    39
                   ———
   Rem.            (8)
   Multiply         20
                   ———
         13)       160  (12 s.
                   ..
                    13
                   ———
                    30
                    26
                   ———
   Rem.            (4)
   Multiply         12
                   ———
         13)        48   3 d.
                    39
                   ———
                   (9)
   Multiply          4
                   ———
         13)        36  (2 10/13 qrs.
                     2
                   ———
   Rem.            (10)  l.   s.  d.  qrs.
              Facit      43—12—2 | 2 10/13
```

Quest. 4. Another Example may be this following *viz.* If 14 *l.* of *Tobacco* cost 27 *s.* what will 478*l.* cost at that rate?

Work

Work according to the last Rule, and you will find it to amount to 921 *s.* 10 *d.* 1 $\frac{2}{14}$ *qrs.* and by the 5th Rule of the 8th Chapter 921 *s.* may be reduced to 46 *l.* 1 *l.* So that then the whole worth or value of the 478 *l.* will be 49 *l.* 1 *s.* 10 *d.* 1 $\frac{2}{14}$ *qrs.* the whole Work followeth.

```
       l.   s.   l.
   If 14—27—478
             27
         ————————
          3346
          956
        ———————— 2|0
   14) 12906 (92|1 (46 l.
        ...   ..
        126    8
       ————  ————
         30   12
         28   12
        ———  ————
         26  (1) s.
         14
        ———
Remains (12)
Multiply 12
        ————
         24
         12
        ——————
   24) 144 (10 d.
        ..
        14
       ———
Remains (4)
Multiply 4
        ———
     14 (16
        14 (1 2/14 qr.
       ———
Remains (2)
     l.   s.  d.  qr.
Facit 64—1—10—1 2/14
```

9. In the Rule of Three it many times happeneth, that although the first and third numbers be Homogeneal (that is of one kind, as both Money, Weight, Measure, *&c.*) yet they may not be of one denomination, or perhaps they may both consist of many denominations, in which case you are to reduce both numbers to one denomination; and likewise your second number (if it consisteth (at any time) of divers denomination) must be reduced to the least name mentioned, or lower if you please, which being done, Multiply the second and third together, and divide by the first, as is directed in the 7th Rule of this Chapter.

And note, that always the Answer to the Question is in the same denomination that your second number is of, or is reduced to, as was hinted before.

Quest. 5. If 15 Ounces of Silver be worth 3 *l.* 15 *s.* what are 86 Ounces worth at that rate?

In this Question, the numbers being ordered according to the 6th Rule of this Chapter, the first and third numbers are Ounces, and the second number is of divers Denominations, *viz.* 3 *l.* 15 *s.* which must be reduced to Shilling, and the Shillings multiplied by the third number, and the product divided by the first, gives you the Answer in Shillings, *viz.* 430 Shillings, which are reduced to 21 *l.* 10 *s.* See the Work.

```
oz.     l.      s.      oz.
15 ——— 3 ——— 15 ——— 86
        20
      ————
        75
        86
      ————
        450
        600
      ———— 2|0      l.    s.
15) 6450 (43|0 (21——10
    ...     ..
     60    4
    ————  ————
     45    3
     45    2
    ————  ————
     (0)  (10) s.
```

In resolving the last Question, the Work would have been the same, if you had reduced your second Number into Pence, for then the Answer would have been 5160 Pence, equal to 21 *l.* 10 *s.* or if you had reduced the second Number into Farthings, the Quotient or Answer would have been 29640 Farthings equal to the same as you may prove at your leisure.

Quest. 6. If 8 *l.* of Pepper cost 4 *s.* 8 *d.* what will 7 *C.* 3 *qrs.* 14 *l.* cost?

In this Question the first Number is 8 *l.* and the third is 7 *C.* 3 *qrs.* 14 *l*, which must be reduced to the same Denomination with the first, *viz.* into Pounds, and the second Number must be reduced into Pence; then multiply and divide according to the 7th Rule fore-going, and you will find the Answer to be 6174 Pence, which is reduced into 25 *l.* 14 *s.* 6 *d.*

```
   l.     s.  d.          C. qrs.  l.
If 8 cost 4—8 what will   7—3—14 cost ?
          12                4
          ——               ——
          56               31
                           28
                           ———
                           252
                           62
                           ———
                           882
                            56 second Number
                          ————
                          5292
                         4410
                        ————— 12)    2|0)    l.  s.  d.
                     8) 49392 (6174 (51|4 (25—14—6
                        ....   ...   ..
                        48     60     4
                        ——     ——    ——
                        13     17    11
                         8     12    10
                        ——     ——    ———
                        59     54   (14)s.
                        56     48
                        ——     ——
                        32    (6) d.
                        32
                        ——          l.  s.  d.
                       (0) Facit 25—14—6   Quest.
```

Quest. 7. If 3 C. 1 *qr.* 14 *l.* of Raisins cost 9 *l.* 9 *s.* what will 6 C. 3 *qrs.* 20 *l.* of the same cost?

Here the first and third Numbers each consist of divers Denominations, but must be brought both into one Denomination, *&c.* as you see in the Operation which followeth; the Answer is 388 *s.* which is reduced into 19 *l.* 8 *s.*

C. qr. l. l. s. C. qr. l.

If 3—1—14 *cost* 9—9 *what will* 6—3—20 *cost?*

4	20	4
13	189	27
28		28
138		216
27		56
278 *Pounds*		776 *Pounds*
		189 *second Number*

6984
6208
776

368) 146664 (38|8 2|0) l. s. (19—8

1134 2

3326 18
3024 18

3024 (8) s.
3024

(0)

l. s.
Facit 29—8

Quest. 8. If in 4 Weeks I spend 13 *s.* 4 *d.* how long will 53 *l.* 6 *s.* last me at that rate?

Answer, 2138 *Days* equal to 6 *Years*, 48 *Days.* See the Work.

If

```
     s. d.          w.          l.  s.
If  13—4 require  4 what will  53—06
     12             7           20
    ———            ———        ———
     30          28 days      1066
     13                         12
    ———                       ———
    160 pence                 2132
                              1066
                             ———
                             12792 pence
                                28 second number]
                             ———
                            102336
                             25584
                            ———— 365)
                    16,0 (358171|6 (2238 (6 years
                          ....       2190
                          32        ———
                         ——— Rem. (48) day
                          38
                          32
                         ———            ye. days
                          61      Facit 6—48 50/160
                          48
                         ———
                          137
                          128
                         ———
                  Remains (96)
```

Queſt. 2. Suppoſe the Yearly Rent of a Houſe, a Yearly Penſion, or Wages be 73 *l.* I deſire to know how much it is *per* Day?

Here you are to bring the Year into Days, and ſay, if, 365 Days require 73 *l.* what will 1 Day require?

Now when you come to multiply 73 by 1, the Product is the ſame, for 1 neither multiplieth nor divideth, and 73 cannot be divided by 365, becauſe the Diviſor

Divisor is bigger than the Dividend, wherefore bring the 73 *l.* into Shillings and they make 1460, which divide by the first Number 365, and the Quote is 4 Shillings for the Answer, as you see in the Work.

```
    days      l.     day
    365 ——— 73 ——— 1
            20
          ————
365) 1460 (4 s.
     1560                Facit 4 s. per Day
    ————
      (0)
```

Quest. 10. A Merchant bought 14 Pieces of Broad-cloth, each Piece containing 28 Yards, for which he gave after the rate of 13 *s.* 6 $\frac{1}{2}$ *d. per* Yard, now I desire to know how much he gave for the 14 Pieces at that rate?

First, Find out how many Yards are in the 14 Pieces, which you will do if you multiply the 14 Pieces by 28 (the Number of Yards in a Piece) and it makes 392; then say, If 1 Yard cost 13 *s.* 6$\frac{1}{2}$ *d.* what will 392 Yards cost? Work as followeth, and the Answer you will find to be 127400 Half-pence, which reduced make 265 *l.* 8 *s.* 4 *d.* For after you have multiplied your second and third Numbers together, the Product is 127400, which (according to the seventh Rule) should be divided by the first number, but the first number is 1, which neither multiplieth nor divideth, and therefore the Quotient or fourth number is the same with the Product of the second and third, which is in Half pence, because the second number was so reduced. See the Work as followeth.

```
                    28
                    14
                   ----
                   112
                    28
                   ----
                   392 yards in 14 the pieces.

  yd.    s.  d.          yds
If 1 cost 13—6½ what will 392 cost ?
          12             325 the second number.
         ----           ------
          32             1960
          13             714
         ----           1176
         162          --------    2|0)      l.  s.  d.
           2        24) 127400  (53|0|8 (265—8—
         ----            ....    ..
half-pen. 325.          120      4
                       ----    ----
                         74     13
                         72     12
                       ----    ----
                        200     10
                        192     10
                       ----    ----
                               (8) shillings
       l.  s.  d.  Rem. (8) ½ pence, or 4 d.
Facit 265—8—4
```

*Quest.*11.A Draper bought 420 *yds.* of Broad-cloath and gave for it after the rate of 14 *s.* 10 *d.* ¾ *per* Ell *English*, now I demand how much he paid for the whole at that rate?

Bring your Ell into Quarters, and your given Yards into Quarters, the Ell is 5 Quarters, and in 420 Yards are 1680 Quarters: then say, If 5 Quarters cost 14 s. 10 ¾ *d.* (or 715 *Farthings*) what will 1680 Quarters cost? *Facit* 250 *l.* 5 *s.* 0 *d.* See the Operation.

Ell *Yards*

1 420

5 4

5 *qrs.* 1683 *qrs.*

qrs. *s.* —— *d.*

f 5 —— 14 —— 10 $\frac{3}{4}$ —— 1680

12 715

28 8400

15 1680

178 *d.* 11760

4 ——— 96|0) *l.*

715 *qrs.* 5) 1201200 (24024|0 (250

10 192

20 482

20 480

12 48) 240 (5*s.*

10 240

20 (0)

20

(0)

l. *s.* *d.*

Facit 250 — 5 — 0

Quest. 12. A Draper bought of a Merchant 50 pieces f Kerseys, each piece containing 34 Ells *Flemish* (the Ell *Flemish* being 3 quarters of a Yard) to pay after he rate of 8 *s.* 4 *d. per* Ell *English*, I demand how much the 50 pieces cost him at that rate?

First, Find how many Ells *Flemish* are in the 50 pieces by multiplying 50 by 34, the product is 1700, which bring into quarters by 3, it makes 5100 quarters, hen proceed, as in the last Question, and the Answer ou will find to be 102000 pence, or 425 *l.* Behold he Operation, as followeth.

If

```
 s.  d.            34
 8—4               50
 12               ————
————              1700 Ells Flemish
100 d.               3
                  ————
                  5100 qrs.

   qrs.   d.    qrs.
If 5 —— 100 —— 5100
                 100
         —————————24|0) d.
            5) 510000 (10200|0 (42[illegible]
               ......      ...
                 5          96
               ————       ————
                 10         60
                 10         48
               ————       ————
               (000)       120
                           120
Facit 425 l.              ————
                           (00)
```

Quest. 13. A Goldsmith bought a Wedge of Go[ld] which weighed 14 *l.* 3 *oz.* 8 *p.w.* for the Sum of 51[4 l.] 4 *s.* I demand what it stood him in *per* Ounce? Answ[er] 60 Shillings, or 3 *l.* See the Work.

```
   l.      oz.     p.w.      l.       s.      oz.
If 14 ——— 3 ——— 8 ——— 514 —— —4 ——— 1[illegible]
   12                  20 shillings         200
  ————                ————                ————
   31                 10284 shillings   20 p.[w.]
   14                    20 p.w.
  ————             ————————— 2|0)
  171 oz.      3428) 205680 (6|0 (3 l.
   20                  ..6
  ————              20568 ———          s.
 3428 p.w.          ————— (0)   Facit 60 or 3[l.]
                     (0)
```

Que[st.]

Quest. 14. A Grocer bought 4 *hhds* of Sugar, each weighing near 6 *C.* 2 *qrs.* 14 *l.* which cost him 2 *l.* 8 s. 6 *d. per C.* I demand the value of the 4 *hdds* at that rate?

First, find the weight of the 4 *hhds*, which you may do by reducing the weight of one of them into pounds, and Multiply them by 4 (the number of *hdds*) and they make 2968 *l.* then say, If 1 *C.* or 112 *l.* cost 2 *l.* 8*s.* 6*d.* what will 2968 *l.* cost? *Facit.* 64*l.* 5*s.* 3*d.* as by the Operation.

```
                                              C.    qrs.    l.
                                              6——2——14
                                              4
                                             ——
                                             26
                                             28
                                            ———
 l.   l.  s.  d.     l.                      212
 112—2—8—06—2968                              53
     20             582                     ———
    ———            ————                     742 l. in 1 hhd.
     48             5936                      4 hogsheads
     12            23744                    ————
    ———           14840                     2968 l. in 4 hhds.
    102           ————— 12)     2|0)
     48   112) 1727376 (15423 (128|15 (64 l.
    ———          .....       ...
    582       112        12      12
             ————      ————    ————
              607        34       8
              560        24       8
             ————      ————    ————
              473      102     (5) shillings
              448       96
             ————      ————
              257       63
              224       60
             ————      ————
              336      (3) pence
             ————        l.   s.   d.
              (0)   Facit 63—43—
```

Quest

Quest. 15. A Draper bought of a Merchant 8 Pac[ks] of Cloth, each Pack containing 4 Parcels, and each P[ar]cel 10 Pieces, and each Piece 26 Yards, and gave a[t] the rate of 4 *l.* 16 *s.* for 6 Yards, now I desire to kn[ow] how much he gave for the whole. *Answer*, 6656 *l.*

First, find out how many Yards there were in [the] 8 Packs, and by the following Work you will find th[ere] are 8320 Yards; then say, if 6 Yards cost 4 *l.* 16 [s.] what will 8320 Yards cost, &c.

```
                                            8 Packs
                                            4
                                           ----
                                            32 Parcels
                                            10
                                           ----
                                           320 Pieces
 yds  l.   s.    yds                        26
If 6—4—16—8320                             ----
    20        96                          1920
 ---------  ---------                     640
    96      49920                        ------
            74880                         8320 yds
         -----------  2|0)      l.
         6) 798720 (1331210(6656
            ......    ....
            6         12
           ---        ---
            19        13
            18        12
           ---        ---
            18        11
            18        10
           ---        ---
             7         12
             6         12
           ---        ---
            12        (0)
            12
Facit 6656 l. ---
            (0)
```

By this time the Learner is (I suppose) well exercised in the Practick and Theorick of the Rule of Three Direct, but at his leisure he may look over the following Questions, whose Answers are given, but the Operation purposely omitted as a Touchstone for the Learner thereby to try his Ability in what hath been delivered in the former Rules.

Quest. 16, If 24 *l.* of Raisins cost 6 *s.* 6 *d.* what will 18 Frails cost each weighing Neat 3 *qrs.* 18 *l.* *Answer*, 24 *l.* 17 *s.* 3 *d.*

Quest. 17. If an Ounce of Silver be worth 5 Shillings, what is the price of 14 Ingots, each Ingot weighing 7 *l.* 5 *oz.* 10 *p.w.* *Answer*, 313 *l.* 5 *s.*

Quest. 18. If a piece of Cloth cost 10 *l.* 16 *s.* 8 *d.* I demand how many Ells *English* there are in the same? when the Ell at that rate is worth 8 *s.* 4 *d.* *Answer*, 26 Ells *English*.

Quest. 19. A Factor bought 84 Pieces of Stuffs, which cost him in all 537 *l.* 12 *s.* at 5 *s.* 4 *d.* *per* Yard, I demand how many Yards there were in all, and how many Ells *English* were contained in a Piece of the same? *Answer*, 2016 Yards in all, and $19\frac{1}{5}$ Ells *English per* Piece.

Quest. 20. A Draper bought 242 Yards of Broad-cloth, which cost him in all 254 *l.* 10 *s.* for 86 Yards of which he gave after the rate of 21 *s.* 4 *d.* *per* Yard, I demand how many he gave *per* Yard for the remainder? *Answer*, 20 *s.* 10 *d.* $3\frac{64}{56}$ *per* Yard.

Quest. 21. A Factor bought a certain quantity of Serge and Shalloon, which together cost him 226 *l.* 14 *s.* 10 *d.* the quantity of Serge he bought was 48 Yards at 3 *s.* 4 *d.* *per* Yard, and for every two Yards of Serge he had 5 Yards of Shalloon, I demand how many Yards of Shalloon he had, and how much the Shalloon cost him *per* Yard? *Answer*, 120 Yards of Shalloon at 1 *l.* 16 *s.* $5\frac{58}{120}$ *per* Yard.

Quest. 22. An Oyl-man bought 3 Tun of Oyl, which cost him 151 *l.* 14 *s.* and it so chanced that it leaked out 85 Gallons, but he is minded to sell it again, so as that he may be no loser by it, I demand how he

must

must sell it *per* Gallons? *Answer*, at 4 *s*. 6 $\frac{174}{671}$ *d*. per Gallon.

Quest. 23. Bought 6 Packs of Cloth, each Pack containing 12 Cloths, which at 8 *s*. 4 *d*. *per Ell Flemish* cost 1080 *l*. I demand how many Yards there were in each Cloth? *Answer*, 27 Yards in each Cloth.

Quest. 24. A Gentleman hath 536 *l*. *per annum*, and his Expences are one Day with another 18 *s*. 10 *d*. 3 *qrs*. I desire to know how much he layeth up at the Years end? *Answer*, 191 *l*. 3 *s*. 0 *d*. 1 *qr*.

Quest. 25. A Gentleman expendeth daily one Day with another 27 *s*. 10 $\frac{1}{2}$ *d*. and at the Year's end layeth up 340 *l*. I demand how much is his Yearly Income? *Answer*, 848 *l*. 14 *s*. 4 $\frac{1}{2}$ *d*.

Quest. 26. If I sell 14 Yards for 10 *l*. 10 *s*. 00 *d*. how many Ells *Flemish* shall I sell for 283 *l*. 17 *s*. 09 *d*. at that rate? *Answer*, 504$\frac{2}{3}$ Ells *Flemish*.

Quest. 27. If 100 *l*. in 12 Months gain 6 *l*. Interest, how much will 75 *l*. gain in the same time, and at the same rate? *Answer*, 4 *l*. 10 *s*.

Quest. 28. If 100 *l*. in 12 Months gain 6 *l*. Interest, how much will it gain in 7 Months at that rate? *Answer*, 3 *l*. 10 *s*.

Quest. 29. A certain Usurer put out 75 *l*. for 12 Months, and received Principal and Interest 81 *l*. I demand what rate *per Cent*. he received Interest? *Answer*, 8 *l*. *per Cent*.

Quest. 30. A Grocer bought 2 Chests of Sugar, the one weighed Neat 17 *C*. 3 *qrs*. 14 *l*. at 2 *l*. 6 *s*. 8 *d*. *per C*. the other weighed Neat 18 *C*. 1 *qr*. 21 *l*. at 4$\frac{1}{2}$ *d*. *per l*. which he mingleth together, now I desire to know how much a *C*. weight of this Mixture is worth? *Answer*, 2 *l*. 4 *s*. 3 *d*. 2 $\frac{1078}{4087}$ *qrs*.

Quest. 31. Two Men, *viz*. A and B, departed both from one place, the one goes East, and the other West, the one Travelleth 4 Miles a Day, and the other 5 Miles a Day, how far are they distant the 9th Day after their departure? *Answer*, 81 Miles.

Quest.

Quest. 12. *A*, flying every Day 40 Miles is pursued the 4th Day after by *B*, posting 50 Miles a Day, now the Question is in how many Days, and after how many Miles Travel will *A* be overtaken?

More's Arithm. Chap. 7. ex. 35.

Answer, *B* overtakes him in 12 Days, when they have travelled 500 Miles.

11. The general Effect of the Rule of Three Direct, is contained in the Definition of the same, that is, to find a fourth Number in proportion consisting of two equal Reasons as hath been fully shewn in all the foregoing Examples.

The second Effect is, by the price or value of one thing to find the price or value of many things of the like kind.

The third Effect is, by the price or value of many things to find the price of one, or by the price of many things (the said price being one) to find the price of many things of like kind.

The fourth Effect is, by the price or value of many things, to find the price or value of many things of like kind.

The fifth Effect is, thereby to reduce any Number of Moneys, Weight, or Measure, the one sort into the other, as in the Rules of Reduction contained in the Eighth Chapter foregoing. Examples of its various Effects hath been already answered.

12. The Rule of 3 Direct is thus proved, *viz.* Multiply the first Number by the fourth, and note the Product, then mutiply the second Number by the third, and if this Product is equal to the Product of the first and fourth, then the work is rightly performed, otherwise it is erroneous.

The Proof of the Rule of Three Direct.

So the first Question of this Chapter (whose Answer or fourth Number we found to be 18 *s.*) is thus proved, *viz.* the first Number is 4, which multiplied by 18 (the fourth) produceth 72. And the second and third Numbers are 12 and 6, which multiplied together produce 7 *s.* equal to the Product of the first and fourth, and therefore I conclude the Work to be rightly performed.

Always observing, that if any thing remain after yo[u] have divided the Product of the second and third Num[-]bers by the first, such Remainder in proving the same must be added to the Product of the first and fourt[h] Numbers, whose Sum will be equal to the Product o[f] the second and third.(the second number being of th[e] same denomination with the fourth, and the first o[f] the same denomination with the third.)

So the fourth Question of this Chapter being agai[n] repeated, *viz.* If 14 *l.* of Tobacco cost 27 *s.* what wi[ll] 478 *l.* cost at that rate? The Answer (or fourth Num[-]ber) was 46 *l.* 01 *s.* 10*d.* 1*qr.* $1\frac{1}{4}$, which is thus proved *viz.* bring the fourth Number into Farthings, and i[t] makes 44249, which multiplied by the first Numbe[r] 14, produceth 619488, (the second which remaineth being added thereto) then (because I reduce my fourt[h] Number into Farthings,) I reduce my second (*viz.* 27 into Farthings, and they are 1296, which multiplied by the third Number 478, their Product is 619488 equa[l] to the Product of the first and fourth Numbers. Where[-]fore I conclude the Operation to be true. This is a[n] infallible way to prove the *Rule of Three Direct*, and it i[s] deduced from the 12*th Section* of the 9*th Chapter.*

Thus much concerning *The Single Rule of Three Di[-]rect*, and I question not but by this time the Learner i[s] sufficiently qualify'd to resolve any Question pertinen[t] to this Rule, not relying upon Fractions, or *Geometri[-]cal Magnitudes.* Those that are desirous to see the De[-]monstration of this Rule, let them read the sixth Cha[-]pter of (the Ingenious) Mr. *Kersey*'s Appendix to *Win[-]gate*'s Arithmetick. Or the sixth Chapter of Mr. *Ough[-]tred*'s (incomparable) *Clavis Mathematica*: By both which Authors this Rule is largely demonstrated, bein[g] grounded upon the 19*th Prop.* of the 7*th*, and the 19*th Prop.* of the 9*th* of *Euclid. Elem.*

CHA[P.]

CHAP. XI.

The Single Rule of Three Inverse.

1. THE Golden Rule, or Rule of 3 Inverse, is when there are 3 *Numbers* given to find a fourth, in such proportion to the 3 given *Numbers*, so as the 4th proceeds from the 2d, according to the same Rate, Reason, or Proportion that the first proceeds from the third, or the Proportion is.

As the third Number is in proportion to the second, so is the first to the fourth. *Alsted. Matth. lib. 2. cap. 14.*

So if the 3 Numbers given were 8, 12, and 16, and it were required to find a fourth Number in an inverted proportion to these, I say, that as 16 (the third *Number*) is the double of the first Term or *Number* (8) so must 12 (the second *Number*) be the double of the fourth; so will you find the fourth *Term* or *Number* to be 6. And as in the *Rule of Three Direct*, you multiply the second and third together, and divide their Product for a fourth Proportional *Number*.

2. In the *Rule of 3 Inverse*, you must multiply the second Term by the first (or first Term by the second) and divide the Product thereof by the third *Term*, so the Quotient will give you the fourth *Term* sought in an Inverted *Proportion*. The same Order being observed in this *Rule*, as in the *Rule of 3 Direct*, for placing and disposing of the given *Numbers*, and after your *Numbers* are placed in order, that you may know whether your Question be to be resolved by the *Rule Direct* or *Inverse*, observe the General Rule following.

3. When your Question is stated, and your *Numbers* orderly disposed, Consider in the first place whether the fourth *Term* or *Number* sought, ought to be more or less than the second *Term*; which you may easily do: And if it is required to be more, or greater than the second *Term*, then the lesser *Extream* must be your Divisor; but if it require less, then the biggest *Ex-*

tream must be your Divisor (in this Case, the first and third Numbers are called *Extreams* in respect of the second) and having found out your Divisor, you may know whether your Question belong to the Rule *Direct* or *Inverse*; for if the third Term be your Divisor, then it is *Inverse*, but if the first Term be your Divisor, then it is a *Direct Rule*. As in the following Questions.

Quest. 1. If 8 Labourers can do a certain piece of Work in 12 Days, in how many Days will 16 Labourers do the same? *Answer*, in 6 Days.

Having placed the Numbers according to the sixth Rule of the tenth Chapter, I consider that if 8 Men can finish the Work in 12 Days, 16 Men will do it in lesser (or fewer Days than 12.) therefore the biggest Extream must be the Divisor, which is 16, and therefore it is the Rule of 3 *Inverse*, wherefore I multiply the first and second Numbers together, *viz.* 8 by 12, and their Product is 96, which divided by 16, quotes 6 Days for the *Answer*, and in so many Days will 16 Labourers perform a piece of Work, when 8 can do it in 12 Days.

lab. *days* *lab.*
8——12——16
8
——
16) 96 (6 *days.*
96
——
(0)
Facit 6 *days.*

Quest. 2. If when the Measure (*viz.* a peck) of Wheat cost 2 shillings, the peny Loaf weighed (according to the Standard, Statute, or Law of *England*) 8 Ounces, I demand how much it will weigh when the Peck is worth 1 *s.* 6 *d.* according to the same Rate or proportion? *Answer*, 10 *oz.* 13 *p.w.* 8 *gr.*

Having placed and reduced the given Numbers according to the 6 and 9 Rules of the 10*th* Chapter, I consider that at 1 *s.* 6 *d. per* Peck, the Penny Loaf will weigh more than at 2 *s. per* Peck; for as the price decreaseth, the weight increaseth, and as the price increases so the weight diminisheth; wherefore because the first Term requireth more than the second, the lesser Extream must be the Divisor, 1 *s.* 6 *d.* or 18 *d.* and having finished the Work, I find the *Answer* to be 10 *oz.*

13 *p.w.* 8. *gr.* and so much will the penny Loaf weigh when the Peck of Wheat is worth 1 *s.* 6 *d.* according to the given Rate of 8 Ounces, when the Peck is worth 2 Shillings, the Work is plain in the following Operation.

```
 s.          oz.          s.          d.
 2 ————— ——8 ————————1———— ————6
12          24          12
——          ——          ——
24          32          18
            16
           ———— oz. p.w. gr.
       18) 192 (10—13—8
            ..
            18
           ————
           (12)
            20
           ———— p.w.
       18) 240 (13
            ..
            18
           ————
            60
            54
           ————
            (6)
            24
           ————
            12
           ————
       18) 144 (8 gr.
           144
           ————
            (0)
```

Quest. 3. How many pieces of Money or Merchandise at 20 *s. per* piece, are to be given or received for 240 pieces, the value or price of every piece being 12 shillings? *Answer*, 144. For if 12 *s.* require 240 pieces then 20 shillings will require less; therefore the biggest Extream must be the Divisor, which is the third number, *&c.* See the Work.

 If

s. pieces s.
If 12—240—20
12

480
240
240) 288|0 (144 pieces at 20 s. per piece.

2

8
8

8
8

(0)

Quest. 4. How many Yards of 3 quarters broad are required to double, or be equal in measure to 30 Yards, that are 5 quarters broad? *Answer*, 50 Yards: For say, if 5 quarters wide require 30 Yards long, what length will three quarters broad require? Here I consider that three quarters broad will require more Yards than 30, for the narrower the Cloth is, the more in length will go to make equal measure with a broader Piece.

qrs. long qrs.
5——30——3
5

3) 150 (50 yds.

15

(0)

Quest. 5. At the Request of a Friend, I lent him 200 *l.* for 12 Months. Promising to do me the like Courtesy at my Necessity; but when I came to request it of him, he could let me have but 150 *l.* now I desire to know how long I may keep this Money to make plenary satisfaction for my former kindness to my Friend? *Answer*, 16 Months. I say, If 200 *l.* require 12 Months, what will 150 *l.* require? 150 *l.* will require more time than 12 Months, therefore the lesser *Extream* (*viz.* 150) must be the Divisor, multiply

and

and divide, and you will find the fourth inverted Proportional to be 16, and so many Months I ought to keep the 150 *l.* for satisfaction.

Quest. 6. If for 24 *s.* I have 1200 *l.* weight carried 36 Miles, how many Miles shall 1800 *l.* be carried for the same Money? *Answer*, 24 Miles.

Quest. 7. If for 24 *s.* I have 1200 *l.* carried 36 Miles, how many Pound weight shall I have carried 24 Miles for the same money? *Answer*, 1800 pound weight.

Quest. 8. If 100 Workmen in 12 Days finish a piece of Work or Service, how many Workmen are sufficient to do the same in 3 Days? *Answer*, 400 Workmen.

Quest. 9. A Colonel is besieged in a Town in which are 1300 Soldiers, with Provision of Victuals only for 3 Months, the Question is, how many of his Soldiers must he dismiss, that his Victuals may last the remaining Soldiers 6 Months? *Answer*, 500 he must keep, and dismiss as many.

Quest. 10. If Wine worth 20 *l.* is sufficient for the Ordinary of 100 Men, when the Tun is sold for 30 *l.* how many Men will the same 20 pounds worth suffice when the Tun is worth 24 *l.*? *Answer*, 125 Men.

Quest. 11. How much Plush is sufficient to line a Cloak, which hath in it 4 Yards of 7 Quarters wide, when the Plush is but 3 Quarters wide? *Answer*, $9\frac{1}{3}$ Yards of Plush.

Quest. 12. How many Yards of Canvas that is Ell wide, will be sufficient to line 20 Yards of Say, that is 3 Quarters wide? *Answer*, 12 Yards.

Quest. 13. How many Yards of Matting that is two Foot wide, will cover a Floor that is 24 Foot long, and 20 Foot broad? *Answer*, 240 Foot.

Quest. 14. A Regiment of Soldiers consisting of 1000, are to have new Coats, and each Coat to contain 2 Yards, 2 Quarters of Cloath, that is 5 Quarters wide, and they are to be lined with Shalloon that is 3 Quarters wide, I demand how many Yards of Shalloon will line them? *Answer*, $16666\frac{2}{3}$ Quarters of Yards, or $4166\frac{2}{3}$ Yards.

Quest. 15, A Messenger makes a Journey in 24 Days when the Day is 12 Hours long, I desire to know in how many Days he will go the same when the Day is 16 Hours long? *Answer*, In 11 Days.

Quest. 16. Borrowed of my Friend 64 *l.* for 18 Months, and he hath occasion another time to borrow of me for 12 Months, I desire to know how much I must lend to make good his former kindness to me: *Answer*, 42 *l.* 13 *s.* 5 *d.*

3. The general Effect of the Rule of 3 *Inverse* is contained in the Definition of the same, that is, to find a fourth Term in a Reciprocal Proportion inverted to the Proportion given.

The second Effect, is, by two Prices or Values of two several Pieces of Money or Merchandize known, to find how many Pieces of the one Price is to be given for so many of the other. And consequently to reduce and exchange one sort of Money, or Merchandize into another. Or contrariwise, to find the Price unknown of any Piece given to exchange in Reciprocal Proportion.

The third Effect, is, by two differing Prices of a Measure of Wheat bought or sold, and the weight of the Loaf of Bread, made answerable to one of the Prices of the Measures given, to find out the Weight of the same Loaf answerable to the other Price of the said Measure given. Or contrariwise by the two several Weights of the same prized Loaf, and the Price of the Measure of Wheat answerable to one of these Weights given, to find out the other Price of the Measure answerable to the other Weight of the same Loaf.

The fourth Effect, is, by two Lengths, and one Breadth of two Rectangular Planes known, to find out another Breadth unknown. Or by two Breadths and one Length given, to find out another Length unknown in an inverted Proportion.

The fifth Effect, is, by double Time and a capital Sum of Money borrowed or lent, to find out another capital Sum answerable to one of the given Times, or or otherwise, by two Capital Sums, and a Time answerable to one of them given to find out a Time answerable to the other Capital Sum in Reciprocal Reason.

The sixth Effect, is, by two differing Weights of Carriage and the distance of the Places in Miles or in Leagues given to find another distance in Miles, answerable to the same price of Payment; Or otherwise by two Distances in Miles, and the Weight answerable to one of the Distances (being carried for a certain price) to find out the Weight answerable to the other Distance for the same Price.

The seventh Effect, is by double Workmen, and the Time answerable to one of the Numbers of Workmen given, to find out the Time answerable to the other number of Workmen, in the performance of any Work or Service. Or contrariwise, by double Time, and the Workmen answerable to one of those Times given, to find out the Number of Workmen answerable to the other Time, in the performance of any Work or Service.

Also by a double Price of Provision, and the number of Men, or other Creatures nourished for a certain Time, answerable to one of the Prices of Provision given, to find out another Number of Men or other Creatures answerable to the other Price of the Provision for the same time. Or contrariwise, by two numbers of Men or other Creatures nourished, and one price of Provision answerable to one of the numbers of Creatures given, to find out the other price of the same Provision answerable to the other Number of Creatures, both being supposed to be nourished for the same, *&c.* As in the fore-going Examples is fully declared.

☞ To prove the Operation of the Rule of 3 Inverse, multiply the third and fourth Terms together, and note their Product; and multiply the first and second together, and if their Product is equal to the Product of the third and fourth, then is the Work truly wrought, but if it falleth out otherwise, then it is erroneous.

As in the first Question of this Chapter, 16 (the third *Number*) being multiplied by 6 (the fourth *Number*) the Product is 96, and the Product of 8 (the first Number) multiplied by 12 (the second Number) is 96, equal to the first Product, which proves the Work to be right.

And Note, that if in Division any thing remain, such Remainder must be added to the Product of the third and fourth Terms, and if the Sum be equal to the Product of the first and second the Homogeneal Terms (being of one Denomination) the Work is right.

CHAP. XII.

The Double Rule of Three Direct.

WE have already delivered the *Rule of Single Proportion*, and we come now to lay down the *Rules of Plural Proportion*.

1. *Plural Proportion*, is when more Operations in the Rule of Three than one, are required before a Solution can be given to the Question propounded. Therefore in Questions that require Plurality in *Proportion*, there are always more than three Numbers.

2. When there are given 5 Numbers, and a sixth is required in proportion thereunto, then this sixth proportion is said to be found out by the *Double Rule of Three*, as in the Question following, *viz.*

If 100 *l.* in 12 Months gain 6 *l.* Interest, how much will 75 *l.* gain in 9 Months?

3. Questions in the *Double Rule of Three* may be resolved either by two *Single Rules of Three*, or by one *Single Rule of Three*, Compounded of the Five given Numbers.

4. The *Double Rule of Three* is either *Direct*, or else *Inverse*.

5. The *Double Rule of Three Direct*, is, when unto 5 given Numbers, a sixth proportional may be found out by two *Single Rules of Three Direct*.

6. The Five given Numbers in the *Double Rule of Three*

Three Direct consist of 2 parts, *viz.* First, a Supposition, and Secondly, of a Demand; the Supposition is contained in the three first of the five given Numbers, and the Demand lies in the two last; as in the Example of the second Rule of this Chapter, *viz.* If 100*l.* in 12 Months gain 6 *l.* Interest, what will 75 *l.* gain in 9 Months? Here the Supposition is expressed in 100 *l.* 12, and 6; for it is said, if (or suppose) 100, in 12 Months gain 6*l.* Interest, and the Demand lyeth in 75 and 9; for it is demanded how much 75 *l.* will gain in 9 Months?

7. When your Question is stated, the next thing will be to dispose of the given Numbers in due order and place, as a preparative for Resolution; which that you may do, First, observe which of the given Numbers in the Supposition is of the same Denomination with the Number acquired, for that must be the second Number (in the first Operation)of the Single Rule of 3, and one of the other Numbers in the Supposition (it matters not which) must be the first Number, and that Number in the Demand which is of the same Denomination with the first, must be the third Number, which three Numbers being thus placed, will make one perfect Question in the Single Rule of Three, as in the fore-mention'd Example: First, I consider that the Number required in the Question is the Interest or Gain of 75 *l.* therefore that Number in the Supposition which hath the same Name (*viz.* 6 *l.* which is the Interest or Gain of 100 *l.*) must be the second Number in the first Operation, and either 100 or 12 (it matters not which) must be the first Number; but I will take 100, and then for the third Number, I put that Number in the Demand, which hath the same Denomination with 100, which is 75, (for they both signifie Pounds principal) and then the Numbers will stand as you see in the Margent.

100—6—75

But

But if I had for the first *Number* put the other *Number* in the Supposition, *viz.* 12, which signifieth 12 Months, then the third Number must have been 9, which is that Number in the Demand which hath the same Denomination with the first, *viz.* 9 Months, and then they will stand as in the Margent.

12——6——9

There yet remain two Numbers to be disposed of, and those are, one in the Supposition, and another in the Demand; that which is of the Supposition I place under the first of the three Numbers, and the other which is in the Demand I place under the third Number, and then 2 of the Terms in the Supposition will stand (one over the other) in the first place, and the 2 Terms in the Demand will stand (one over the other) in the third place, as in the Margent.

100——6——75		
12		9

Or thus,

12——6——9		
100		75

8. Having disposed, or ordered the Numbers given according to the last Rule, we may proceed to a Resolution, and first I work with the three uppermost Numbers, which according to the first disposition are 100, 6, and 75, which is as much as to say, If 100 *l.* require 6 *l.* (Interest) how much will 75 *l.* require? which by the 3*d* Rule of the 11*th* Chapter I find to be *Direct*, and by the 7*th* and 8*th* Rules of the 10*th* Chapter, I find the fourth *Proportional Number* to be 4 *l.* 10 *s.* so that by the foregoing single Question I have discovered how much Interest 75 *l.* will gain in 12 Months, the Operation whereof followeth on the Left-hand under the Letter *A*; and having discovered how much 75 *l.* will gain in 12 Months, we may by another Question easily discover how much it will gain in 9 Months, for this 4*th* Number (thus found) I put in the middle between the two lowest *numbers* of the five, after they are placed according to the 7*th* Rule of this Chapter; and then it will be a second Number, in another Question in the Rule of Three,

m. l. s. m.

the Numbers being 12—4—10—9 the first and third Numbers

Numbers being of one Denomination, *viz.* both Months, and may be thus expressed. If twelve Months require 4 *l.* 10 *s.* Interest, what will 9 Months require? And by the third Rule of the 11 Chapter, I find it to be the *Direct* Rule, and by working according to the Directions laid down in the 7. 8, and 9 Rules of the 10*th* Chapter, I find the fourth *Proportional Number* to the last single Question to be 03 *l.* 07 *s.* 06 *d.* which is the sixth *Proportional Number* to the 5 given Numbers, and is the Answer to the general Question. The Work of the last single Question is expressed on the right-side of the Page under the Letter *B*, as followeth:

100——6——75
12 9

A

l. l. l.
If 100——6——75
75
———
30
42
———*l.* *s.*
1|00) 4|50 (4--10
4
———
Rem. (50)
Mult. 20
———
1|00 (10|00 (10 *s.*

l. *s.*
Facit 4——10

B

Then say,
m. *l.* *s.* *m.*
If 12——4——10——9
20
———
90 *shillings*
12
———
180
90
———
1080 *pence*
9
——— 12) 2|0 *l.* *s.* *d.*
129720 (810 (6|7 (3—7—6
6
96 72———
—— ——(7 *s.*)
12 90
12 84
—— ——
(0) (6)

l. *s.* *d.*
Facit 3——7——6

So that by the foregoing Operation I conclude, that if 100 *l.* in 12 Months gain 6 *l.* Intereſt, 75 *l.* will gain 3 *l.* 7 *s.* 6 *d.* in 9 Months after the ſame rate.

The Anſwer would have been the ſame if the 5 given *Numbers* had been ordered according to the ſecond method, *viz.* as you ſee in the Margent.

12	6	9
100		75

For firſt, I ſay, if 12 Months gain 6 *l.* what will 9 Months gain? This Queſtion I find to be *Direct* by the 3*d* Rule of the 11th Chapter, and by the 7th and 8th Rules of the 10th Chapter, I find the fourth proportional Number to theſe three to be 4 *l.* 10 *s.*

Thus have I found out what is the Intereſt of 100 *ll.* for 9 Months, and I am now to find the Intereſt of 75 *l.* for 9 Months; to effect which, I make this 4th Number (found as before) to be my ſecond Number in the next Queſtion, and ſay, if 100 *l.* require 4 *ll.* 10 *s.* what will 75 *l.* require? This Queſtion I find (by the ſaid third Rule of the 11th Chapter) to be *Direct*, and by the ſaid 7th, 8th, and 9th Rules of the 10th Chapter, I find the Anſwer to be as before, *viz.* 3 *ll.* 7 *s.* 6 *d.*

This Rule hath been ſufficiently explained by the foregoing Example, ſo that the Learner may be able to reſolve the following (or any other) Queſtions pertinent to the *Double Rule of 3 Direct*, whoſe Anſwers are there given, but the Operation purpoſely omitted to try the Learner's ability in the knowledge of what hath been before delivered.

Queſt. 2. A ſecond Example in this Rule may be as followeth, *viz.* A Carrier receiving 42 Shillings for the Carriage of 300 weight 150 Miles, I demand how much he ought to receive for the Carriage of 7 C. 3 *qrs.* 14 *ll.* 50 Miles at that rate? *Anſwer*, 36 *s.* 9 *d.*

Queſt. 3. A Reigment of 936 Soldiers eat up 351 Quarters of Wheat in 168 Days, I demand how many Quarters of Wheat 11232 Soldiers will eat in 36 Days at that rate? *Anſwer*, 1404 *Qrs.*

Queſt. 4. If 40 Acres of Graſs be mowed by 8 Men in 7 Days, how many Acres ſhall be mowed by 24 Men in 28 Days? *Anſwer*, 480 Acres.

Queſt.

Queſt. 5. If 48 Buſhels of Corn (or other Seed) yield 576 Buſhels in 1 Year, how much will 240 Buſhels yield in 6 Years at that rate? That is to ſay, if there were Sowed 240 Buſhels every one of the 6 Years? *Anſwer*, 17280 Buſhels.

Queſt. 6. If 40 Shillings is the Wages of 8 Men for 5 Days, what ſhall be the Wages of 32 Men for 24 Days? *Anſwer*, 768 Shillings, or 38 *l.* 8 *s.*

Queſt. 7. If 14 Horſes eat 56 Buſhels of Provender in 16 Days, how many Buſhels will 20 Horſes eat in 24 Days? *Anſwer*, 120 Buſhels.

Queſt. 8. If 8, Cannons in one Day, ſpend 48 Barrels of Powder, I demand how many Barrels 24 Cannons will ſpend in 12 Days at that rate? *Anſwer*, 1728 Barrels.

Queſt. 9. If in a Family conſiſting of 7 Perſons, there are drunk out 2 Kilderkins of Beer in 12 Days, how many Kilderkins will there be drunk out in 8 Days by another Family conſiſting of 14 Perſons? *Anſwer*, 48 Gallons, or 2 Kilderkins and 12 Gallons.

Queſt. 10. An Uſurer put 75 *l.* out to receive Intereſt for the ſame, and when it had continued 9 Months, he received for Principal and Intereſt 78 *l.* 7 *s.* 6 *d.* I demand at what rate *per Cent. per Annum*, he received Intereſt? *Anſwer*, at 6 *l.* *per Cent. per Annum.*

CHAP. XIII.

The Double Rule of Three Inverſe.

1. THE *Double Rule of* 3 *Inverſe*, is, when a Queſtion in the Double Rule of 3 is reſolved by 2 Single Rules of 3, and one of thoſe Single Rules falls out to be *Inverſe*, or requires a fourth Number in *Proportion Reciprocal* (for both the Queſtions are never *Inverſe.*)

2. In all Queſtions of the Double Rule of 3 (as well *Inverſe*, as *Direct*) you are in the diſpoſing of the 5 given

given *Numbers*) to obſerve the 7th Rule of the 12th Chapter, and in reſolving of it by two ſingle Rules, obſerve to make choice of your *Numbers* for the firſt and ſecond ſingle Queſtions according to the directions given in the eighth Rule of the ſame Chapter, as in the Example following, *viz.*

Queſt. 1. If 100*l.* Principal in 12 Months gain 6*l.* Intereſt, what Principal will gain 3 *l.* 7 *s.* 6 *d.* in 9 Months?

This Queſtion is an Inverſion of the firſt Queſtion of the 12th Chapter, and may ſerve for a Proof thereof.

In order to a Reſolution, I diſpoſe of the 5 given *Numbers* according to the 7th Rule of the laſt Chapter, and being ſo diſpoſed, they will ſtand as followeth.

12——————100——————9
6　　　　　　　　　　l. s. d.
　　　　　　　　　　　2—7—6

Or thus,

　　　　　　　　　　　l. s. d.
6——————100——————3—7—6
12　　　　　　　　　　9

Here obſerve, that according to the eighth Rule of the twelfth Chapter, the firſt Queſtion, if you take it from the 5 *Numbers* (as they are ordered or placed firſt) will be, if 12 Months require 100 *l.* principal, what will 9 Months require to make the ſame Intereſt? This (according to the third Rule of the 10th Chapter) is *Inverſe*, and the Anſwer will be found (by the 2d Rule of the 11th Chapter) to be 933 *l.* 6 *s.* 8 *d.* The ſecond Queſtion then will be, If 6 *l.* Intereſt require 133 *l.* 6 *s.* 8 *d.* Principal, how much Principal will 3 *l.* 7 *s.* 6 *d.* require? This is a direct Rule, and the Anſwer in a direct *Proportion* is 75 *l.* See the Work.

First

First I say,

```
    m.     l.      m.
If 12 — 100 —— 9
           12
   ——————————   l.   s.  d.
    9) 1200 (133—6—8
       ...
        9
      ————
        30
        27
      ————
        30
        27
      ————
        (3)
         20
      ————
     9) 60 (6 s.
         54
      ————
        (6)
         12
      ————
     9) 72 (8 d.
         72
        (0)
```

Then

Then I say,

```
   l.           l.    s.   d.        l.    s.   d.
If 6 ——————— 133 —— 6 —— 8 ——————— 3 —— 7 —— 6
  240          20                    20
  ———          ——                    ——
 1440 d.      2666                   67
                12                   12
              ————                   ———
              5340                   140
             2666                     67
             —————                   ———
             32000                   810 d.
               108
             ——————
            320000
           256
         ———————————— 24|0
144|0) 2592000|0 (1800|0 (75 l.
         .....          ..
        144           168
        ————          ———
        1152          120
        1152          120
        ————          ———
         (0)          (0)
```

So that by the fore-going Work I find that if 6 *l.* Intereſt be gained by 100 *l.* in 12 Months, 3 *l.* 7 *s.* 6 *d.* will be gained by 75 *l.* in 9 Months.

But if the Reſolution had been found out by the Numbers as they are ranked in the ſecond place, then the ſecond Queſtion in the Single Rule would have been *Inverſe*, and the firſt Queſtion *Direct*, and the concluſion the ſame with the firſt method, *viz.* 75 *l.*

Queſt. 2. If a Regiment conſiſting of 936 Soldiers can eat up 351 Quarters of Wheat in 168 Days, how many Soldiers will eat up 1404 Quarters in 56 Days at that rate? *Anſwer,* 11232 Soldiers.

Queſt. 3. If 12 Students in 8 Weeks ſpend 48 *l.* I demand how many Students will ſpend 288 *l.* in 18 Weeks? *Anſwer,* 32 Students.

Queſt.

Quest. 4. If 48 *l.* serve 12 Students 8 Weeks, how many Weeks will 288 *l.* serve 4 Students? *Answer*, 143 Weeks.

Quest. 5. If when the Bushel of Wheat cost 3 *s.* 4 *d.* the penny Loaf weigheth 12 Ounces, I demand the weight of the Loaf worth 9 *d.* When the Bushel cost 10 *s.*? *Answer*, 36 Ounces.

Quest. 6. If 48 Pioneers in 12 Days cast a Trench 24 Yards long, how many Pioneers will cast a Trench 168 Yards long in 16 Days? *Answer*, 252 Pioneers.

Quest. 7. If 12 *C.* weight being carried 100 Miles, cost 5 *l.* 12 *s.* I desire to know how many *C.* weight may be carried 150 Miles for 12 *l.* 12 *s.* at that rate? *Answer*, 18 *C.*

Quest. 8. If when Wine is worth 30 *l. per Tun*, 20 pounds worth is sufficient for the ordinary of 100 Men, how many Men will 4 pounds worth suffice when it is worth 24 *l. per Tun?* *Answer*, 25 Men.

Quest. 9. If 6 Men in 24 Days Mow 72 Acres, in how many Days will 8 Men Mow 24 Acres? *Answer*, in 6 Days.

Quest. 10. If when the Tun of Wine is worth 30 *l.* 100 Men will be satisfy'd with 20 *l.* worth, I desire to know what the Tun is worth when 4 *l.* worth will satisfy 25 Men at the same rate? *Answer*, 24 *l. per Tun.*

CHAP. XIV.

The Rule of Three composed of Five Numbers.

THE *Rule of Three Compos'd*, is, when Questions (wherein there are 5 *Numbers* given to find a 6th in proportion thereunto) are resolved by one single Rule of 3 composed of the 5 given *Numbers.*

2. When Questions may be performed by the double Rule of 3 Direct, and it is required to resolve them by the Rule of 3 Composed, first, order or rank your Numbers according to the 7th Rule of the 12th Chapter, then.)

The

The Rule is,

Multiply the Terms (or Numbers) that ſtand one over the other in the firſt place, the one by the other, and make their Product the firſt Term in the Rule of Three Direct; then multiply the Terms that ſtand one over the other, in the third place, and place their Product for the third Term in the Rule of Three Direct, and put the middle Term of three uppermoſt for a ſecond Term; then having found a fourth Proportional, direct to theſe three, this fourth Proportional ſo found, ſhall be the Anſwer required.

So the firſt Queſtion of the 12th Chapter being propoſed, *viz.* If 100 *l.* in 12 Months gain 6 *l.* Intereſt, what will 75 *l.* gain in 9 Months? the Numbers being ranked (or placed) as is there directed and done.

Then I multiply the two firſt Terms, 100, and 12, the one by the other, and their Product is 1200 (for the firſt Term;) then I multiply the two laſt Terms 75 and 9 together, and their Product is 975 for the third Term. Then I ſay, as 1200 is to 6, ſo 675 to the Anſwer, which by the Rule of three Direct, will be found to be 3 *l.* 7 *s.* 6 *d.* as was before found.

2. But if the Queſtion be to be anſwered by the Double Rule of Three Inverſe, then (having placed the Five given Terms as before) multiply the lowermoſt Term of the firſt place, by the uppermoſt Term of the third place, and put the Product for the firſt Term; then multiply the uppermoſt Term of the firſt place, by the lowermoſt Term of the third place, and put the Product for the third Term, and put the ſecond Term of the three higheſt Numbers for the middle Term to thoſe two, then if the Inverſe Proportion is found in the uppermoſt three Numbers, the 4th. Proportional Direct to theſe three ſhall be the Anſwer; ſo the firſt Queſtion of the 13th Chapter being ſtated, *viz.* If a 100 *l.* Principal in 12 Months gain 6 *l.* Intereſt, what Principal will gain 3 *l.* 7 *s.* 6 *d.* in 9 Months? State the Numbers as is there directed in the firſt Order, *viz.*

M.	*l.*	*M.*		
12 ——	100 ——	9		
l.		*l.*	*s.*	*d.*
6		3 ——	7 ——	6

then reduce the 6 *l.* and 3 *l.* 7 *s.* 6 *d.* into Pence, the 6 *l.* is 1440 *d.* and 3 *l.* 7 *s.* 6 *d.* is 810 *d.* then multiply 1440 by 9, the Product is 12960 for the first Term in the Rule of Three Direct, and multiply 810 by 12, the Product is 9720 for the third Term, then I say, As 12960 is to 100 *l.* so is 9720 to the Answer, *viz.* 75 *l.* as before. But if the Terms had been placed after the second Order, *viz.*

l.	*l.*	*l.*	*s.*	*d.*
6 ——	100 ——	3 ——	7 ——	6
M.		*M.*		
12		9		

then the Inverse Proportion is found in the lowest Numbers, and having Composed the Numbers for a single Rule of Three as in the second Rule foregoing, then the Answer must be found by a single Rule of Three Inverse; for here it falls out to multiply 810 by 12 for the first Number, and 1440 by 9 for the third Number, and then you must say, As 9720 is to 100 *l.* so is 12960 to the Answer, which by Inverse Proportion will be found to be 75 *l.* as before.

The Questions in the 12th and 13th Chapters may erve for thy farther Experience.

CHAP. XV.

Single Fellowship.

FELLOWSHIP, is that Rule of Plural Proportion, whereby we Ballance Accompts depending

pending between divers Perſons having put together a General Stock, ſo that they may every Man have his Proportional part of Gain, or ſuſtain his Proportional part of Loſs.

2. The Rule of Fellowſhip is either Single, or it is Double.

3. The Single Rule is when the Stocks propounded are Single Numbers without any reſpect or relation to Time, each Partner continuing his Money in Stock for the ſame Time.

4. In the Single Rule of Fellowſhip, the proportion is, as the whole Stock of all the Partners is in proportion to the Total Loſs or Gain, ſo is each Man's particular ſhare in the Stock, to his particular ſhare in the Gain or Loſs. Therefore take the Total of all the Stocks for the firſt Term in the Rule of Three, and the whole Gain or Loſs for the ſecond Term, and the particular Stock of any one of the Partners for the third Term, then multiply and divide according to the 7th Rule of the 9th Chapter, and the 4th Proportional Number is the particular Loſs or Gain of him whoſe Stock you made your ſecond Number, wherefore repeat the Rule of Three as often as there are particular Stocks or Partners in the Queſtion, and the 4th Terms produced upon the ſeveral Operations are the reſpective Gain or Loſs of thoſe particular Stocks given; as in the Examples following.

Queſt. 1. Two Perſons, *viz.* *A* and *B*, bought a Tun of Wine for 20 *l.* of which *A* paid 12 *l.* and *B* paid 8 *l.* and they gained in the Sale thereof 5 *l.* now I demand each Man's ſhare in the Gains according to his Stock?

Firſt, I find the Sum of their Stocks, by adding them together, *viz.* 12 *l.* and 8 *l.* which are 20 *l.* then according to this Rule, I ſay firſt, if 20 *l.* (the Sum of their Stocks) require 5 *l.* the Total Gain, how much will 12 *l.* (the Stock of *A*) require? Multiply and Divide by the 7th Rule of the ninth Chapter, and the Anſwer is 5 *l.* for the ſhare of *A* in the

12
8
20 *l.*

Gains

gains; then again I say, If 20 *l.* require 5 *l.* what will 8 *l.* require? the Answer is 2 *l.* which is the Gain of *B.* So I conclude that the share of *A* in the Gain is 3 *l.* and the share of *B* in the Gain is 2 *l.* which in all is 5 *l.*

```
      l.      l.      l.
If 20 ——— 5 ——— 12
          12
        ———
      20) 60 (3 l.
          60
        ———
          (0)
      l.      l.      l.
If 20 ——— 5 ——— 8
          8
        ———
      20) 40 (2 l.
```

Quest. 2. Three Merchants, *viz.* A, B, and C, enter upon a joynt Adventure, A put into the common Stock 78 *l.* B put in 117 *l.* and C. put in 234 *l.* and they find (when they make up their Accompts) that they have gained in all 264 *l.* now I desire to know each Man's particular share in *the* Gain?

First, I add their particular Stocks together, and their Sum is 429 *l.* then say, If 429 *l.* gain 264 *l.* what will 78 *l.* Gain? and what 117 *l.* and what will 234 *l.* (the Stocks of A, B, and C,) gain? Work by three several Rules of 3, and you will find

```
      l.
      78
     117
     234
    ———
Sum 429
```

```
                         l.
The Gain of { A } is { 48
            { B }    { 72
            { C }    { 144
                     ———
                 Sum 264
```

Quest. 3. Four Partners, *viz.* A, B, C, and D, b tween them built a Ship which cost 1730 *l.* of whi A paid 446 *l.* B 519 *l.* C 692 *l.* and D 173 *l.* ann Th Freight for a certain Voyage 370 *l.* which is due: the Owners or Builders, I demand each Man's sha therein according to his Charge in building her?

Answer,

	l.
A	74
B	111
C	148
D	37
Sum	370

Quest. 4. A, B, and C, enter Partnership for a cer tain time, A put into the common Stock 364 *l.* B p in 482 *l.* C put in 500 *l.* and they gained 867 *l.* no I demand each Man's share in the Gain proportionab to his Stock.

Answer,

	l.	s.	d.
A	234	09	$3\frac{354}{1346}$
B	310	09	$5\frac{62}{1346}$
C	322	09	$3\frac{930}{1346}$
Sum	867	00	0

The Proof of the Rule of Single Fellowship.

5. To prove the Rule of *Single Fellowship*, add ea Man's particular Gain or Loss tog ther, and if the Total Sum is equ to the general Gain or Loss, th is the Work rightly performed, b otherwise it is erroneous. Exampl In the first Question of this Chapter, the *Answer* wa that the Gain of A was 3 *l.* and the Gain of B 2 which added together make 5 *l.* equal to the Tot Gain given.

If in finding out the *particular Shares* of the ſeveral *Partners*, any thing remain after Diviſion is ended, ſuch remainders muſt be added together, (they being all Fractions of the ſame Denomination) and their Sum divided by the common Diviſor in each Queſtion (*viz:* the total Stock) and the Quotient add to the *particular Gains*, and then if the total Sum is equal to the total Gain, the Work is right, otherwiſe not.

As in the fourth Queſtion, the Remainders were 354, 62, and 930 which added together makes 1346, which divided by 1346, (the Sum of their Stocks) the Quotient is 1 *d.* which I add to the pence, *&c.* and the Sum of their Shares is 867 *l.* equal to the total Gain, wherefore I conclude the Work is right.

CHAP. XVI.

Double Fellowſhip.

1. DOuble Fellowſhip is, when ſeveral Perſons enter into *Partnerſhip* for unequal time, that is, when every Man's *particular* Stock hath a relation to a *particular* time.

2. In the Double Rule of Fellowſhip, multiply each *particular* Stock by its reſpective time, and having added the ſeveral Products together, make their Sum the firſt *Number* (or *Term*) in the Rule of 3, and the total Gain or Loſs the ſecond Number, and the Product of any one's particular Stock by his time, the third *Term*, and the 4th *Number* in *proportion* thereunto is his *particular* Gain or Loſs, whoſe Product of Stock and Time is your third *Number*.

Then repeat (as in Single Fellowſhip) the Rule of 3, as often as there are Products or (Partners) and the *Terms* thereby invented are the *Numbers* required.

Example.

Queſt. 1. A and B enter *Partnerſhip*, A put in 40 *l.* for 3 Months, B put in 75 *l.* for 4 Months, and they gained 70 *l.* now I demand each man's ſhare in th Gains, proportionable to his Stock and Time? *Anſwer* A 20 *l.* B 50 *l.*

To reſolve this Queſtion, I firſt multiply the Stock of A, (*viz.* 50 *l.*) by its time (3 months) and the Product is 120; then I multiply the Stock of B by its time, (*viz.* 75 by 4) and it produceth 300, which I add to the Product of A his Stock and time, and the Sum is 420. Then by the Rule of 3 Direct, I ſay, As 420 (the Sum of the Products) is to 70 (the Total Gain) ſo is 120 (the Product of A his Stock and Time) to 20 *l.* (the ſhare of A in the Gains) and is 300 (the Product of B his Stock and Time) to 50 (the Share of B in the Gains.) And ſo much ought each to have for his ſhare.

	l.		*l.*
	40		75
	3		4
A	120	B	300
			120
		Sum	420

Queſt. 2. A, B, and C make a Stock for 12 months A put in at firſt 364 *l.* and 4 months after that he put in 40 *l.* B put in at firſt 408 *l.* and at the end of months he took out 86 *l.* C put in at firſt 148 *l.* and 3 months after he put in 86 *l.* more, and 5 months after that he put in 100 *l.* more, and at the end of 12 months their Gain is found to be 1436 *l.* I deſire to know each man's Share in the Gains according to his Stock and Time?

Firſt, I conſider that the whole Time of their Partnerſhip is 12 months. Then I proceed to find out the ſeveral Products, or Stock and Time as followeth.

A had at firſt 364 *l.* for 4 months, wherefore their Product is	1456
Then he put in 40 *l.* which with the firſt Sum makes 404 *l.* which continued the remainder of the time, *viz.* 8 months, and their Product is	3232
The Sum of the Products of the Stock and Time of A is	4688

B had

B had 408 *l* in 7 months, whose Product is	2856
And then took out 86 *l.* therefore he left in Stock 322 *l.* which continued the rest of the time, *viz.* five months, whose Product is	1610
The Sum of the Products of the Stock and Time of B is	4466
C put in 148 *l.* for 3 months, whose Product being multiplied is	444
Then he put in 86 *l.* which added to the first, (*viz.* 148 *l.*) makes 234 *l.* which lay in Stock 5 months, their Product is	1170
Then he put in 100 *l.* more, so then he had in Stock 334 *l.* which continued the remainder of the time, (*viz.* 4 months) which multiplied together produce	1336
The Sum of the Product of the money and time of C is	2950
B	4466
A	4688
The Total Sum of all the Products is	12104

Then I say, as 12104 is to 1436 (the Total Gain) so is 4688 to the share of A in the Total Gain, &c. go on as in the foregoing Examples, and you will find their Shares in the Gain to be as followeth, *viz.*

Answer,

		l.	s.	d.
The share of	A is	556	03	$6\frac{6192}{12104}$
	B	529	16	$9\frac{5496}{12104}$
	C	349	19	$8\frac{4416}{12104}$
	Sum	1436	00	0

Quest. 3. Three Grasiers, A, B and C, take a piece of Ground for 46 *l.* 10 *s.* in which A put 12 Oxen for 8 Months, B put in 10 Oxen for 5 Months, and C put 18 Oxen for 4 Months, now the Question is, what shall each Man pay of the 46 *l.* 10 *s.* for his share in that charge?

Answer,

		l.	s.
A	pay	18	00
B		15	00
C		13	00

3. The Proof of this Rule is the same with that of *Single Fellowship*, laid down in the 5th Rule of the 5th Chapter; and note that,

If a Loss be sustained instead of Gain amongst *Partners*, every Man's share to be born in the Loss is to be found after the same Method as their Gain, whether their Stocks be for equal or unequal time.

CHAP. XVII.

Alligation Medial.

1. THE Rule of Alligation is that Rule in Plural Proportion, by which we resolve Questions wherein is a composition or mixture of divers Simples, as also it is useful in the composition of Medicines both for Quantity, Quality and Price. And its Species are two, *viz.* Medial and Alternate.

2. Alligation Medial is, when having the several quantities and prices of several Simples propounded, we discover the mean price or rate of any quantity of the mixture compounded of those Simples, and the Propor-

As the Sum of the Simples to be mingled is to the total Value of all the Simples, so is any part or quantity of the Composition or Mixture to its mean Rate or Price.

Quest. 1. A Farmer mingleth 20 Bushels of Wheat at 5 *s. per* Bushel, and 36 Bushels of Rye at 3 *s. per* Bushel, with 40 Bushels of Barley at 2 *s. per* Bushel, now I desire to know what 1 *Bushel* of that Mixture is worth?

To resolve this Question, add together the given Quantities, and also their Values, which is 96 Bushels, whose total Value is 14 *l.* 8 *s.* as appeareth by the Work following; for,

Bush.		l.
20	*of Wheat at* 5 s. per *Bushel, is*	5—0
36	*of Rye at* 3 s. per *Bushel, is*	5—8
40	*of Barley at* 2 s. per *Bushel, is*	4—0

The Sum of their given quantities is 96, *and their Value is* ——— 14—8

Then say by the Rule of 3 Direct, If 96 Bushels cost (or is worth) 14 *l.* 8 *s.* what is 1 Bushels worth?

bush. *l.* *s.* *bush.*
96——14——8——1
20

96) 288 (3 *s.*

288

——— *Facit*, 3 s. per *Bushel*

(o)

Quest. 2. A Vintner mingleth 15 Gallons of Canary at 8 *s. per* Gallon, with 20 Gallons of Malaga at 7 *s.* 4*d. per* Gallon, with 10 Gallons of Sherry at 6 *s.* 8 *d. per* Gallon, and 24 Gallons of White-wine at 4 *s. per* Gallon, now I demand what a Gallon of that Mixture is worth? Work as in the last Question, and you will find the Answer to be 6 *s.* 2 *d.* 2 *qrs.* $\frac{46}{69}$.

Quest. 3. A Grocer hath mingled 3 *C.* of Sugar at 36 *s. per C.* with 3 *C.* of Sugar at 3 *l.* 14 *s.* 8 *d. per C.* and with 6 *C.* at 1 *l.* 17 *s.* 4 *d. per C.* I desire to know the price of a hundred weight of that Mixture? *Answer*, 2 *l.* 11 *s.* 4 *d.*

The Proof of Allig. Medial.

3. The Proof of this Operatinn is by the Price of any quantity of the mixture to find out the total value of the whole Composition, and if it is equal to the total Value of the several Simples, the Work is right, otherwise not. As in the first Example, the Answer to the Question was, that 3 *s.* is the price of one Bushel; wherefore I say by the Rule of Proportion, If 1 Bushel be 3 Shillings, what is 96 Bushels? *Answer*, 14 *l.* 8 *s.* which is the total Value of the several Simples, wherefore the Work is right.

CHAP. XVIII.

Alligation Alternate.

1. ALligation Alternate is, when there are given the particular prices of several Simples, and thereby we discover such quantities of those Simples, as being mingled together shall bear a certain Rate propounded.

2. When such a Question is stated, place the given prices of the Simples one over the other, and the propounded price of the Composition against them in such sort that it may represent a Root, and they so many branches spring from it, as in the following Example.

Quest. 1. A certain Farmer is desirous to mix 20 Bushels of Wheat at 5 *s.* 60 *d. per* Bushel, with Rye at 3 *s.* or 36 *d. per* Bushel, and with Barley at 2 *s.* or 24 *d. per* Bushel, and Oats at 1 *s.* 6 *d. per* Bushel, and desireth to mix such a quantity of Rye, Barley and Oats with the 20 Bushels of Wheat, as that the whole Composition may be worth 2 *s.* 8 *d.* or 32 *d. per* Bushel.

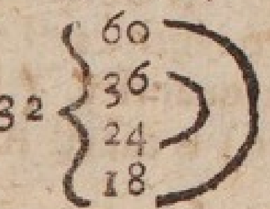
The

The Prices of the Simples being placed according to the last Rule (with the price of the Composition propounded as a root to them) will stand as followeth.

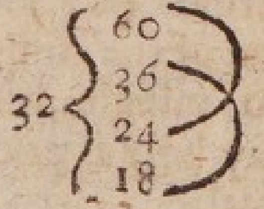
32 { 60 *Pence.* / 36 / 24 / 18

3. Having thus placed the given Numbers, you are to link or combine the several rates of the simples the one to the other, by certain Arches, in such a sort that one that is lesser than the root (or mean rate) may be linked or coupled to another that is greater than the mean rate, so the question last propounded will stand.

1. *Thus,*



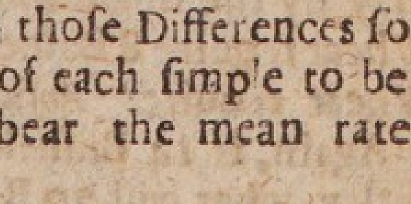
2, *Or thus,*



3. *Or thus,*

4. Then take the Difference between the root and the several Branches and place the Difference of each against the number or Branch, with which it is coupled or linked, and having taken all the Differences and placed them as aforesaid, then those Differences so placed will shew you the number of each simple to be taken to make a Composition to bear the mean rate propounded.

So the Branches of the last Question being linked together as in the first manner, I say the Difference between 32 and 60, is 28, which I put against 18, because 60 is linked with 18, then the difference between 32 and 36 is 4, which I



put against 24, because 36 is linked or coupled with 24, then I say, the difference between 32 and 24 is 8, which I place against 36 (for the reason aforesaid) then I say, the difference between 32 and 18 is 14, which I place against 60; and then the Work will stand as you see in the Margent.

So I conclude that a Composition made of 14 Bushels of Wheat at 60 *d. per* Bushel, and 8 Bushels of Rye at 36 *d. per* Bushel, and 4 Bushels of Barley at 24 *d. per* Bushel, and 28 Bushels of Oats at 18 *d. per* Bushel, will bear the mean price of 32 *d.* or 2 *s.* 8 *d. per* Bushel. And here observe that in this Composition there is but 14 Bushels of Wheat; but I would mingle 20 Bushels, and this kind, (or rather case) of Alligation Alternate, (*viz.*) when there is given a certain quantity of one of the *Simples*, and the quantities of the rest sought to mingle with this given quantity, (that the whole may bear a price propounded) is called Alternation partial.

And the proportion to find out the several quantities to be mingled with the given quantity is as followeth, *viz.*

As the difference annexed to the Branch that is the value of an Integer of the given quantity, is to the other particular Differences, so is the quantity given to the several quantities required.

So here, how to find out so much Rye, Barley and Oats as must be mingled with the 20 Bushels of Wheat; I say by the single Rule of 3 Direct, if 14 Bushels of Wheat require 8 Bushels of Rye, what will 20 Bushels of Wheat require? *Answer*, $11\frac{6}{14}$ Bushels of Rye.

Again, if 14 Bushels of Wheat require 4 Bushels of Barley, what will 20 Bushels of Wheat require? *Answer*, $5\frac{10}{14}$ Bushels of Barley. Again, I say, if 14 Bushels of Wheat require 28 Bushels of Oats, what will 20 Bushels of Wheat require? *Answer*, 40 Bushels of Oats.

And now I say, that 20 Bushels of Wheat mingled with $11\frac{6}{14}$ Bushels of Rye, and $5\frac{10}{14}$ Bushels of Barley, and 40 Bushels of Oats, each bearing the Rates as aforesaid, will make a Composition or heap of Corn that may yield 32 *d. per* Bushel.

But

But, if the branches had been coupled according to the second order, or manner, the differences would have been thus placed, *viz.* the difference between 32 and 60 is 28, which I set against 24, because 60 is linked thereto; and the difference between 32 and 36 is 4, which I set against 18, and the difference between 32 and 24 is 8, which I set against 60; then the difference between 32 and 18 is 14, which I set against his yoke-fellow 36, and then I conclude that if you mix 8 Bushels of Wheat with 14 Bushels of Rye, 28 Bushels of Barley, and 4 Bushels of Oats, each bearing the aforesaid Prices, the whole Mixture may be sold for 32 *d. per* Bushel, as by the Work in the Margent.

32	60	8
	36	14
	24	28
	11	4

You see by this Work, we have found how many Bushels of Rye, Barley and Oats, ought to be mixed with 8 Bushels of Wheat, and to find out how many of each ought to be mixt with 20 Bushels of Wheat, I say, as 8 is to 14, so is 20 to 35 Bushels of Rye. As 8 is to 28, so is 20 to 35 Bushels of Barley. As 8 is to 4, so is 20 to 10 Bushels of Oats, whereby I conclude that if to 20 Bushels of Wheat I put 35 Bushels of Rye, 70 Bushels of Barley, and 10 Bushels of Oats, bearing each the foresaid prices *per* Bushel, that then a Bushel of this mixture will be worth 32 *d.* or 2 *s.* 8 *d.*

And if the Branches had been linked as you see in the third place where each Branch bigger than the Root is linked to two that are lesser than the Root, then in this Case you must have placed the several differences between the Root and Branches, against those two with which each is coupled, as first the difference between 32 and 60 is 28 which I put against 24 and 18, because it is coupled

32	60	8,14	22
	36	8,14	22
	24	28 4	32
	18	28,4	32

 with

with them both, then the difference between 32 and 36 is 4, which I set likewise against 24 and 18, because 36 is linked to them both, then the difference between 32 and 24 is 8, which I put against 60 and 36, because 24 is linked to them both, then the difference between 32 and 18 is 14, which I put against 60 and 36, the yoke-fellows of 18.

Lastly, I draw a Line behind the differences, and add the differences which stand against each Branch, and put the Sum behind the said Line against its proper Branch as you see in the Margent.

And now by this Work I find that 22 Bushels of the Wheat mingled with 22 Bushels of Rye, and 32 Bushels of Barley, and 32 Bushels of Oats, each bearing the said price will make a mixture bearing the mean rate of 32 *d. per* Bushel.

And to find how much of each of the rest must be mingled with 20 Bushels of Wheat, I say,

As 22 is to 22, so is 20 to 20 Bushels of Rye. As 22 is to 32, so is 20 to $29\frac{2}{22}$ bushels of Barley. As 22 is to 32, so is 20 to $29\frac{2}{22}$ Bushels of Oats.

Whereby you see the Questions of Alligation Alternate will admit of more true Answers than one; for we have found three several Answers to this first Question.

Questions of Alternation partial are proved the same way with Questions in Alligation medial, which you may see in the 3 *d.* Rule of the 17th Chapter,

The Proof of Alternation partial.

Quest. 2. A Grocer hath 4 sorts of Sugar, *viz.* of 12 *d. per l.* of 10 *d. per l.* of 6 *per l.* and of 4 *d. per l.* the whole quantity whereof should contain 144 *l.* made of these 4 sorts, I demand how much of each he must take?

Questions of this Nature are resolved by that part of Alligation Alternate called by Arithmeticians Alternation Total, *viz.* where there is given the Sum, and Prices of several Simples, to find out how much of each Simple ought to be taken to make the said Sum or

Quantity

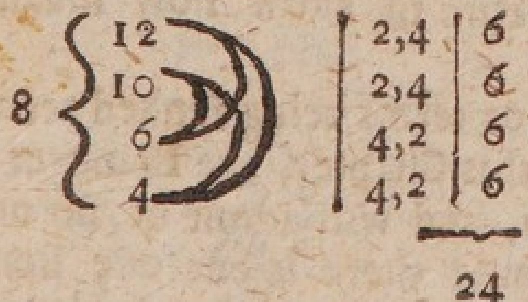
Quantity, ſo that it may bear a certain Rate propounded.

To reſolve this Queſtion I place the ſeveral Prices of the Simples and mean Rate propounded, and link them together, as is directed in the 2d and 3d Rules of this Chapter, and place the differences between the root and branches according to the 4*th* Rule of this Chapter, which then will ſtand one of theſe three ways, *viz.*

First.

Second.

Third



5. Then add the ſeveral differences together, which I have done, and the Sums of the firſt and ſecond order are 12 *l*, and of the third 24 *l.* as you may ſee above, but it is required that there ſhould be 144 *l.* of the compoſition, therefore to find the quantity of each ſimple, to make the whole compoſition 144 *l.* obſerve this general Rule, *viz.*

As the Sum of the differences is to the ſeveral differences, ſo is the total quantity of the compoſition to the quantity of each ſimple.

So to find how much of each ſort of Sugar I ought to take to make 144 *l.* at 8 *d. per l.* I ſay.

l.

As 12 is to 4, ſo is 144 to 48 *l.* at 12 *d. per l.*
As 12 is to 2, ſo is 144 to 24 *l.* at 10 *d. per l.*
As 12 is to 2, ſo is 144 to 24 *l.* at 6 *d. per l.*
As 12 is to 4, ſo is 144 to 48 *l.* at 4 *d. per l.*

whereby

Whereby I find that 48 *l.* at 12 *d. per l.* and 24 *l.* at 10 *d. per l.* and 24 *l.* at 6 *d. per l.* and 48. at 4 *d. per l.* will make a compofition of Sugar containing 144 *l.* worth 8 *d. per l.*

But as the Branches are linked in the fecond order, the anfwer will be 24 *l.* at 12 *d. per l.* and 48 *l.* at 10 *d. per l.* and 48 *l.* at 6 *d. per l.* and 24 *l.* at 4 *d. per l.* to make the faid quantity, and to bear the faid price.

And if you had worked as the Branches are linked after the third order, then you would have found the quantity of 36 *l.* of each.

Queft. 3. A Vintner hath 4 forts of Wine, *viz.* Canary at 10 *s. per* Gallon, Malaga at 8 *s. per* Gallon, Rhenifh-wine at 6 *s. per* Gallon, and White-wine at 4 *s. per* Gallon, and he is minded to make a Compofition of them all of 60 Gallons that may be worth 5 Shillings *per* Gallon. I defire to know how much of each he muft have?

The numbers or terms being ranked according to the fecond Rule of this Chapter, the Branches will be linked as followeth, and will admit of no other manner of coupling, becaufe there is but one Branch that is leffer than the Root, therefore all the reft muft be linked unto it; and the differences between the Root and the three firft branches, *viz.* 10, 8. and 6, which are 5, 3, and 1, muft be fet againft 4, becaufe they are coupled with it, and the difference between the Root (*viz.* 5.) and 4, which is 1. muft be fet againft the 3 other, becaufe it is linked to them all; fo I find 1 Gallon of Canary, 1 Gallon of Malaga, 1 Gallon of Rhenifh-wine, and 9 Gallons of White wine, Prized as above, being mingled together, will be worth 5 *s. per* Gallon, the Sum being 12 Gallons, but there muft be 60 Gallons; wherefore I fay,

5	10	1	1
	8	1	1
	6	1	1
	4.	5 3, 1,	9

As 12 is to 1, fo is 60 to 5 Gallons of Canary.
As 12 is to 1, fo is 60 to 5 Gallons of Malaga.
As 12 is to 1, fo is 60 to 5 Gallons of Rhenifh.
As 12 is to 9, fo is 60 to 45 Gallons of White-wine.

fo

ſo that 5 Gallons of Canary, 5 Gallons of Malaga, 5 Gallons of Rheniſh, and 45 Gallons of White-wine mingled together, will be in all 60 Gallons, worth 5 *s.* *per* Gallon, which was required.

Queſt. 4. A Goldſmith hath Gold of 4 ſeveral ſorts of fineneſs, *viz.* of 24 Carects fine, and of 22 Carects fine, of 20 Carects fine, and of 15 Carects fine. And he would mingle ſo much of each with alloy, that the whole maſs of 28 Ounces of Gold ſo mingled, may bear 17 Carects fine. I demand how much of each he muſt take, the ſecond and third Rules of this Chapter being obſerved, (for inſtead of the alloy I put 0, (becauſe it bears no fineneſs, but it makes a Branch in the Operation) the terms may be Alligated, and the differences added any of theſe 4 ways following, *viz.*

Read Chap. 2. *def.* 2. *of this Book.*

Firſt thus,

17	24	17	17
	22	2	2
	20	2, 17	19
	15	5, 3	8
	0	7, 3	10
		Sum	56

Secondly thus,

17	24	2	2
	22	17	17
	20	2, 17	19
	15	7,	10
	0	5, 3	8
		Sum	5

Thirdly thus,

17	24	2,	2
	22	2,	2
	20	2 17	19
	15	7, 5, 3,	15
	0	3,	3
		Sum	41

Fourthly

Fourthly thus,

17	24	2, 17	19
	22	2, 17	19
	20	2, 17	19
	15	7, 5, 3	15
	c	7, 5, 3	15
		Sum	87

More ways may be given for the Alligating, or linking of the Terms in this Queſtion, but theſe are ſufficient for the Induſtrious, and it ſhall alſo ſuffice to give an Anſwer to the Queſtion as the Terms are link'd the firſt way, not doubting but the ingenious Practitioner will be able at his leiſure to find Anſwers to the other 3 ways, *viz.*

	oz.	*p.w.*	*car.*
As 56 is to 17, ſo is 28 to	8	10	of 24
As 56 is to 2, ſo is 28 to	10	00	of 22
As 56 is to 19, ſo is 28 to	9	10	of 20
As 56 is to 18, ſo is 28 to	4	00	of 15
As 56 is to 10, ſo is 28 to	5	00	of alloy.

Thus much well practiſed and underſtood, is ſufficient for underſtanding of Alligation.

The proof of Alternation Total.

In Queſtions of Alternation Total, the Anſwer given is true, when the Sum of each of the quantity of Simples found, agrees with the Sum or Quantity propounded, as in the laſt Queſtion, the Anſwer was 8 *oz.* 10 *p.w.* of 24 Carects fine, 10 *oz.* of 22 Carects fine, 9 *oz.* 10 *p.w.* of 20 Carects fine, 4 *oz.* of 15 Carects fine, and 5. *oz.* of Alloy which added together make 28 *oz.* the quantity propounded.

CHAP. XIX.

Reduction of Vulgar Fractions.

1. WHat a Vulgar Fraction is, and its parts and ſeveral kinds, hath been already ſhewed in

the 19, 20, 21, 22, 23, 24, and 31 Definitions of the first Chapter of this Book, which the Learner is desired diligently to observe before he proceeds.

2. To reduce a Vulgar Fraction (which discovereth the principal knowledge of Fractions, and therefore ought greatly to be regarded) we shall discover plainly under these eight several Heads (or Rules) following, *viz.*

1. To reduce a mixt Number into an improper Fraction.

2. To reduce a whole Number into an improper Fraction.

3. To reduce an improper Fraction into its equivalent whole (or mixt Number.

4. To reduce a Fraction into its lowest Terms equivalent to Fractions given.

5. To find the value of a Fraction in the known parts of Coyn, Weight, Measure, *&c.*

6. To reduce a Compound Fraction to a Simple one of the same Value.

7. To reduce divers Fractions having unequal Denominators, to Fractions of the same Value, having an equal Denominator.

8. To reduce a Fraction of one Denomination to another of the same Value.

1. *To reduce a mixt Number to an improper Fraction.*

The Rule is, *Vide Chap.* 1. *defin.* 31.

Multiply the Integral part (or whole Number) by the Denominator of the Fraction, and to the Product add the Numerator, and that Sum place over the Denominator for a new Numerator; so this new Fraction shall be equal to the mixt Number given. As for Example.

1. Reduce $18\frac{3}{7}$ into an improper Fraction, multiply the whole Number 18 by 7 the Denominator, and to the Product add the Numerator 3, the Sum is 129, which put over the Denominator 7, and it makes $\frac{129}{7}$ for the Answer, as followeth.

$$\begin{array}{r} 18\frac{3}{7} \\ 7 \\ \hline 129 \end{array}$$

facit $\frac{129}{7}$

2. Reduce $183\frac{5}{21}$ to an improper Fraction, *facit* $\frac{3848}{21}$.
3. Reduce $56\frac{13}{22}$ to an improper Fraction, *facit* $\frac{1245}{22}$.

II. *To reduce a whole Number to an improper Fraction.*

The Rule is,

Multiply the given Number by the intended Denominator, and place the Product for a Numerator over it. As for *Example.* *Vide Chap.* 1. *Defin.* 23.

1. Let it be required to reduce 15 into a Fraction whose Denominator shall be 12. To Effect which I multiply 15 by the intended Denominator (12) the Product is 180, which I place over 12 as a Numerator, and it makes $\frac{180}{12}$ which is equal to 15, as was required; as *per* Margent.

facit $\frac{180}{12}$

15
12
30
15
180

2. Reduce 36 into an improper Fraction whose Denominator shall be 26, *facit* $\frac{936}{26}$.

3. Reduce 135 into an improper Fraction whose Denominator shall be 16, *facit* $\frac{2160}{16}$.

III. *To reduce an improper Fraction into its equivalent whole or mixt Number.*

The Rule is,

Divide the Numerator by the Denominator, and the Quotient is the whole Number equal to the Fraction, and if any thing remain, put it for a Numerator over the Divisor. *Example.*

1. Reduce

1. Reduce $\frac{436}{8}$ into its equivalent mixt Number. Divide the Numerator 436 by the Denominator 8, and the Quotient is 54, and 4 remain, which put for a Numerator over the Divisor 8, the Answer is $54\frac{4}{8}$, as followeth,

$$
\begin{array}{l}
8)\ 436\ (54\frac{4}{8} \\
\quad 40 \\
\hline
\quad 36 \qquad \textit{Facit}\ 54\frac{4}{8} \\
\quad 32 \\
\hline
\quad\ 4
\end{array}
$$

2. Reduce $\frac{3476}{15}$ to a mixt Number, *facit* $231\frac{11}{15}$.

3. Reduce $\frac{15576}{136}$ to a mixt Number, *facit* $114\frac{72}{136}$.

IV. *To reduce a Fraction into its lowest terms equivalent to the Fraction given.*

The Rule is,

1. If the *Numerator* and *Denominator* are even *Numbers*: take half the one, and half of the other as often as may be, and when either of them fal's out to be an odd Number, then divide them by any Number that you can discover will Divide both *Numerator* and *Denominator* without any Remainder; and when you have thus proceeded as low as you can reduce them, then this new *Fraction* so found out, shall be the *Fraction* you desire, and will be in value equal to the given *Fraction*.

Example.

1. Let it be required to reduce $\frac{192}{336}$ into its lowest Terms. First. I take the half of the *Numerator* 192 and it is 96; then half of the *Denominator*, and it is 168, so that now it is brought to $\frac{96}{168}$, and next to $\frac{48}{84}$, and by halfing still to to $\frac{24}{42}$, and their half is $\frac{12}{21}$, and now I can no longer half it, because 21 is an odd *Number*, wherefore I try to Divide them by 3, 4, 5, 6, *&c.* and I find 3 divides them both without any remainder, and brings them to $\frac{4}{7}$, as *per* Margent.

192	96	48	24	12	4
336	168	84	42	21	7

So

So I conclude $\frac{4}{7}$ thus found to be equal in value to the given *Fraction* $\frac{192}{336}$.

2. What is $\frac{10976}{12544}$ in its lowest terms? *Answer* $\frac{7}{8}$.

3. What is $\frac{13442}{15886}$ in its lowest terms? *Answer* $\frac{11}{13}$.

There is yet another way more excellent than the former to reduce a *Fraction* into its lowest terms, and that is by finding a common Measurer, *viz.* the greatest number that will divide the Numerator and Denominator without any remainder, and by that means reduce a *fraction* to its lowest terms at the first work; and to find out this common measurer divide the Denominator by the Numerator, and if any thing remains, divide your Divisor thereby; and if any thing yet remains, then divide your last Divisor by it; do so until you find nothing remains; then this last Divisor shall be the greatest common measurer, and reduce them into their lowest Terms at one Work.

Vide Ought. Cla. Math. Cap. 7.

Example.

4. Reduce $\frac{228}{304}$ into its lowest Terms by a common measurer; to effect which, I divide the Denominator 304 by the Numerator 228 and there remains 76, then I divide 228 (the first Divisor) by 76 (the remainder) and it quotes 3, and nothing remains; wherefore the last Divisor 76 is the common measurer; by which I divide the *Numerator* of the given *Fraction*, *viz.* 228, it quotes 3 for a new *Numerator*, then I divide the *Denominator* 304 by 76, and it quotes 4 for a new *Denominator*, that now I have found $\frac{3}{4}$ equal to $\frac{228}{304}$.

5. Reduce $\frac{6048}{7392}$ into its lowest Terms by a common measurer, *facit* $\frac{9}{11}$.

6. Reduce $\frac{30816}{23382}$ into its lowest Terms by a common measurer; *facit* $\frac{13}{86}$.

A Compendium.

Note that if the *Numerator* and *Denominator* of a *Fraction*, and each with a Cypher or Cyphers, then cut off as many Cyphers from the one as from the other, and the remaining Figures will be a Fraction of the same value, *viz.* $\frac{3400}{7100}$ will be found to be reduced to $\frac{34}{71}$,

by

y cutting off the 2 Cyphers from the Numerator and enominator, with a dash of the Pen thus, $\frac{34}{71}|\frac{00}{00}$, and $\frac{60}{00}$, will be $\frac{46}{70}$, thus $\frac{46}{70}|\frac{0}{0}$, *&c.*

V. *To find the Value of a Fraction in the known parts of Coyn, Weights, &c.*

The Rule is,

Multiply the Numerator by the parts of the next in- rior Denomination that are equal to an Unit of the me Denomination with the Fraction, then divide that roduct by the Denominator, and the Quote gives you Value in the same parts you multiplied by, and if any ing remain, multiply it by the parts of the next in- rior Denomination, and divide as before; do so till ou can bring it no lower, and the several Quotients ill give you the Value of the Fraction as was requir'd, nd if any thing at last remain place it for a Numera- or over the former Denominator; some few Exam- les will make the Rule plain.

1. What is the Value of $\frac{27}{29}$ *l. Sterling*? To answer is Question I multiply the Numerator 27 by 20 the Shillings in a Pound) the Product is 540, which I di- ide by 29 (the Denominator) and the Quotient is 18 *s.* d there remains 18, which I multiply by 12 Pence, d the Product (126) I divide by the Denominator 6, the Quotient is 7 *d.* and 13 remains, which I mul- ply by 4 Farthings, the Product is 52, which I still ivide by 29, the Quotient is 1 Farthing, and there re- aineth 23, which I put for a Numerator over the De- ominator 29, so I find the Value of $\frac{27}{29}$ *l.* to be 18 *s.* *d.* 1 *qr.* $\frac{23}{29}$, as by the following Operation: and after e same manner are the Values of the Fractions in the veral Examples following found out.

$\frac{27}{29}$ *l.*

$\frac{27}{29}$ *l.*

Multiply 27
20

29) 540 (18 *s.* 7 *d.* 1 $\frac{23}{29}$ *qr.*
29
250
232

Remains (18)
Multiply 12
36
18

29) 216 (7 *d.*
203

Remains (13)
Multiply 4

29) 52 (1 $\frac{23}{29}$ *qr.*
29

Remains (23)

Facit 18 *s.* — 7 *d.* — 1 $\frac{23}{29}$ *qr.*

2. What is the value of $\frac{11}{15}$ *l. Sterling? Facit*, 14 *s.* 8 *d.*

3. What is the value of $\frac{238}{257}$ *l. Sterling? Facit*, 4 *s.* 1 *d.* $\frac{27}{137}$.

4. What is $\frac{17}{21}$ *C.* weight? *Facit*, 3 *qrs.* 1*l.* 5 *oz.* $\frac{1}{2}$

5. What is $\frac{36}{151}$ *l. Troy* weight? *Facit*, 3 *oz.* 5 *p.w.* 22 $\frac{28}{151}$ *gr.*

6. What is $\frac{41}{66}$ of a Year? *Answer* 229 *days*, 7 *hours*, 12 *min.*

VI. *To reduce a Compound Fraction to a Simple one of the same Value.*

What a Compound Fraction is, hath been shewn in Chap. 1. Definition 24. and to reduce it to a Simple Fraction of the same Value.

The Rule is,

Multiply the Numerators continually, and place the last Product for a new Numerator, then multiply the Denominators continually, and place the last Product for a new Denominator. So this single Fraction shall be equal to the Compound Fraction given. *Example,*

1. Reduce $\frac{2}{3}$ of $\frac{3}{5}$ of $\frac{5}{8}$ to a Simple Fraction.

Multiply the Numerators 2, 3, and 5 together, they make 30 for a new Numerator; then I multiply the Denominators 3, 5, and 8 together, and their Product is 120 for a Denominator, so the Simple Fraction is $\frac{30}{120}$, and cutting off the Cyphers, it is $\frac{3}{12}$ equal to $\frac{1}{4}$ by the fourth Rule foregoing.

5	2
3	3
15	6
8	5
120	30

Facit, $\frac{30}{120}$ or $\frac{3}{12}$ or $\frac{1}{4}$.

2. What is $\frac{7}{10}$ of $\frac{5}{9}$ of $\frac{4}{7}$ of $\frac{11}{12}$? *Answer,* $\frac{1540}{7560}$ or $\frac{154}{756}$ or $3\frac{77}{378}$ in its least Terms.

3. What is $\frac{11}{12}$ of $\frac{13}{14}$ of $\frac{27}{28}$? *Answer,* $\frac{3203}{4872}$.

By this you may know how to find the Value of a Compound Fraction, *viz.* first reduce it to a Simple one, and then find out his Value by the 5th Rule foregoing.

What is the Value of $\frac{3}{4}$ of $\frac{5}{6}$ of $\frac{10}{1}$ of a Pound? *Answer*, 11 *s.* 3 *d.*

VII. *To reduce of Fractions of unequal Denominators, Fractions of the same Value having equal Denominators.*

The Rule is,

Multiply all the Denominators together, and the Product shall be the Common Denominator. Then multiply each Numerator into all the Denominators except its own, and the last Product put for a Numerator over the Denominator found out as before. So this new Fraction is equal to that Fraction, whose Numerator you multiplied into the said Denominators. Do so by all the Numerators given, and you have your desire.

Example.

1. Reduce $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{7}{8}$, to a Common Denominator, multiply the Denominators 4, 5, 6, and 8 together continually, and the Product is 960 for the Common Denominator, then multiply the Numerator 3 into the Denominators 5, 6, and 8, and the Product is 720 which is a Numerator to 960 (found as before) so $\frac{720}{960}$ is equal to the first Fraction $\frac{3}{4}$, then I proceed to find a new Numerator to the second Fraction, *viz.* $\frac{4}{5}$, and multiply 4 (into all the Denominators except its own, *viz*) into 4, 6, and, 8 which produceth $\frac{768}{960}$ equal to $\frac{4}{5}$, then multiply the Numerator 5 into the Denominators 4. 5, and 8, the Product is $\frac{800}{960}$ equal to $\frac{5}{6}$. Then multiply the Numerator 7 into the Denominators 4, 5 and 6, the Product is $\frac{840}{960}$ equal to $\frac{7}{8}$, and the Work is done; so that for $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{7}{8}$, I have $\frac{720}{960}$, $\frac{768}{960}$, $\frac{800}{960}$, $\frac{840}{960}$.

2. Reduce $\frac{11}{22}$, $\frac{14}{23}$, and $\frac{19}{21}$ into a Common Denominator, *faciunt*, $\frac{5313}{5796}$, $\frac{3528}{5796}$, and $\frac{5244}{5796}$.

VIII. *To reduce a Fraction of one Denomination to another.*

1. This is either Aſcending, or Deſcending. Aſcending when a Fraction of a ſmaller is brought to a greater Denomination, and Deſcending when a Fraction of a greater Denomination is brought lower.

2. When a Fraction is to be brought from a leſſer to a greater Denomination, then make of it a Compound Fraction by comparing it with the intermediate Denominations between it and that you would have it reduced to, then (by the *6 th* Rule foregoing) reduce your Compound to a ſimple Fraction, and the Work is done. Example,

Queſt. 1. It is required to know what part of a pound *ſterling* $\frac{5}{7}$ of a penny is?

To reſolve this, I conſider that 1 *d* is $\frac{1}{12}$ of a ſhilling, and a ſhilling is $\frac{1}{20}$ of a pound; wherefore $\frac{5}{7}$ *d.* is $\frac{5}{7}$ of $\frac{1}{20}$ of a pound, which by the ſaid *6th* Rule I find to be $\frac{5}{1680}$ of a pound *ſterling* of *Engliſh* Money.

Queſt. 2. What part of a pound *Troy* weight is $\frac{4}{5}$ of a penny weight? *Anſwer,* $\frac{4}{5}$ of $\frac{1}{20}$ of $\frac{2}{12}$ *l.* equal to $\frac{4}{1200}$ *l. Troy.*

3. When a Fraction is brought from a greater to a leſſer Denomination than multiply the Numerator by the parts contained in the ſeveral Denominations betwixt it and that you would reduce it to; then place the laſt Product over the Denominator of the given Fraction. Example,

Queſt. 3. I would reduce $\frac{3}{5}$ *l.* to the Fraction of a penny, to do which, I multiply the Numerator 3 by 20 and 12, the Product is 720, which I put over the Denominator 5, it makes $\frac{720}{5}$ of a penny; equal to $\frac{3}{5}$ *l.*

Queſt. 4. What parts of an Ounce *Troy* is $\frac{5}{16}$ *l?* *Anſwer,* $\frac{60}{16}$ *oz.*

CHAP. XX.

Addition of Vulgar Fractions.

1. IF your Fractions to be added have a common Denominator, then add all the Numerators together, and place their Sum for a Numerator to the common Denominator, which new Fraction is the Sum of the given Fractions; and if it be improper, reduce it to a whole or mixt Number, by the 3*d*. Rule of the 19*th* Chapter.

Quest. 1. What is the Sum of $\frac{7}{24}$, $\frac{9}{24}$, $\frac{16}{24}$, and $\frac{14}{24}$?

The Denominators are equal, *viz.* every one is 24, wherefore add the Numerators together, *viz.* 7, 9, 16 and 14, their Sum is 46, which put over the Denominator 24, it makes $\frac{46}{24}$ the Sum of the given Fractions, which will be reduced to the mixt Number $1\frac{22}{24}$, or $1\frac{11}{22}$.

2. But if the Fractions to be added have unequal Denominators, then reduce them to a common Denominator by the 7*th* Rule of the 19*th* Chapter, and then add the Numerators together, and put the Sum over the common Denominator, *&c.* as before in the last Example.

Quest. 2. What is the Sum of $\frac{3}{5}$, $\frac{7}{8}$, $\frac{9}{10}$, and $\frac{11}{12}$?

The Fractions reduced to a common Denominator are, $\frac{2880}{4800}$ $\frac{4400}{4800}$ and $\frac{4320}{4805}$ the Sum of their Numerators is 15800, which put over the common Denominator, makes $\frac{15800}{4800}$ or $\frac{157}{48}$, equal to the mixt number $3\frac{14}{48}$ or $3\frac{7}{24}$ for the Sum required.

Quest. 5. What is the Sum of $\frac{11}{17}$ $\frac{21}{49}$, and $\frac{36}{47}$? *Answer*, $1\frac{37555}{39216}$.

If you are to add mixt Numbers together, then add the Fractional parts as before, and if their Sum be an improper Fraction, reduce it to a mixt Number, and add its Integral part to the Integral parts of the given mixt Numbers, and the Work is done.

Quest. 4. What is the Sum of $13\frac{3}{4}$ and $24\frac{5}{8}$?

First

First add the *Fractions* $\frac{3}{4}$ and $\frac{5}{8}$ the Sum is $1\frac{12}{32}$, then add this Integer 1, to 13 and 24, their Sum is 38, and put after it the *Fraction* $\frac{12}{32}$ it is $38\frac{12}{32}$ for the *Answer*, or it is $38\frac{3}{8}$.

Quest. 5. What is the Sum of $48\frac{1}{7}$, $64\frac{5}{8}$ and $130\frac{3}{4}$: *Facit*, $243\frac{180}{224}$, or $243\frac{45}{56}$.

4. If any of the *Fractions* to be added is a Compound *Fraction*, it must first be reduced to a simple *Fraction* by the *6th* Rule of Chapter 19, and then add it to the rest, according to the 2 *d.* Rule of this Chapter. Example.

Quest. 6. What is the Sum of $\frac{3}{4}$, $\frac{5}{6}$ and $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$?

Reduce $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$ into a simple *Fraction*, and it is $\frac{105}{192}$, which reduced with the other two, and added are $2\frac{600}{4608}$.

Quest. 7. What is the Sum of $\frac{11}{12}$ and $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$? *Answer*, $1\frac{5}{12}$.

5. If the *Fractions* to be added are not of one denomination, they must be so reduced, and then proceed as before.

Quest. 8. What is the Sum of $\frac{3}{4}$ *l.* and $\frac{5}{6}$ *s.*?

Of the given Fractions here, one is of a pound, and the other Fraction of a shilling; and before you can add them together, you must reduce $\frac{5}{6}$ *s.* to the Fraction of a pound as the other is (by the *8th* Rule of Chapter *19.*) and it makes $\frac{5}{120}$ *l.* then $\frac{3}{4}$ *l.* and $\frac{5}{120}$ *l.* will be found to be $\frac{380}{480}$ *l.* or $\frac{38}{48}$ *l.* by the 7th Rule of Chapter 19, and in its lowest terms $\frac{19}{24}$ *l.* by the 4th. Rule of Chapter 19.

It would have been the same, if (by the latter part of the 8th Rule of Chapter 19.) you had reduced $\frac{3}{4}$ *l.* to the Fraction of a Shilling, which yon would have found to have been $\frac{60}{4}$ *s.* which added to $\frac{5}{6}$ *s.* by the said 17th Rule of the last Chapter, the sum is 15 *s.* $\frac{20}{24}$ which is equal to the Sum found as before, *viz.* $\frac{19}{24}$ *l.* for (by the 5th Rule of Chapter 19.) the value of $\frac{19}{24}$ *l.* will be found to be 15 *s.* 10 *d.* and so will 15 *s.* $\frac{20}{24}$ be found to be just as much.

Quest. 9. What is the Sum of $\frac{2}{5}$ *l.* $\frac{3}{5}$ *s.* and $\frac{3}{5}$ *d.* *Answer,* $\frac{259500}{600000}$, or $\frac{2595}{6000}$ *l.* or in the lowest terms $\frac{519}{1200}$.

CHAP. XXI.

Subtraction of Vulgar Fractions.

1. THE Rules in Addition for reducing the given Fractions to one Denomination, are here to be observed; for before *Subtraction* can be made, the *Fractions* must be reduced to a *Common Denominator*, then subtract one *Numerator* from the other, and place the *Remainder* over the *Common Denominator*, which *Fraction* shall be the excess or difference between the given *Fractions*. *Example,*

Quest. 1. What is the difference between $\frac{3}{4}$ and $\frac{5}{7}$? The given *Fractions* are reduced to $\frac{21}{28}$ and $\frac{20}{28}$, then subtract the *Numerator* 20 from the *Numerator* 21, and there remains 1, which being put over the *Denominator* 28 makes $\frac{1}{28}$ for the answer or difference between $\frac{3}{4}$ and $\frac{5}{7}$.

Quest. 2. What is the difference between $\frac{5}{6}$ and $\frac{3}{6}$ of $\frac{5}{8}$?

Reduce the *Compound Fraction* $\frac{3}{6}$ of $\frac{5}{8}$ to a *Simple Fraction*, then proceed as before, and the Answer is $\frac{110}{240}$ equal to $\frac{11}{24}$.

2. When a *Fraction* is given to be subtracted from a whole *Number*, subtract the *Numerator* from the *Denominator*, and put the Remainder for a *Numerator* to the given *Denominator*, and subtract an Unit (for that you borrow'd) from the whole Number, and the remainder place before the *Fraction* found as before, which mixt Number is the Remainder or difference sought. *Example,*

Quest. 3. Subtract $\frac{7}{10}$ from 48.

Answer, 57$\frac{3}{10}$; for if you subtract 7 (the *Numerator*) from 10 (the *Denominator*) there remains 3, which put over 10 is $\frac{3}{10}$ and 1 (I borrowed) from 48 rests 47, to which joyn $\frac{3}{10}$, and it makes 47$\frac{3}{10}$ for the excess.

Quest. 4. Subtract $\frac{13}{20}$ from 57, remains 56$\frac{8}{21}$.

3. If

3. If it is required to ſubtract a *Fraction* from a mixt number, or one mixt number from another, reduce the Fractions to a common Denominator, and if the Fraction to be ſubtracted be leſſer than the other, then ſubtract the leſſer Numerator from the greater, and that is a Numerator for the common Denominator; then ſubtract the leſſer Integral part from the greater, and the remainder with the remaining *Fraction* thereto annexed is the difference required between the two given mixt Numbers. Example,

Queſt. 5. Subtract $26\frac{3}{7}$ from $54\frac{5}{8}$.

Firſt, Subtract $\frac{3}{7}$, *viz.* $\frac{18}{42}$ from $\frac{5}{6}$, *viz.* $\frac{26}{42}$, the remainder is $\frac{17}{42}$, then 26 from 54 remaineth 28, to which annex $\frac{17}{42}$, it makes $28\frac{17}{42}$ for the Anſwer.

4. But if the *Fraction* to be ſubtracted is greater than the *Fraction* from whence you ſubtract, then having firſt reduced the *Fraction* to a common Denominator, take the Numerator of the greater *Fraction* out of the Denominator, and add the remainder to the Numerator of the leſſer *Fraction*, and their Sum is a new Numerator to the common Denominator, which *Fraction* note, then (for the 1 you borrowed) add 1 to the Integral part to be ſubtracted, and ſubtract it from the greater Number, and to the remainder annex the *Fraction* you noted before, ſo this new mixt number ſhall be the difference ſought. Example,

Queſt. 6. Subtract $14\frac{3}{4}$ from $29\frac{4}{7}$.

The *Fractions* reduced are, *viz.* $\frac{3}{4}$ equal to $\frac{21}{28}$ and $\frac{4}{7}$ equal to $\frac{16}{28}$, now I ſhould ſubtract $\frac{21}{28}$ from $\frac{16}{28}$, but I cannot, therefore I ſubtract 21 from 28 reſts 7, which added to 16 (the leſſer Numerator) makes 23 for a Numerator to 28; *viz.* $\frac{23}{28}$, then I come to the Integral parts 14 and 29, and ſay, 1 that I borrowed and 14 is 15, which taken from 29 there reſts 14, to which annexing $\frac{23}{28}$ it is $14\frac{23}{28}$ for the remainder or difference between $14\frac{3}{4}$ and $29\frac{4}{7}$.

Queſt. 7. I Subtract $96\frac{9}{16}$ from $74\frac{4}{5}$, *facit* $37\frac{40}{90}$.

CHAP. XXII.

Multiplication of Vulgar Fractions.

1. IF the Multiplicand and Multiplier are simple (or single) Fraction, then multiply the Numerators together for a new Numerator, and the Denominators for a new Denominator, which new Fraction is the Product required.

Quest. 1. What is the Product of $\frac{5}{7}$ by $\frac{9}{11}$? *facit* $\frac{45}{77}$.

For the Numerators 5 and 9 being multiplied make 45, and the Denominators 7 and 11 being multiplied make 77.

Quest. 2. What is the Product of $\frac{18}{23}$ by $\frac{21}{37}$? *fac.* $\frac{378}{851}$

2. If the Fractions to be multiplied are mixt Numbers, reduce them to improper Fractions by the 1st Rule of the ninth Chapter, then proceed as before.

Quest. 3. What is the Product of $48\frac{3}{5}$ by $13\frac{5}{6}$?

The given mixt Numbers being reduced to improper Fractions are $48\frac{3}{5}$ equal to $\frac{243}{5}$, and $13\frac{5}{6}$ equal to $\frac{83}{6}$, now $\frac{243}{5}$ multiplied by $\frac{83}{6}$ according to the first Rule of this Chapter, produceth $\frac{20169}{30}$ or $672\frac{9}{30}$.

Quest. 4. What is the Product of $430\frac{6}{20}$ by $18\frac{3}{7}$? *Facit,* $\frac{555474}{70}$ or $7935\frac{24}{70}$.

3. If a Compound Fraction is to be multiplied by a Simple Fraction, first reduce the Compound Fraction into a Simple Fraction, then multiply the one by the other, as is taught above.

Quest. 5. What is the Product of $\frac{16}{21}$ by $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$? The Compound Fraction $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$ reduced is $\frac{60}{140}$ or $\frac{6}{14}$, which multiplied by $\frac{16}{21}$ produceth $\frac{96}{294}$, which in its lowest Terms is $\frac{16}{49}$ for the Answer.

And if the Multiplicand and Multiplier are both Compound Fractions, reduce them both to Simple ones, then multiply these new Fractions as before, so have you the Product.

Quest. 6. What is the Product of $\frac{3}{4}$ of $\frac{2}{3}$ by $\frac{3}{5}$ of $\frac{1}{2}$? *Answer,* $\frac{18}{120}$ in its lowest Terms $\frac{3}{20}$.

Quest. 7. What is the Product of $\frac{1}{2}$ of $\frac{3}{8}$ by $\frac{3}{5}$ of $\frac{5}{8}$?

Answer,

Answer, $\frac{60}{360}$ or $\frac{6}{36}$ in its least terms $\frac{1}{6}$.

4. If a Fraction be to be multiplied by a whole number, put under the given whole number an Unit for a denominator, whereby it will be an improper Fraction, then multiply these Fractions as before. Example.

Quest. 8. What is the product of 24 by $\frac{2}{3}$?

Answer, $\frac{48}{3}$, for 24 by putting an Unit under it will be $\frac{24}{1}$ and $\frac{24}{1}$ by $\frac{2}{3}$ produceth $\frac{48}{3}$ or 16.

Quest. 9. What is the product of 36 by $\frac{9}{11}$? *Answer*, $\frac{324}{11}$ or 29 $\frac{5}{11}$.

CHAP. XXIII.

Division of Vulgar Fractions.

1. IF the Dividend and the Divisor are both simple Fractions, then multiply the numerator of the dividend into the denominator of the Divisor, and the product is a new numerator, and multiply the denominator of the Dividend into the Numerator of the Divisor, and the product is a new denominator, which new Fraction thus found, is the Quotient you desire. Example.

Quest. 1. What is the quotient of $\frac{5}{8}$ divided by $\frac{3}{5}$?

$$\frac{3}{5} \quad \frac{5}{8} \quad \frac{25}{24}$$

Answer, $\frac{25}{24}$ or 1 $\frac{1}{24}$ for first I multiply (5) the numerator of the dividend into (5) the denominator of the divisor, and the product (25) is a numerator for the Quotient, then I multiply (8) the denominator of the dividend into (3) the numerator of the divisor, and the product (24) I put in the quotient for a denominator, so I find $\frac{25}{24}$ is the quotient sought.

Quest. 2. What is the quotient of $\frac{10}{21}$ divided by $\frac{2}{3}$?

Answer, $\frac{30}{42}$ equal $\frac{5}{7}$ in its lowest terms.

2. But if you would divide a simple Fraction by a compound, or a compound by a simple, first reduce

such compound to a simple *Fraction*, then go on as before.

Quest. 3. What is the Quotient of $\frac{3}{10}$ divided by $\frac{3}{4}$ of $\frac{2}{3}$? *Answer*, $\frac{36}{60}$ or $\frac{3}{5}$, first reduce $\frac{3}{4}$ of $\frac{2}{3}$ into a *Simple Fraction*, and it is $\frac{6}{12}$ by which $\frac{3}{10}$ being divided, the Quotient is $\frac{36}{60}$, in its equal least terms to $\frac{3}{5}$. And if the Dividend and Divisor be both compound *Fractions*, reduce them both to simple *Fractions*, then divide the one by the other, as in Rule 1 before-going.

Quest. 4. What is the Quote of $\frac{2}{3}$ of $\frac{3}{4}$ divided by $\frac{2}{3}$ of $\frac{5}{6}$?

Answer, $\frac{180}{120}$ or $\frac{18}{12}$ or $1\frac{6}{12}$ or $1\frac{1}{2}$ in its lowest terms.

3. If the Dividend, or Divisor, or both are mixt Numbers, reduce them to improper *Fractions*, and perform *Division* as you were taught before. Example.

Quest. 4. What is the Quote of $12\frac{3}{4}$ divided by $21\frac{4}{5}$?

Answer, $\frac{255}{436}$, for $12\frac{3}{4}$ is equal to $\frac{51}{4}$, and $21\frac{4}{5}$ is equal to $\frac{109}{5}$, and the Quote of $\frac{51}{4}$ divided by $\frac{109}{5}$ is as before $\frac{255}{436}$.

4. If you divide a Fraction by a whole Number, or a whole Number by a Fraction, make the whole Number an improper Fraction, by putting an Unit for a Denominator to it, as was taught in Rule 4. of Chap 22. and then perform *Division* as before was taught. Example.

Quest. 6. What is the Quote of 8 divided by $\frac{3}{5}$

Answ. $\frac{40}{3}$ which is equal to $13\frac{1}{3}$, being reduced as is is before directed. See the Work in the Margent.

$$\frac{2}{5}\Big)\,\frac{8}{1}\,\Big(\frac{40}{3} \text{ or } 13\tfrac{1}{3}$$

Quest. 7. What is the quotient of $\frac{3}{5}$ divided by 8? *Answer*, $\frac{3}{40}$ as *per* Margent.

$$\frac{8}{1}\Big)\,\frac{3}{5}\,\Big(\frac{3}{40}$$

CHAP.

The Rule of Three Direct in Vulgar Fractions.

CHAP. XXIV.

1. AS in the *Rule of Three* in whole *Numbers*, so likewise in *Fractions*, you must see that the *Fractions* of the first and third places be of the same Denomination.

2. See that if any of the given *Fractions* be Compound, they be reduced to Single ones of the same Value.

3. If there are given mixt Numbers, reduce them to improper Fractions by the first of *Chap.* 19.

4. If any of the three Terms is a whole Number, make it an improper *Fraction* by constituting an Unit for its Denominator.

Having reduced your Fraction as is directed in the four last Rules, then proceed to a Resolution which is performed the same way as in whole Numbers, respect being had to the Rules delivered for the working of *Fractions*, *viz.* multiply the 2d and 3d *Fraction* together, according to the first Rule of *Chap.* 22. and divide the Product by the first *Fraction*, according to the 1st Rule of *Chap.* 23. and the Quotient is the Answer.

Or (which is better)

5. Multiply the Numerator of the first *Fraction* into the Denominators of the second and third, and the Product is a new Denominator, then multiply the Denominator of the first *Fraction* into the Numerators of the second and third, and the Product is a new Numerator; which new *Fraction* is the 4th Proportional or Answer, which (if it be an improper *Fraction*) must be reduced to a whole or mixt Number by the third Rule of Chap. 19. *Examples*,

Quest. 1. If $\frac{3}{4}$ Yards of Cloth cost $\frac{5}{8}$ *l.* what will $\frac{1}{10}$ Yards cost?

Having placed the given *Fractions* according to the 6th Rule of Chap. 10. I proceed to the Resolution, and first I multiply the Numerator of the first *Fraction* (3) into 8 and 10, the denominators of the second and third fractions and the product is 246 for a denominator, then I multiply 4 the denominator of the first fraction into 5 and 9 the Numerators of the second and third fractions,

yrds.	l.	yds.	l.
$\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{10}$	$\frac{180}{240}$

Facit $\frac{180}{240}$ l. equal to $\frac{3}{4}$ l.

the product is 180 for a Numerator, which Numerator 180 and denominator 240 make $\frac{180}{240}$ *l.* for the Answer, equal to $\frac{3}{4}$ or 15 *s.*

Quest. 2. If $\frac{2}{3}$ *l.* buy $\frac{5}{6}$ *yds* of Cloth, what will $\frac{11}{12}$ *yds* cost at that rate?

Answer; $\frac{132}{180}$ *l.* equal to $\frac{11}{15}$ *l.* or 14 *s.* 8 *d.*

Quest. 3. If $\frac{7}{8}$ *l.* cost $\frac{3}{4}$ *s.* what will $\frac{8}{9}$ *s.* buy?

Answer, $\frac{224}{216}$ equal to $1\frac{1}{7}$ *l.*

Quest. 4. If $\frac{3}{5}$ of an Ell of Holland cost $\frac{1}{3}$ of 1 Pound, how much will $12\frac{2}{3}$ Ells cost at that rate?

Answer, $\frac{190}{27}$ equal to $7\frac{1}{27}$ *l.*

In resolving the last Question and the two next, observe the third Rule of this Chapter foregoing.

Quest. 5. If $\frac{9}{10}$ of a C. cost 284 *s.* what will $7\frac{5}{6}$ *C.* cost at that rate?

Answer, $2366\frac{2}{3}$ *s.* or 118 *l.* 6 *s.* 8 *d.*

Quest. 6. If $3\frac{1}{4}$ *yds.* of Velvet cost $3\frac{5}{8}$ *l.* how much will $10\frac{1}{2}$ *yds* cost at that rate?

Answer, $11\frac{37}{52}$ *l.*

Quest. 7. If 3 *yds.* of Broad-cloth cost $2\frac{4}{5}$ *l.* what will $10\frac{1}{7}$ *yrds* cost at that rate?

Answer, 13 *l.* 9 *s.* 4 *d.*

In working the last Question and the 4 next, observe the *4th* Rule of this Chapter foregoing.

Quest. 8. If 14 *l.* of Pepper cost 14 *s.* $6\frac{3}{4}$ *d.* I demand the price of $73\frac{3}{4}$ *l.*

Answer, 3 *l.* 16 *s.* $7\frac{2}{56}$ *d.*

Quest. 9. If 1 *l.* of Cochenele cost 1 *l.* 5 *s.* what will $36\frac{7}{10}$ *l.* cost?

Answer, 45 *l.* 17 *s.* 6 *d.*

Quest.

Quest. 10. If one Yard of Broad-cloth 15 $\frac{5}{8}$ *s.* what will 4 Pieces, each containing 27 $\frac{3}{7}$ Yards, cost at that rate?

Answer 85 *l.* 14 *s.* 3 $\frac{3}{7}$ *d.*

Quest. 11. A Mercer bought 3 $\frac{1}{2}$ Pieces of Silk, each piece qt. 24 $\frac{3}{8}$ Ells at 6 *s.* 0 $\frac{3}{4}$ *d per* Ell, I demand the value of 3 $\frac{1}{2}$ Pieces at that rate?

Answer, 26 *l.* 3 *s.* 4 $\frac{3}{4}$ *d.*

In resolving the 4 next Questions observe the 8th Rule of Chapter 19.

Quest. 12. If $\frac{2}{5}$ of an Ounce of Silver cost 2 *s.* I demand the price of 11 $\frac{2}{3}$ *l.* at that rate?

Answer, 35 *l.*

Quest. 13. If 5 $\frac{5}{7}$ *l.* of Gold is worth 205 *l.* 14 *s.* 3 $\frac{3}{7}$ *d.* what is a Grain worth at that rate?

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

Quest. 14. If $\frac{3}{4}$ yds of Silk is worth $\frac{3}{4}$ of $\frac{5}{6}$ *l. l.* what is the price 15 $\frac{5}{6}$ Ells *Flemish*?

Answer, 9 *l.* 6 *s.* 8 *d.*

Quest. 15. If $\frac{2}{3}$ of $\frac{3}{4}$ of a Pound of Cloves cost 6 *s.* 2 $\frac{2}{7}$ *d.* what cost the *C.* weight at that rate?

Answer, 69 *l.* 12 *s.* 6 *d.*

Note, That when the Answers to the Questions in this and the next Chapter are given in Fractions, they are given in their lowest Terms.

CHAP. XXV.

The Rule of Three Inverse in Fractions.

1. IT hath been already taught (in the third Rule of the 11th Chapter) how to discover when the 4th Proportional Number (to the three given Numbers) is to be found out by a Rule of 3 Direct, and when by a Rule of 3 Inverse, to which Rule the Learner is now referred.

2. When (in Fractions) you find a Question to be resolved by a Rule of 3 Inverse, *viz.* when the third Term is the Divisor, (then having reduced the Terms

exactly according to the Rules in Chap. 24.) multiply the Numerators of the 3 Fractions into the Denominators of the second and first Fractions, and the product is a new Denominator, then multiply the Denominator of the third Fraction into the Numerators of the second and first Fractions, and the Product is a new Numerator, which w Fraction thus found is the Answer to the Question.

Quest. 1. If $\frac{3}{4}$ of a yard of Cloth that is 2 *yds.* wide will make a Garment, how much of any other Drapery that is $\frac{3}{5}$ of a yard wide will make the same Garment?

Answer, $2\frac{1}{2}$ yards.

Quest. 2. I lent my Friend 46 *l.* for $\frac{4}{5}$ of a Year, how much ought he to lend me for $\frac{7}{18}$ of a Year?

Answer, $63\frac{3}{5}$ *l.*

Quest. 3. If $\frac{2}{3}$ of a yard of Cloth that is $2\frac{1}{3}$. yards wide will make any Garment, what breadth is that Cloth, when $1\frac{3}{4}$ yards will the same Garment?

Answer, $\frac{39}{63}$ of a yard wide.

Quest. 4. How many Inches in length of a Board that is 9 Inches broad will make a Foot square?

Answer, 16 Inches in length.

Quest. 5. If when the Bushel of Wheat cost $4\frac{1}{4}$ *s.* the penny Loaf weigheth $10\frac{1}{3}$ Ounces, what will it weigh when the Bushel cost $8\frac{9}{10}$ *s.*?

Answer, $\frac{184}{264}$ Ounces.

Quest. 6. If 12 Men can Mow $24\frac{1}{2}$ Acres in $10\frac{2}{4}$ Days, in how many Day will 6 Men do the same?

Answer, In $21\frac{1}{4}$ Days.

CHAP. XXVI.

Rules of Practice.

IN the Single Rule of Three, when the first of the 3 Numbers in the Question (after they are disposed according to the 6th Rule of Chap. 10.) hapneth

to

to be an Unit (or 1) the Question many times may be resolved far more speedily than by the Rule of 3, which kind of Operation is commonly called Practice, and indeed it is of excellent use amongst Merchants, Tradesmen and others, by reason of its speedinefs in finding a Resolution to such kind of Questions.

2. The chiefest Question resolveable by these brief Rules may be comprehended under the several general Heads or Cases following, *viz.*

When the given price of the Integer consists.
1. *Of farthings under 4*
2. *Of pence under 12.*
3. *Of pence and farthings.*
4. *Of shillings under 20.*
5. *Of shillings pence and farthings.*
6. *Of pounds.*
7. *Of pounds, shillings, pence and farthings.*

It would be very convenient for the Practical Arithmetician to have by heart the several Products of the Nine Digits multiplied by 12, for his speedy reducing Pence into Shillings, or Shillings into Pence, which he may gain by the following Table.

12 Times	1	is	12
	2		24
	3		36
	4		48
	5		60
	6		72
	7		84
	8		96
	9		108

3. Shillings are practically reduced into Pounds thus, *viz.* cut off the Figure standing in the place of Units with a dash of the Pen, and note it for Shillings, then draw a Line under the given Number, and take half

half of the remaining Figures (after the first is cut off) and set them under the Line, and they are so many Pounds, but if the last Figure is odd, then take the lesser half, and add 10 to the Figure so cut off (as before) for Shillings, as if I were to reduce 43658 Shillings into Pounds, first I cut off the last Figure (8) for Shillings, then I take half of the remaining Figures (4365) thus, half of 4 is 2, which I put under the Line, then ½ of 3 is 1, and because 3 is an odd Number, I make the next Figure 6 to be 16, and I go on, saying, ½ of 16 is 8, and then ½ of 5 is 2, which is the last Figure; wherefore because 5 is an odd Number, I add 10 to the 8 I cut off, and it makes 18 *s.* so that I find it to be 2182 *l.* 18 *s.* as *per* Margent.

4365|8	
l.	s.
2182—	18

4. It is likewise convenient that the Learner be acquainted with the Practical Tables following, the first containing the Aliquot (or even) parts of a Shillling, the second containing the Aliquot parts of a Pound.

	d.		*s.*
The even parts of a Shilling	6	is	$\frac{1}{2}$
	4		$\frac{1}{3}$
	3		$\frac{1}{4}$
	2		$\frac{1}{6}$
	$1\frac{1}{2}$		$\frac{1}{8}$
	1		$\frac{1}{12}$

	s. — *d.*		*l.*
The even parts of a Pound.	10—00	is	$\frac{1}{2}$
	6—08		$\frac{1}{3}$
	5—00		$\frac{1}{4}$
	4—00		$\frac{1}{5}$
	3—04		$\frac{1}{6}$
	2—06		$\frac{1}{8}$
	2—00		$\frac{1}{10}$
	1—08		$\frac{1}{12}$
	1—00		$\frac{1}{20}$

Case

Case 1.

5. When the price of the Integer is a Farthing, then take the 6th part of the given Number, which will be so many Three-half-pences, and if any thing remains it is Farthings by the 7th Rule of Chapter 9, then consider that Thre-half-pence is $\frac{1}{8}$ of a Shilling, wherefore take the eighth part of them for Shillings, and if any thing remain they are so many 3 half-pence, which reduce into Pounds by the third Rule foregoing. *Example.* What comes 67486 *l.* to, at a Farthing *per l.* First, I tak $\frac{1}{6}$ of 67486 and it is 11247 Three-half-pence and 4 Farthings, or one Penny; then $\frac{1}{8}$ of 11247 is 1405*s.* and 7 remains, which is 7 Three half-pence, or $10\frac{1}{2}$ *d.* which with the 4 Farthings before make $11\frac{1}{2}$ *d.* and 1405 Shillings, which by the 3d Rule is 70 *l.* 5 *s.* In all 70 *l.* 5 *s.* 11 *d.* $\frac{1}{2}$ for the *Answer*. See the Work following

	l. *d.*
$\frac{1}{6}$	67486 *at* $\frac{1}{4}$ *per l.*
	d.
$\frac{1}{8}$	11247—1
$\frac{1}{20}$	140|5—10
	l. *s.* *d.*
	70—5—$11\frac{1}{2}$ *facit.*

Other Examples follow.

$\frac{1}{6}$	8576 *l. at* 1 *qr.*	$\frac{1}{6}$	6386 *l. at* 1 *qr.*
$\frac{1}{8}$	1429——2 *qrs.*	$\frac{1}{8}$	06 3——2 *qrs.*
$\frac{1}{20}$	17|8——8 *d.*	$\frac{1}{20}$	13|2——11 *d.*
	l. s. d.		l. s. d.
	8—18—8 *facit.*		6—12—11 *facit.*

6. When

6. When the price of the Integer is 2 Farthings, then take the third part of the given Number for so many Three-half-pences, and the remainder (if any) is Half-pence, then take the eighth part of that for Shillings, as before, *&c.*

Examples.

$\frac{1}{3}$	7368 *l.* at 2 *qrs*
$\frac{1}{8}$	2456
$\frac{1}{20}$	30|7
	l. s. 15—7 *facit*

$\frac{1}{3}$	8347 *l.* *at* 2 *qrs.*
$\frac{1}{8}$	2782—— 2 *qrs.*
$\frac{1}{20}$	34|7——9 *d.* $\frac{1}{2}$
	l. s. d. 17—7—9$\frac{1}{2}$ *facit*

7. When the price of the Integer is 3 Farthings, then take half the given Number for Three-half-pence, (and if any thing remain it is 3 Farthings) then take the eighth of that for Shillings, as before, *&c.*

$\frac{1}{2}$	4736 *l.* *at* 3 *qrs.*
$\frac{1}{8}$	2368
$\frac{1}{20}$	22,6
	l. s. 14—16 *facit*

$\frac{1}{2}$	5425 *l.* *at* 3 *qrs.*
$\frac{1}{8}$	2712——.8 *qrs.*
$\frac{1}{20}$	33|9
	l. s. d. qrs. 16—7—0··3 *fa.*

Case 2.

8. When the given price of the Integer, is a part, or parts of a Shilling, (*viz.* Pence) divide the given Number of Integers (whose Value is sought) by the Denominator of the Fraction representing the even part, and the Quote is Shillings (always minding the 7th Rule of the 9th Chap.) and those Shillings may be reduced into Pounds by the 3d Rule of this Chapter. Example, Let it be required to find the Value of 438 *l.*

at

at 3*d.* *per l.* I consider 3 *d.* is $\frac{1}{4}$ of a Shilling, and 438 *l.* will cost so many 3 Pences, wherefore I divide 438 by 4 the Denominator of $\frac{1}{4}$, and the Quote is 109 Shillin s, and 2 remains, which is 2 three-Pences or 6 *d.* the whole value is 5 *l.* 9 *s.* 6 *d.* as by the following Work appeareth.

$\frac{1}{2}$	438 *l.* at 3 *d.*
$\frac{1}{20}$	10|9 — 6
	l. s. d.

facit 5—9—6

More Examples follow.

	l. d.
$\frac{1}{2}$	3574 *at* 6 *per l.*
$\frac{6}{12}$	178|7

facit 89 *l.* 7 *s.*

	l. d.
$\frac{1}{6}$	5316 *at* 2 *per l.*
$\frac{1}{20}$	88.6

facit 44 *l.* 6 *s.*

	l. d.
$\frac{1}{3}$	438 *at* 4 *per l.*
$\frac{1}{20}$	14.6

facit 7 *l.* 6 *s.*

	l. d.
$\frac{1}{8}$	6389 *at* 1$\frac{1}{2}$ *per l.*
$\frac{1}{20}$	79|8 — 7*d.* $\frac{1}{2}$

facit 39 *l.* 14 *s.* 7 *d.* $\frac{1}{2}$

	l. d.
$\frac{1}{4}$	879 *at* 3 *per l.*
$\frac{1}{10}$	21|9—9 *d.*

facit 10 *l.* 19 *s.* 9 *d.*

	l. d.
$\frac{1}{12}$	818 *at* 1 *per l.*
$\frac{1}{20}$	6.8 — 2 *d.*

facit 3 *l.* 8 *s.* 2 *d.*

9. If the price of the Integer be Pence under 12, and yet not an even part, then it may be divided into even parts, and so the parts of the given Number ta-

ken,

ken accordingly, and added together, as if it were 5 *d.* which is 3 *d.* and 2 *d.* *viz.* $\frac{1}{4}$ and $\frac{1}{6}$ of a shilling, first take $\frac{1}{4}$ of the given number, and then $\frac{1}{6}$ thereof, and add them together, and their Sum is the Answer in shillings, still observing Rule 7 of Chap. 9. for the remainders (if any be) then bring the shillings into pounds by the 3d Rule foregoing. Likewise 7 *d.* is $\frac{1}{3}$ and $\frac{1}{4}$, so 9 *d.* is $\frac{1}{2}$ and $\frac{3}{4}$, and 10 *d.* is $\frac{1}{2}$ and $\frac{1}{3}$, and 11 *d.* is $\frac{1}{3}$ and $\frac{1}{3}$ and $\frac{1}{4}$ of a shilling, or else many times your work may be shortned thus, *viz.* when the said given price is to be divided into even parts of a shilling or of a pound, after you have taken the first even part, the other may be an even part of that part, as in the next Example, where is given 439 *l.* at 5 *d. per l.* now I may divide it thus, *viz.* into 4 *d.* and 1 *d.* and 4 *d.* being $\frac{1}{3}$ of a shilling, and 1 *d.* being $\frac{1}{4}$ of 4 *d.* I first take $\frac{1}{3}$ of 499 *l.* and it gives 146 *s.* 4 *d.* and for the 1 *d.* I take $\frac{1}{4}$ of 146 *s.* 4 *l.* which is 36 *s.* 7 *d.* which in all comes to 9 *l.* 2 *s.* 11 *d.* Examples follow.

	l. d.		yds. d.
	439 *at* 5 *per l.*		417 *at* 9 *per yd.*
$\frac{1}{3}$	146——4	$\frac{1}{2}$	208 —— 6
$\frac{1}{4}$	36——7	$\frac{1}{2}$	104——3
	18|2——11		31|2——9
	9 *l.* 2 *s.* 11 *d. facit*		15 *l.* 12 *s.* 9 *d. facit*

	ells. d.		ells d.
	587 *at* 7 *per ell.*		286 *at* 10
$\frac{1}{3}$	195——8	$\frac{1}{2}$	143
$\frac{1}{4}$	146——9	$\frac{1}{3}$	95——4
	34|2——5		23|8——4
	17 *l.* 2 *s.* 5 *d. facit*		11 *l.* 18 *s.* 4 *d. facit*

836

	yds. d.		l. d.
	836 *at* 8 *per yd.*		534 *at* 11
$\frac{1}{3}$	278—8	$\frac{1}{3}$	178
$\frac{1}{3}$	278—8	$\frac{1}{3}$	178
	55|7—4	$\frac{1}{4}$	133—6
	27 *l.* 17 *s.* 4 *d. facit*		48|0—6
			24 *l.* 9 *s.* 6 *d. facit*

Case 3.

10. When the price of the Integer is Pence and Farthings, if it make an even part of a Shilling, work as before, but if they are uneven, as Penny Farthing, Penny three Farthings, 2 *d.* 1 *qr.* or 2 *d.* 3 *qrs.* or 3 *d.* *qrs.* or the like, then first work for some even part, and then consider what part the rest is of that even part, and divide that Quotient thereby, then add them together, and reduce them to Pounds as before. *Example*, 3470 *l.* at 1 *d.* 1 *qr.* *per l.* first I work for the Penny by dividing 3470*l.* by 12 for 1*d.* is $\frac{1}{12}$ of a Shilling, and the Quote is 289 *s.* 2 *d.* then I conceive that one Farthing is the $\frac{1}{4}$ of a Penny, and the value of 1 Farthing, will be $\frac{1}{4}$ of the Value at one Penny, and therefore I take $\frac{1}{4}$ of 289 *s.* 2 *d.* which is 72 *s.* 3 *d.* 2 *qrs.* and add them together, and they are 18 *l.* 1 *s.* 5 *d.* 2 *qrs.* as by the Margent. Other Examples of the same nature follow.

	l. *qrs.*
$\frac{1}{12}$	3470 *at* 5
$\frac{1}{4}$	289—2
	72—3—2
$\frac{1}{20}$	36|1—5
	l. *s.* *d.*
	18—1—5$\frac{1}{2}$

	l. d.		yds d.
$\frac{1}{12}$	4360 at $1\frac{1}{4}$	$\frac{1}{2}$	673 at $1\frac{3}{4}$
$\frac{1}{4}$	363 — 4	$\frac{1}{6}$	71 — $1\frac{1}{2}$ d.
	90 — 10		11 — $11\frac{3}{4}$
	454 — 2		813 — $6\frac{3}{4}$
	l. s. d.		l. s. d.
	22 — 14 — 2 facit		facit 4 — 3 — $6\frac{3}{4}$

$\frac{1}{6}$	485 l. at 2 $\frac{1}{4}$ d.	$\frac{1}{2}$	420 yds at $7\frac{1}{2}$
$\frac{1}{8}$	80 — 10 d.	$\frac{1}{4}$	263
	10 — $1\frac{1}{4}$		5
	9|0 — $11\frac{1}{4}$	$\frac{1}{20}$	32|5
	4 l. 10 s. $11\frac{1}{4}$ d.		16 l. 5 s. facit

$\frac{1}{6}$	654 l. at $2\frac{1}{2}$ d.	$\frac{1}{2}$	137 yds at $10\frac{1}{2}$ d.
$\frac{1}{4}$	109	$\frac{1}{2}$	68 — 6 d.
	27 — 3 d.	$\frac{1}{2}$	34 — 3
			17 — $1\frac{1}{2}$
	13|6 — 3	$\frac{1}{20}$	11|19 — $10\frac{1}{2}$ d.
	6 l. 16 s. 3 d.		5 l. 19 s. $10\frac{1}{2}$ facit

Case. 4.

11. When the price of the Integer is 2 *s.* then cut off the Figure in the place of Units of the given Numbers, and double it for Shillings, and the Figures on the other hand are Pounds. *Example,* 437 *yds* at 2 *s. per yd,* cut off the last Figure 6 and double it, it makes 12 Shillings, and the other two Figures, *viz.* 43 are so many pounds, so that their Value is 43 l. 12*s.* as *per* Margent.

43	6
43 *l.*	12 *s.*

12. Hence

12. Hence it is evident that when the given price of an Integer is an even number of ſhillings, then if you take half of that even number of ſhillings, and multiply the given number of Integers thereby, doubling the firſt figure of the product, and ſetting it apart for ſhillings, the reſt of the product will be pounds, which pounds and ſhillings is the value ſought. Example, What coſt 536 *yds.* at 8 *s. per yd?* To reſolve which I take ½ of 8 *s.* (the price of a *yd.*) which is 4, and multiply 536 thereby, ſaying, 4 times 6 is 24, then I double the firſt figure 4, makes 8 for ſhillings, and carry 2 to the next product, *&c.* I find the reſt of the product to be 214, which I note for pounds, ſo the value of 536 *yds*, at 8 *s. per yd.* is 214 *l.* 8 *s.* as *per* Margent. More Examples follow.

536 *yds.* at 8 *s.*
4
———
214 *l.* 8 *s.*

56 *yd.* at 6 s. *per yd.*	420 *yds*, at 12 s. *per yd.*
16 l. 16 s. *facit.*	252 l. *facit.*
123 *yds.* at 4 s. *per yd.*	326 *yds.* at 14 *s. per yd.*
24 *l.* 12 s. *facit.*	228 l. 4 s. *facit.*
48 *ells* at 8 s. *per ell.*	48 *yds.* at 16 s. *per yd.*
19 l. 4 s. *facit.*	98 l. 8. *facit.*
84 *yds.* at 10 s. *per yd.*	52 *yds.* at 18 s. *per yd.*
42 l. *facit*	46 l. 16 s. *facit.*

13. If the given price of the Integer is an odd number of ſhillings, then work firſt for the even number of ſhillings by the laſt Rule, and for the odd ſhilling take $\frac{1}{20}$ of the given Number of Integers according to the 3d Rule of this Chapter, and add them together, and you have your deſire. Examples follow.

yds. *s.*	*ells.* *s.*
422 *at* 3 *per yard.*	431 *at* 13
l. *s.*	*l.* *s.*
42——4	58——12
21——2	221——11
63——6 *facit.*	280——03 *facit.*

ells. *s.*	*ells.* *s.*
516 *at* 7 *per ell.*	324 *at* 17 *per ell.*
l. *s.*	*l.* *s.*
154——16	259——04
25——16	16——04
180——12 *facit.*	275——08 *facit.*

14. Except when the given price of the Integer is 5 *s.* for then it is sooner anſwered by taking $\frac{1}{4}$ of the given number whoſe value is ſought, as in the following Examples.

$\frac{1}{4}$	*yds.* *s.* 436 *at* 5 109 *l. facit.*	$\frac{1}{4}$	*ells* *s.* 206 *at* 5 *per ell* 51 *l.* 10 *s. facit.*

Caſe 5.

15. When the given price of an Integer is ſhillings and pence, or ſhillings pence, and farthings; then if the ſhillings and pence be an even part of a pound, divide the given number of Integers, whoſe value you ſeek by the denominator of that Fraction repreſenting that even part. As for Example, What is the price of 384 *yards* at 6 *s.* 8 *d.* per *yard?* Here I conſider that 6 *s.* 8 *d.* is $\frac{1}{3}$ of a pound, where-

wherefore I divide 384 by 3, and the Quote is the *Answer*, *viz.* 128 *l.* so that 384 *yds.* at 6 *s.* 8 *d.* per *yd.* amounts to 128 *l.* as *per* Margent, still observing the 7th Rule of the 9th Chapter.

$\frac{1}{3}$	384
	128 *l. facit*

More Examples follow,

$\frac{1}{3}$	438 *ells at* 6 *s.* 8 *d.*	$\frac{1}{8}$	443 *yd. at* 2 *s.* 6 *d.*
	146 *l. facit.*		55 *l.* 7 *s.* 6 *d. facit*
$\frac{1}{6}$	525 *at* 3 *s.* 4 *d.*	$\frac{1}{12}$	729 *yds. at* 1 *s.* 8 *d.*
	87 *l.* 10 *s. facit*		60 *l.* 10 *s. facit.*

16. When the given Value of the Integer is Shillings and Pence, and not an even part of a Pound, yet many-times it may be divided into parts (*viz.* 6 *s.* 6 *d.* is 4 *s.* and 2 *s.* 6 *d.* for the 4 *s.* work according to the 12th Rule foregoing, and for the 2 *s.* 6 *d.* take the eighth part of the given Number, and add them together, then their Sum is the Value required.)

So 8 *s.* 6 *d.* will be divided into 6 *s.* and 2 *s.* 6 *d.* and the price of the given Number may be found out as before, *&c.* Examples follow.

	yds. *s.* *d.*		*ells* *s,* *d.*
	386 at 8—8		540 at 5—4
$\frac{1}{3}$	128 *l.*—13—4	$\frac{1}{10}$	54 *l.*——0
$\frac{1}{10}$	38——12—0	$\frac{1}{6}$	90——0
	167 *l.* 5 *s.* 4 *d. facit*		144 *l. facit.*
	ells *s.* *d.*		*yds.* *s.* *d.*
s.	427 at 8—6	$\frac{1}{3}$	386 at 14—8
			4
6	128 *l.*——2—0		154 *l.*—-8—0
$\frac{1}{8}$	53——7—6		128—-13—4
	181 *l.* 9 *s.* 6 *d. fac.*		283 *l.* 1 *s.* 4 *d. fac.*

17. When

17. When the given price of the Integer is Shillings and Pence, and you cannot readily divide them according to the last Rule, then multiply the given Number whose value you seek by the number of Shillings in the price of the Integer, and then for the Pence work by the 8*th* Rule foregoing, then add the Numbers together, and their Sum is the value sought in Shillings; as for Example, What is the value of 392 *yds.* at 6 *s.* 9 *d. per yd.* Here 6 *s.* 9 *d.* cannot be made any even part, nor indeed can it be divided into even parts of a pound, wherefore I multiply the given number of *yards* 392 by 6, for the 6 *s.* the Product is 2352 Shillings, then for the 9 *d.* I divide it into 6 *d.* and 3 *d.* and work for them by the 8*th* Rule foregoing, and at last add the Shillings together, they make 2646 *s.* and by the 3*d.* Rule they are reduced to 132 *l.* 6 *s.* the value of 392 *yds.* at 6 *s.* 9 *d. per yard.* See the Work following.

	yds.	*s.*	*d.*
	392 *at*	6 —	
	6		
	2352		
1/2	196		
1/2	98		
1/20	264|6		
	132 *l.* 6 *s. facit*		

Other Examples follow.

s.	*l.*	*s.*	*d.*
	480 *at*	4 —	10
	4		
	1920		
1/2	240		
1/3	160		
	232|0		
	116 *l. facit.*		

s.	*Ells*	*s.*	*d.*
	732 *at*	12 —	7
	12		
	8784		
1/3	244		
1/4	183		
	921|1		
	460 *l.* 11 *s. facit.*		

18 When

18. When the given price of the Integer is Shillings, Pence and Farthings, then multiply the given Number of Integers by the number of Shillings contained in the value of the Integer, and for the Pence and Farthings follow the 10th Rule of this Chapter.

Examples.

	yds.	*s.*	*d.*
	438 at	18 —	$6\frac{3}{4}$
	8		
	3504		
1	219		
$\frac{1}{8}$	27 —	$4\frac{1}{2}$ *d.*	
	375|0 —	$4\frac{1}{2}$	
	fac. 187 *l.* 10*s.* $4\frac{1}{2}$ *l.*		

	ells	*s.*	*d.*
	370 at	14 —	$2\frac{3}{4}$
	14		
	1480		
	370		
	5180		*d.*
$\frac{1}{6}$	61 —		8
$\frac{1}{4}$	15 —		5
$\frac{1}{2}$	7 —		$8\frac{1}{4}$
	526|4 —		$9\frac{1}{2}$
	fac. 263*l.* 4*s.* 9*d.* $\frac{1}{2}$		

	ells	*s.*	*d.*
	136 at	9 —	$2\frac{1}{2}$
	9		
	1224 —		0
$\frac{1}{6}$	22 —		8
$\frac{1}{4}$	5 —		8
	125|2 —		4
	fac. 62*l.* 12*s.* 4*d.*		

	ells	*s.*	*d.*
	431 at	2 —	$4\frac{1}{2}$
	2		
	862		
$\frac{1}{4}$	107 —		9 *d.*
$\frac{1}{8}$	53 —		$10\frac{1}{2}$
	102|3 —		$7\frac{1}{2}$
	facit 51*l.* 3*s.* $7\frac{1}{2}$ *d.*		

Case 6.

19. When the given Value of the Integer is Pounds, then multiply the number of Integers whole Value is sought by the price of the Integer, and the Product is the Answer in Pounds.

Examples.

C. *l.*	C. *l.*
42 *at* 2 *per* C.	13 *at* 8 *per* C.
84 *l. facit*	104 *l. facit*
C. *l.*	C. *l.*
30 *at* 3 *per* C.	48 *at* 12 *per* C.
90 *l. facit.*	576 *l. facit.*

Case 7.

20. If the price of the Integer is Pounds and Shillings, then for the Pounds work as in the last Rule, and for the Shillings as in the 12 and 13 Rules before-going; then add the Numbers produced from them both, and the Sum is the Value sought.

Examples.

	C. *l.* *s.*		*grofs.* *l.* *s.*
	46 *at* 2——4		82 *at* 4—10
2*l.*	92 *s.*	4 *l.*	328
4*s.*	9——4	10*s.*	41
	101 *l.* 4 *s. facit*		369 *l. facit*

	grofs. *l.* *s.*		*grofs.* *l.* *s.*
	58 *at* 3—7		26 *at* 3—15
3*l.*	174 *s.*	3 *l.*	78
6*s.*	78——8	14*s.*	18——4
1*s.*	2——18	1*s.*	1——6
	174 *l.* 6 *s. facit*		97 *l.* 10 *s. facit*

21. When

21. When the given Price of an Integer consists of Pounds, Shillings, and Pence, with Farthings, then work for the Shillings, Pence, and Farthings, first according to the 18 Rule of this Chapter, and find the total value of the given Number, as if there were no Pounds, then work with the Pounds according to the 19 Rule of this Chapter, and add the Numbers thus found, and their Sum is the Total Value required,

Examples of this Rule follow.

C. *l.* *s.* *d.*
113 *at* 1—13—4 $\frac{1}{2}$

639
213

13 *s.* | 2760 *d.*
3 *d.* | 53——3
1$\frac{1}{2}$ *d.* | 26——7$\frac{1}{2}$

284|8——10$\frac{1}{2}$

1 *l.* | 142 *l.* 08 *s.* 10$\frac{1}{2}$ *d.*
213

355 *l.* 8 *s.* 10$\frac{1}{2}$ *d.* *facit*,

C. *l.* *s.* *d.*
37 *at* 3—8—10 $\frac{1}{2}$

296 *d.* | 8 *s.*
18—6 | 6 *d.*
9—3— | 3 *d.*
4—7$\frac{1}{2}$ | 1$\frac{1}{2}$ *d.*

32|8 --4$\frac{1}{2}$ *d.*

16 *l.* 8 *s.* 4$\frac{1}{2}$ *d.*
111 | 3 *l.*

127 *l.* 8 *s.* 4$\frac{1}{2}$ *d.* *fac.*

gross *l.* *s.* *d.*
415 *at* 2—9—3$\frac{3}{4}$

9 *s.* | 3744
2 *d.* | 104
$\frac{3}{4}$ *d.* | 26

387|4

193 *l.* 14 *s.*
2 *l.* | 832

1025 *l.* 14 *s.* *facit.*

gross *l.* *s.* *d.*
48 *at* 3—15—11$\frac{1}{2}$

240
48

720 | 15 *s.*
24 | 6 *d.*
16 | 4
6 | 1$\frac{1}{2}$ *d.*

76|8
38—6 [illegible]
14[illegible]

18[illegible] *l.* 6 [illegible] *facit*

22. When there is given the Value of an Integer, and it is required to know the Value of many such Integers together, with $\frac{1}{4}$ or $\frac{1}{2}$ or $\frac{3}{4}$ of an Integer, then first (by the former Rules) find out the Value of the given number of Integers, and then for $\frac{1}{4}$ of an Integer take $\frac{1}{4}$ of the given Value of an Integer, or for $\frac{1}{2}$ take $\frac{1}{2}$ of the given Value of the Integer, and for $\frac{3}{4}$ first take the $\frac{1}{2}$ of the given Value, and then $\frac{1}{2}$ of that $\frac{1}{2}$, setting each part under the precedent, then adding them together, their Sum will be the required Value of the Integers and their parts. Example, What is the Value of 116$\frac{1}{2}$ *yds.* at 4 *s.* 6 *d. per yard?* To give an Answer, first I Work for the Value of 116 *yds.* by the 15th Rule foregoing, and then for the $\frac{1}{2}$ *yd.* I take $\frac{1}{2}$ of 4 *s.* 6 *d.* which is 2 *s.* 3 *d.* and add to the rest found as before, then is that Sum the total Value of 116$\frac{1}{2}$ *yds.* at 4 *s.* 6 *d. per yd.* which I find to amount to 26 *l.* 4 *s.* 3 *d.* as by the Work in the Margent.

yds.	s. d.	
116$\frac{1}{2}$ *at*	4—6	
11 *l.*	12 *s.*	2 *s.*
	14—10 *d.*	2 *s.* 6 *d.*
	2—3	$\frac{1}{2}$ *yd.*
26—4—3 *Facit.*		

Other Examples follow.

224$\frac{1}{4}$ *yds. at* 4 *s.* 10 *d.*

1290 ——	4 *s.*
162 ——	6 *d.*
108 ——	4 *d.*
1—2$\frac{1}{2}$ *d.*	$\frac{1}{4}$ *yd.*
156|7 *s.* 2$\frac{1}{2}$ *d.*	
78 *l.* 7 *s.* 2$\frac{1}{2}$ *d. facit.*	

720$\frac{1}{2}$ *yds. at* 6 *s.* 8 *d.*

240 *l.* 3 *s.* 4 *d. Facit.*

228 *ells at* 12 *s.* 11 *d.*

2736 ——	12 *s.*
76 ——	4 *d.*
76 ——	4 *d.*
57 ——	3 *d.*
6——5$\frac{1}{2}$ *d.*	$\frac{1}{2}$ *ell.*
3——2$\frac{3}{4}$ *d.*	$\frac{1}{4}$ *ell.*
2954—8$\frac{1}{4}$ *d.*	
147 *l.* 14 *s.* 8$\frac{1}{4}$ *d. facit.*	

C. qrs. l.	l. s. C.
28—3—14 *at*	1——10
28 *l.* ——	1 *l.*
14 *l.* ——	10 *s.*
00—15 *s.*	$\frac{1}{2}$ *C.*
7 *s.* 6 *d.*	$\frac{1}{4}$ *C.*
3 *s.* 9	14 *l.*
43 *l.* 6 *s.* 3 *d. facit.*	

Many more Queſtions may be ſtated, and ſeveral other Rules of Practice may be ſhewn according to the Method of divers Authors; but what have been delivered here are ſufficient for the Practical Arithmetician in all Caſes whatſoever.

CHAP. XXVII.

The Rule of Barter.

1. BArter is a Rule amongſt Merchants, which (in the Exchanging of one Commodity for another) informs them ſo to proportion their Rates, as that neither may ſuſtain Loſs.

2. To reſolve Queſtions in Barter, it will not be difficult to him that is acquainted with the Golden Rule, or Rule of 3, it being altogether uſed in reſolving ſuch Queſtions.

Queſt. 1. Two Merchants, (*viz.* A and B) *Barter*, A hath 13 *C.* 3 *qrs.* 14 *l.* of Pepper at 2 *l.* 16 *s. per C.* and B hath Cotton at 9 *d. per l.* I demand how much Cotton B muſt give A for his Pepper?

Anſwer, 9 *C.* 1 *qr.*

Firſt, find by the Rule of 3. or the Rules of Practce foregoing, how much the Pepper is worth, ſaying,

If 1 *C.* coſt 2 *l.* 16 *s.* what will 13 *C.* 3 *qrs.* 14 *l.* coſt?

Anſwer, 38 *l.* 17 *s.*

Secondly, By the Rule of 3 ſay, if 9 *d.* buy 1 *l.* of Cotton, how much will 38 *l.* 17 *s.* Buy?

Anſwer, $9\frac{1}{4}$ *C.* and ſo much Cotton muſt B give to A for 13 *C.* 3 *qrs.* 14 *l.* of Pepper at 2 *l.* 16 *s. per Cent.* when the Cotton is worth 9 *d. per l.*

Quest. 2. Two Merchants (A and B) *Barter*, A hath Ginger worth 1 *l.* 17 *s.* 4 *d. per C.* but in *Barter* he will have 2 *l.* 16 *s. per C.* B hath Nutmegs worth 5 *l.* 12 *s. per C.* now I demand how B must rate his Nutmegs *per C.* to mak his gain in *Barter* equal to that of A?

Answer, 8 *l.* 8 *s.*

Say, By the Rule of 3, If 1 *l.* 17 *s.* 4 *d.* require 2 *l.* 16 *s.* in *Barter*, what will 5 *l.* 12 *s.* require in *Barter*?

Facit 8 *l.* 8 *s.*

Quest. 3. A and B *Barter*, A hath 120 Yards of Broad-cloth worth 6 *s. per yd.* but in *Barter* he will have 8 *s. per yd.* B hath Shalloon worth 4 *s. per yd.* Now I demand how many Yards of Shalloon B must give A for his Broad-cloth, making his Gain in *Barter* equal to that of A?

Answer, 180 Yards of Shalloon.

First (as in the last Question) find out how B ought to Sell his Shalloon in *Barter*, *viz.* say if 6 *s.* require 8 *s.* what will 4 *s.* require?

Answer, 5 *s.* 4 *d.*

Thus you see that B must Sell his Shalloon in *Barter* at 5 *s.* 4 *d.* if A Sell his Broad Cloth at 8 *s. per yd.*

It remaineth now to find out how much Shalloon B must give for 120 Yards of Broad-cloth, which after the same method used to resolve the first Question of this Chapter is found to be 180, and so many Yards of Shalloon must B give A for the 120 Yards of Broad-cloth.

Quest. 4. A and B *Bartered*, A had 14 *C.* of Sugar worth 6 *d. per l.* for which B gave him 1 *C.* 3 *qrs.* of Cinnamon, I demand how B rated his Cinnamon *per l.*

Answer, 4 *s. per l.*

Quest. 5. A and B *Barter*, A hath 4 Tun of Brandy worth 37 *l.* 16 *s.* ready Money, but in *Barter* he hath 30 *l.* 8 *s. per* Tun, and A giveth B 21 *C.* 2 *qrs.* 11 ½ *l.* or Ginger for his 4 Tun of Brandy, I desire to know how B Sold his Ginger in *Barter per C.* and how much was worth in ready Money.

Answer,

Answer, For 9 *l.* 6 *s.* and 8 *d.* in *Barter*, and it was worth 7 *l.* *per Cent* in ready Money.

Quest. 6. A and B *Barter*, a hath 320 dozen of Candles at 4 *s.* 6 *d.* *per* Dozen, for which B giveth him 30 *l.* in Money, and the rest in Cotton at 8 *d.* *per l.* I demand how much Cotton he must give him more than the 30 *l.*

Answer, 11 *C.* 1 *qr.*

Quest. 7. A and B *Barter.* A hath 608 yards of Broad Cloth worth 14 *s.* *per yd.* for which B giveth him 125 *l.* 12 *s.* ready money, and 85 *C.* 2 *qrs.* 24 *l.* of Bees Wax, now I desire to know how he reckoned his Wax *per C.*

Answer, 3 *l.* 10 *s.* *per C.*

CHAP. XXVIII.

Questions in Loss and Gain.

Quest. 1. A Merchant bought 436 yards of Broad-Cloth for 8 *s.* 6 *d.* *per* yard, and Selleth it again at 10 *s.* 4 *d.* *per* yard, now I desire to know how much he gained in the Sale of the 436 yards?

Answer, 39 *l.* 19 *s.* 4 *d.*

First find out by the Rule of Three, or by practice how much the Cloth cost him at 8 *s.* 6 *d.* *per* yard, which I find to be 185 *l.* 6 *s.* then by the same Rule find out how much he sold it for, *viz.* 225 *l.* 5 *s.* 4 *d.* then Subtract 185 *l.* 6 *s.* which it cost him, from 225 *l.* 5 *s.* 4 *d.* which he Sold it for, and there remaineth 39 *l.* 19 *s.* 4 *d.* for his Gain in the Sale thereof.

Otherwise it may sooner be resolved thus, first find out how much he gained *per yd.* *viz.* Subtract 8 *s.* 6 *d.* which he gave *per yd* from 10 *s.* 4 *d.* which he Sold it for *per yd.* the remainder is 1 *s.* 10 *d.* for his gains *per yd.* Then say, If 1 *yd.* gain 1 *s.* 10 *d.* what will 436 *yds.* gain? the *Answer*, by Practice, or the Rule of Three is 39 *l.* 19 *s.* 4 *d.* as was found before.

Quest. 2. A Draper bought 124 *yds.* of Holland Cloth, for which he gave 31 *l.* I desire to know how he must Sell it *per yd.* to gain 10 *l.* 6 *s.* 8 *d.* in the whole Sale of the 124 *yards*? *Answer*, at 6 *s.* 8 *d. per yard.*

Add the Price which it cost him; (*viz.* 31 *l.*) to his intended Gain, (*viz.* 10 *l.* 6 *s.* 8 *d.*) the Sum is 41 *l.* 6 *s.* 8 *d.* then say,

If 124 *yds.* require 41 *l.* 6 *s.* 8 *d.* what will 1 *yd.* require? by the Rule of Three I find the Answer 6 *s.* 8 *d.*

Quest. 3. A Grocer bought 3 *C.* 1 *qr.* 14 *l.* of Cloves, which cost him 2 *s.* 5 *d. per l.* and sold them for 52 *l.* 14 *s.* I desire to know how much he gained in the whole? *Answer*, 8 *l.* 12 *s.*

Quest. 4. A Draper bought 86 Kerseys for 129 *l.* I demand how he must Sell them *per* piece to gain 15 *l.* in laying out 100 *l.* at the rate? *Answer*, 1 *l.* 14 *s.* 6 *d. per* piece; for,

As 100 *l.* is to 115 *l.* so is 129 *l.* to 148 *l.* 7 *s.*

So that by the proportion above, I have found how much he must receive for the 86 Kerseys to gain after the rate of 15 *l. per C.* then to find how he must Sell them *per* piece, I say,

As 86 pieces are to 148 *l.* 7 *s.* so is 1 piece to 1 *l.* 14 *s.* 6 *d*, which is the number sought.

Quest. 5. A Grocer bought $4\frac{1}{4}$ *C.* of Pepper for 15 *l.* 17 *s.* 4 *d.* and (it proving to be Damnified) is willing to lose 12 *l.* 10 *s. per Cent.* I demand how he must Sell it *per l.*? *Answer*, 7 *d. per l.*

Subtract 12 *l.* 10 *s.* the loss of 100 *l.* from 100 *l.* and there remains 87 *l.* 10 *s.* then say,

As 100 *l.* is to 87 *l.* 10 *s.* so is 15 *l.* 17 *s.* 4 *l.* to 13 *l.* 17 *s.* 8 *d.* so much as he must Sell it all for to lose after the rate propounded: Then to know how he must Sell it *per l.* I say,

As 13 *l.* 17 *s.* 6 *d.* is to $4\frac{1}{4}$ *C.* so is 1 *l.* to 7 *d.*

Quest.

Quest. 6. A Plummer sold 10 Fodder of Lead (the Fodder containing $19\frac{1}{2}$ *C.*) for 204 *l.* 15 *s.* and gained after the Rate of 12 *l.* 10 *s. per* 100 *l.* I demand how much it cost him *per C?* *Answer*, 18 *s.* 8 *d.*

To resolve this Question, add 12 *l.* 10 *s.* (the Gain *per Cent.*) to 100 *l.* and it makes 112 *l.* 10 *s.* then say,

As 112 *l.* 10 *s.* is to 100 *l.* so is 204 *l.* 15 *s.* to 182 *l.*

Which 182 *l.* is the Sum it cost him in all; then reduce your 10 Fodders to half hundreds and it makes 390, then say,

As 390 half hundreds is to 182 *l.* so is 2 half hundreds to 18 *s.* 8 *d.* the price of 2 half hundreds, or one *C.* weight, and so much it stood him in *per C.* weight.

Quest. 7. A Merchant bought 8 Tuns of Wine, which being Sophisticated, he Selleth for 400 *l.* and loseth after the rate of 12 *l.* in receiving a 100 *l.* now I demand how much it cost him *per* Tun? and how he selleth it *per* Gallon to lose after the said rate? *Answer*, It cost 56 *l. per* Tun, and he must sell it at 3 *s.* 11 *d.* $2\frac{10}{21}$ *qrs. per* Gallon to lose 12 *l.* in receiving 100 *l.*

To resolve this Question, I consider in the first place, that in receiving 100 *l.* he loseth 12 *l.* therefore 100 *l.* comes in for 112 *l.* laid out, wherefore to find out how much he laid out for the whole, I say,

As 100 *l.* is to 112 *l.* so is 400 *l.* to 448 *l.* and so much the 8 Tun cost him: then to find how much it cost *per* Tun, I say,

As 8 is to 448 *l.* so is 1 to 56 *l.* the price it cost *per* Tun.

Now to find how he must Sell it *per* Gallon, reduce the 8 Tuns into Gallons, they make 2016, then say,

As 2016 Gallons is to 420 *l.* so is 1 Gallon to 3 *s.* 11 *d.* $2\frac{10}{21}$ *qrs.* the price he must Sell it at *per* Gallon to lose as aforesaid.

Quest. 8. A Merchant bought 8 Tuns of Wine, which being Sophisticated, he is willing to Sell for 400 *l.* and loseth at that rate 12 *l.* in laying out 100 *l.* upon the same, now I demand how much it cost him *per* Tun?

Here I consider that for 100 *l.* laid out, he receiveth but 88 *l.* therefore to find what the 8 Tuns cost him, I say,

As 88 *l.* is to 100 *l.* so is 400 *l.* to $454\frac{6}{11}$ the price it all cost him, then to find how much *per* Tun, I say,

As 88 is to $454\frac{6}{11}$ *l.* so is 1 to $56\frac{9}{11}$ or 56 *l.* 16 *s.* 4 *d.* 1 $\frac{5}{11}$ *qr. per* Tun.

CHAP. XXIX.

Equation of Payments.

1. EQuation of Payments, is that Rule amongst Merchants whereby we reduce the times for Payments of several Sums of Money, to an Equated time for Payment of the whole Debt, without Damage to Debter or Creditor, and,

The Rule is,

2. Multiply the Sums of each particular Payment by its respective Time, then add the several Products together, and their Sum divide by the Total Debt, and the Quotient thence arising is the Equated Time for the Payment of the whole Debt. Example,

Quest. 1. A is indebted to B in the Sum of 130 *l.* whereof 50 *l.* is to be paid at 2 Months, and 50 *l.* at 4 Months, and the rest at 6 Months, now they agree to make one Payment of the Total Sum, the Question is, what is the Equated Time for Payment without Damage to Debtor or Creditor?

To

To resolve this Question I multiply each Payment by its time, *viz.*

50 l. multiplied by 2 mon. produceth——100
50 l. multiplied by 4 mon. produceth——200
30 l. multiplied by 6 mon. produceth——180

The Sum of the Product is——480

Then I divide 480 (the Sum of the Products by 130 (the total Debt) and the Quotient is $3\frac{9}{13}$ Months for the time of paying that whole Debt.

Quest. 2. A Merchant hath owing him 1000 *l.* to be paid as followeth, *viz.* 600 *l.* at 4 Months, 200 *l.* at 6 Months, and the rest (which is 200 *l.*) at 12 Months, and he agreeth with his Debtor to make one Payment of the whole; I demand the time of Payment without Damage to Debtor or Creditor?

600 l. multiplied by 4 Months is——2400
200 l. multiplied by 6 Months is——1200
200 l. multiplied by 12 Months is——2400

The Sum of the Product is——6000

and the Sum of the Products (6000) being divided by the whole Debt (1000 *l.*) Quotes 6 Months for the time of Payment of the whole Debt.

3. The truth of the Rule is thus manifest, if the Interest of that Mony which is paid (by the equated time) after it is due, be equal to the Interest of that Money which (by the Equated time) is paid so much sooner than it is due at any rate *per C.* then the Operation is true, otherwise not. Example.

The Proof of the Rule of Equation of Payments.

In the last Quest. 600 *l.* should have been paid at 4 Months, but is not discharged till 6 Months (that is 2 Months after it is due) wherefore its Interest or 2 Months at 6 *per C. per Annum.* is 6 *l.* and then

200 *l.* was to be paid at 6 Months, which is the equated time for its Payment, therefore no Intereſt is reckoned for it, but 200 *l.* ſhou'd have been paid at 12 Months, but it is to be paid at 6 Months, which is 6 Months ſooner than it ought, wherefore the Intereſt of 200 *l.* for 6 Months is 6 *l.* (accompting 6 *l. per Cent. per Annum*) which is equal to the Intereſt of 600 *l.* for 2 Months, wherefore the Work is right.

Queſt. 3. A Merchant hath owing him a certain Sum to be diſcharged at 3 equal Payments, *viz.* $\frac{1}{3}$ at two Months, $\frac{1}{3}$ at four Months, and $\frac{1}{3}$ at eight Months, the Queſtion is, what is the equated time for the Payment of the whole Debt?

In Queſtions of this Nature (*viz.* where the Debt is divided into equal or unequal parts) each of the parts is to be multiplied by its time, and the Sum of the Product is the Anſwer.

$\frac{1}{3}$ *Multiplied by* 2 *mon. produceth* $\frac{7}{8}$
$\frac{1}{3}$ *Multiplied by* 4 *mon. produceth* $1\frac{1}{3}$
$\frac{1}{3}$ *Multiplied by* 8 *mon. produceth* $2\frac{2}{3}$

The Sum of the Product is $4\frac{2}{3}$

which is $4\frac{2}{3}$ Months for the equated time of Payment.

If inſtead of the *Fractions* repreſenting the parts) you had wrought by the Numbers themſelves (repreſented by thoſe parts) according to the firſt and ſecond Examples, it would have been the ſame Anſwer; as ſuppoſe the Debt had been 60 *l.* then $\frac{1}{2}$ of it is 30 *l.* for each Payment, *viz.* at 2, 4, and 8 Months, then

30 *l. Multiplied by* 2 *mon. produceth* 60
30 *l. Multiplied by* 4 *mon. produceth* 120
30 *l. Multiplied by* 8 *mon. produceth* 240

The Sum of the Product is 420

which divided by 90 (the whole Debt) quoteth $4\frac{60}{90}$ or $4\frac{2}{3}$ Months as before.

Queſt.

Quest. 4. A Merchant oweth a Sum of Money to be paid $\frac{1}{2}$ at 5 Months, and $\frac{1}{4}$ at 8 Months, and $\frac{1}{4}$ at 10 Months, and he agreeth with his Creditor to make one total Payment; I demand the time, without damage to Debtor or Creditor? Work as in the last Question, and you will find the Answer to be 7 Months.

Quest. 5. A is indebted to B 640 *l.* whereof he is to pay 40 *l.* present Money, 350 *l.* at 3 Months, and the rest (*viz.* 250 *l,*) at 8 Months, and they agree to make an Equated time for the whole Payment; now I demand the Time?

In Questions of this Nature, (*viz.* where there is ready Money paid) you are (in Multiplying) to neglect the Mony that is to be paid present, and work with the rest as is before directed, and divide the Sum of the Products by the whole Debt, and the Quote is the Answer: For here 40 *l.* is to be paid present, and hath no time allowed, and according to the Rule it should be multiplied by its time, which is (0) therefore 40 times 0 is 0- which neither augmenteth nor diminisheth the Dividend; wherefore to proceeed according to direction) I say,

350 *by* 3 *Months produceth*	1050
250 *by* 8 *Months produceth*	2000
The Sum of the Product is	3050

which divided by 640, the whole Debt, the Quote is $4\frac{49}{64}$ Months, the time of Payment.

Quest. 6 A is indebted to B in a certain Sum, $\frac{1}{2}$ whereof is to be paid present Money, $\frac{1}{3}$ at 6 Months, and the rest at 8 Months; now I demand the Equated time for the Payment of it all?

Answer, $3\frac{1}{3}$ Months is the time of Payment.

Quest. 7. A is indebted to B 120 *l.* whereof $\frac{1}{3}$ is to be paid at 3 Months, $\frac{1}{4}$ at 6 Months, and the rest at 9 Months; what is the Equated time for the Payment of the whole Sum?

Answer, At 6 $\frac{1}{4}$ Months.

Quest. 8. A is indebted to B 320 *l.* which is due at the end of 6 Months, but A is willing to pay him 140 *l.* present, provided he can have the remainder forborn so much the longer to make satisfaction for his kindness, which is agreed upon, I desire to know what time ought to be alloted for the Payment of the 280 *l.* remaining?

To resolve this Question, First find out what is the Interest of 140 *l.* for the time it was paid before it was due, at 6 *per Cent.* (or any other rate) (*viz.* 6 Months) and you will find it to be 4 *l.* 4 *s.* Then it is evident that the remaining 280 *l.* must be detained so much longer than 6 Months as the while it may eat out that Interest, *viz.* 4 *l* 4 *s.* which is thus found out, *viz.* First, see what is the Interest of 280 *l.* for a Month, or any other time; but here we will take one Month, and its Interest for one Month is 28 *s.*

Then by the Rule of Three say,

As 28 *s.* is to 1 Month, so is 84 *s.* to 3 Months; so that the 280 *l.* remaining must be kept 3 Months, beyond its first time of Payment, (*viz.* 6 Months) which added thereto makes 9 Months, at the end of which time A ought to make Payment of the Remainder.

CHAP. XXX.

EXCHANGE.

THE the Rule of Exchange informeth Merchants how to Exchange Moneys, Weights, or Measures of one Country into (or for) the Moneys, Weights, or Measures of another Country, and when the Rate, Reason, or Proportion betwixt the Money, Weights or Measures of different Countries is known, it will not be difficult for the Practitioner that is well acquainted with the Rule of Proportion (or Rule of Three) to resolve any Question wherein it is required

to

to exchange a given Quantity of the one kind into the same Value of another kind.

2. In Questions of Exchange there is always a comparison made between the Coyns, *&c.* of two Countries (or kind) or of more.

3. In Questions where there is a Comparison made between two things (whether they be be Money, Weights, *&c.*) of different kinds, or (Countries) there may be a Solution found by a Single Rule of Three, as may appear by the following Example.

Quest. 1. A Merchant at *London* delivered 370 *l. Sterling* to receive the same at *Paris* in *French* Crowns; the Exchange $3\frac{1}{3}$ *French* Crowns *per* Pound *Sterling*. I demand how many *French* Crowns ought he to receive?

In placing the Numbers, observe the 6th Rule of the 10 Chapter, which being done, the given Numbers will stand thus,

l.	*Crowns*	*l.*
1 ——	$3\frac{1}{3}$ ——	370

and being reduced according to the Rules of the 24th Chapter, will stand thus;

	l.		*Crowns*		*l.*		*Crowns*
As	$\frac{1}{1}$	is to	$\frac{10}{3}$	so is	$\frac{370}{1}$	to	$1233\frac{1}{3}$.

So that I conclude he ought to receive $1233\frac{1}{3}$ *French* Crowns at *Paris* for 370 *l.* delivered at *London*.

Quest. 2. A Merchant delivered at *Amsterdam* 587 *l. Flemish* to receive the value thereof at *Naples* in Ducats the Exchange $4\frac{4}{5}$ Ducats *per l. Flemish*. I demand how many Ducats he ought to receive?

The Proportion is as followeth.

	l.		*Ducats*		*l.*		*Ducats*
As	$\frac{1}{1}$	is to	$\frac{24}{5}$	so is	$\frac{587}{1}$	to	$2817\frac{3}{5}$

So I find he ought to receive $2817\frac{3}{5}$ Ducats at *Naples* for the 587 *l. Flemish* delivered at *Amsterdam*.

Quest. 3. A Merchant at *Florence* delivereth 3478 Ducatoons, to receive the Value at *London* in Pence, the Exchange at $53\frac{1}{2}$ Pence *Sterling per* Ducatoon; I demand how much *Sterling* he ought to receive?

The

The Proportion for Refolution is,

	Duc.		d.		Duc.		d.
As	$\frac{1}{2}$	is to	$\frac{107}{2}$	fo is	$\frac{3472}{1}$	to	186073

which is equal to 775 *l.* 6 $\frac{1}{12}$ for the Anfwer.

I might here (according to the Cnftom of Arithmetical Writers) lay down Tables for the Reduction of Foreign Coyns to *Englifh*; but by reafon of their Inftability (for they continue not at a conftant Standard, as our *Sterling* Money doth, but are fometimes raifed and fometimes depreffed) I fhall forbear.

4. When there is a Comparifon made between more, than two different Coyns. Weights, or Meafures, there arifeth ordinarily two different Cafes from fuch a Comparifon.

1. When it is required to know how many Pieces of the laft Coyn, Weights, or Meafure are equal in Value to a known Number of Pieces of the laft Coyn, Weight, or Meafure.

2. When it is required to find out how many Pieces of the laft Coyn, Weight, or Meafure are equal in Value to a given Number of the firft fort of Coyn, Weight, or Meafure.

An Example of the firft Cafe may be this, viz.

Queft. 4. If 150 pence at *London* are equal to 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducats at *Naples* make $34\frac{1}{2}$ Shillings at *Bruffels*, then how many Penee at *London*, are equal to 138 Shillings at *Bruffels*? *Facit*, 960 *d*.

The Queftion may be refolved by two Single Rules of Three: for firft I fay,

If $\frac{3}{1}$ Ducats at *Naples* make 150 Pence at *London*, how many Pence will $4\frac{4}{5}$ Ducats make?

Anfwer, 240 Pence.

By the foregoing Proportion, we have difcovered that $4\frac{4}{5}$ Ducats at *Naples* make 240 Pence at

London:

London: and by the Tenour of the Question we see that $4\frac{4}{5}$ Ducats at *Venice* make $34\frac{1}{2}$ Shillings at *Brussels*, therefor 240 *d*. at *London* are equal to $34\frac{1}{2}$ *s*. at *Brussels*, (for the things that are equal to one and the same thing are also equal to one another) wherefore we have a way laid open to give a Solution to this Question by another Single Rule of Three, whose proportion is.

As $34\frac{1}{2}$ Shillings at *Brussels* is to 240 Pence at *London*, so is 138 shil. at *Brussels* to 960 Pence at *London*, which is the Answer to the Question.

An Example of the second Case may be thus, viz.

Quest. 5. If 40*l*. *Averdupois* weight at *London* is equal to 36 *l*. weight at *Amsterdam*, and 90 *l*. at *Amsterdam* makes 116 *l*. at *Dantzick*, then how many Pounds at *Dantzick* are equal to 112 *l*. *Averdupois* weight at *London*?

Answer, $129\frac{23}{25}$ Pounds at *Dantzick*.

This Question is likewise answered by two Single Rules of Three, *viz*. First, I say,

As 36 *l*. at *Amsterdam* is to 40 *l*. at *London*.

So is 90 *l*. at *Amsterdam* to a 100 *l*. at *London*.

And by the Question you find that 90 *l*. at *Amsterdam* is 116 *l*. at *Dantzick*, and therefore 100 *l*. at *London* is likewise equal thereunto, wherefore again, I say,

As 100 *l*. at *London* is to 116 *l*. at *Dantzick*.

So is 112 *l*. at *London* to $129\frac{23}{25}$ *l*. at *Dantzick*.

By which I find that $129\frac{23}{25}$ *l*. at *Dantzick* are equal to 112 *l*. *Averdupois* weight at *London*.

5. There is a more speedy way to resolve such Questions as are contained under the two Cases beforementioned, laid down by Mr. *Kersey* in the third Chapter of his Appendix to Mr. *Wingate*'s Arithmetick, where he hath given two Rules for the Resolution of the Questions pertinent to the said two Cases.

6. But I shall lay down a general Rule for the Solution of both Cases; and first, let the Learner observe the following Directions in placing of the given Terms, *viz*.

7. Let there be made two Columns, and in these Columns, so place the given Terms one over the other, as that in the same Column there may not be found two Terms of the same kind one with the other.

Having thus placed the Terms, the General Rule is,

Observe which of the said Columns hath the most Terms placed in it, and multiply all the Terms therein continually, and place the last Product for a Dividend; then multiply the Terms in the other Column continually, and let the last Product be a Divisor, then divide the said Dividend by the said Divisor, and the Quotient then arising is the Answer to the Question.

So the Example of the first of the said Cases being again repeated, *viz.* If 150 Pence at *London* make 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducats at *Naples* make $34\frac{1}{2}$ Shillings at *Brussels*, then how many Pence at *London* are equal to 131 Shillings at *Brussels*?

The Terms being placed according to the 7th Rule will stand as followeth,

	A	B	
Pence at Lond.	150	3	*Ducats at Na.*
Ducats at Na.	$4\frac{4}{5}$	$34\frac{1}{2}$	*Shill. at Bruss.*
Shill. at Bruss.	138		

Having thus placed the Terms that in neither Column there is two Terms of one kind, then observe that the Column under A hath most Terms in it, therefore they must be multiplied together for a Dividend, *viz.* 150 multiplied by $4\frac{4}{5}$ produceth $\frac{3600}{5}$ which multiplied by 138 produceth $\frac{496800}{5}$ for a Dividend, then in the Column under B there are 3 and $34\frac{1}{2}$ which multiplied together, produce $\frac{207}{2}$ for a Divisor; then having divided $\frac{49600}{5}$ by $\frac{207}{2}$, the Quotient is 960 Pence for the Answer as before.

Again, Let the Example of the second Case be again repeated, *viz.* If 40 *l. Averdupois* weight at *London* make 36 *l.* weight at *Amsterdam*, and 90 *l.* at *Amsterdam* make 116 at *Dantzick*, then how many Pounds at *Dantzick* are equal to 112 *l. Averdupois* weight at *London*?

The

The Terms being disposed according to the 7th Rule foregoing, will stand thus,

	A	B	
l. at Lond.	40	36	*l. at Amsterdam*
l. at Amst.	90	116	*l. at Dantzick*
		112	*l. at London*

whereby I find that the Terms under B multiplied together produce 467710 for a Dividend, and the Terms under A, *viz.* 40 and 90 produce 3600 for a Divisor, and Division being finished, the Quotient giveth $19\frac{3312}{4690}$ Pounds at *Dantzick* for the Answer.

CHAP. XXXI.

Single Position.

1. NEgative Arithmetick, called the Rule of False is that by which we find out a Truth, by Numbers invented or supposed, and this is either Single or Double.

2. The Rule of Single Position is, when at once, *viz.* by one False Position, or feigned Number, we find out the true Number sought.

3. In the Single Rule of False, when you have made choice of your Position, work it according to the tenour of the Question, as if it were the true Number sought, and if by the ordering your Position you find the result either too much or too little you may then find out the Number sought by this Proportion following, *viz.*

As the result of your Position is to the Position, so is the given Number to the Number sought.

Example.

Quest. 1. A Person having about him a certain Number of Crowns, said, If the fourth, and third, and sixth of them were added together they would make just 45*l.* now I demand the number of Crowns he had about him? *Answer*, 60 Crowns.

To

To reſolve this Queſtion I ſuppoſe he had 24 Crowns (or any other Number that will admit of the like Diviſion) now the fourth of 24 is 6, and the third is 8, and the ſixth is 4, all which parts, (*viz.* 6, 8, and 4,) being added together make but 18, but it ſhould be 45, wherefore I ſay by the Rule of Three,

As 18, the Sum of the parts is to the Poſition 24, ſo is 45 the given Number to 60 the true Number ſought.

For the fourth of 60 is 15, and the third of 60 is 20, and the ſixth of 60 is 10, which added together make 45.

Queſt. 2. Three Perſons, *viz.* A, B, C, thus diſcourſe together concerning their Age, quoth B to A, I am as old and half as old again as you, then quoth C to B I am twice as old as you, then quoth A to them and I am ſure the Sum of all our Ages is 165, now I demand each Man's Age? *Anſwer*, A 30, B 45, C 90 Years of Age, which added together, make 165.

CHAP. XXXII.

Double Poſition.

1. THE Rule of Double Poſition is when 2 falſe Poſitions are aſſumed to give a Reſolution to the Queſtions propounded,

2. When any Queſtion is ſtated in Double Poſition make ſuch a Croſs as followeth.

a X *b*
d X *c*

3. Then make choice of any Number you think may be convenient for your working, which call your firſt Poſition, and place it at the end of the Croſs at *a*, then work with this Poſition (as if it were the true Number

Number fought) according to the nature of your Question, then having found out your Error, either too much or too little, place it on that fide the Crofs *d*. then make choice of another Number of the fame Denomination with the firft Perfon (which call your fecond Pofition) and place it on that fide of the Crofs at *b*, then work with this Pofition as with the former, and having found out your Error, either too much or too little, place it on that fide of the Crofs at *c*, and then the Pofitions will ftand at the top of the Crofs, and the Errors at the bottom, each under his correfpondent Pofition, and then multiply the Errors into the Pofitions crofs-wife, that is to fay, multiply the firft Pofition by the fecond Error, and the fecond Pofition by the firft Error, and put each Product over its pofition.

4. Having proceeded fo far, then confider whether the Errors were both alike, that is, whether they were both too much,or both too little, and if they are alike: then Subtract the leffer product from the greater, and fet the remainder for a Dividend, then Subtract the leffer Error from the greater, and let the remainder be a Divifor, then the Quotient arifing by this Divifion, is the Anfwr to the Queftion.

5. But if the Errors are unlike,that is,one too much, and the other too little, then add the Products of the Pofitions and Errors together, and their Sum fhall be a Dividend, then add the Errors together, and their Sum fhall be a Divifor, and the Quotient arifing hence is the Anfwer; which two laft Rules may be kept in Memory by this Verfe following, *viz.*

When Errors are of unlike kinds
Addition *doth enfue,*
But if alike, Subtraction *finds*
Dividing Work for you.

Queft. 1. A, B, and C Build a Houfe which coft 76 *l.* of which A paid a certain Sum unknown, B paid

paid as much as A, and 10 *l.* over, and C paid as much as A and B, now I desire to know each Man's Share in that Charge?

Having made a Cross according to the 2d Rule, I come according to the third Rule to make choice of my first Position, and here I suppose A paid 6 *l.* which I put upon the Cross as you see, then B paid 16 *l.* (for it is said he had paid 10 *l.* more than A) and C paid 22 *l.* for it is said he paid as much as A and B, then I add their parts.

l.					*l.*
9					A 6
19					B 16
28	120	168	288		C 22
——		6 X 9			——
56	12)	X	(14		*Sum* 44
	32		20		
75		12			76
56					44
——					——
20					*Error* 32

and they amount to 44, but it is said they paid 76 *l.* wherefore it is 32 too little, which I note down at the bottom of the Cross under its Position for the first Error.

Secondly, I suppose A paid 9 *l.* then B paid 19 *l.* and C 28 *l.* all which added together, make 56, but they should make 76, wherefore the Error of this Position is 20, which I put at the bottom of the Cross under its Position for the second Error, then I multiply the Errors and the Positions cross-wise, *viz.* 32 (the Error of the first Position) by 9 (the second Position) and the Product is 288. Then I multiply 20 the Error of the second Position) by 6 (the first Position) and the Product is 120.

Then (according to the 4th Rule) I subtract the lesser Product from the greater, (*viz.* 120 from 288, because the Errors are both alike, *viz.* too little))

and

and there remaineth 168 for a Dividend, then I Subtract 20, (the lesser Error) from 32 (the greater Error) and the Remainder is 12, for a Divisor, then I Divide 168 by 12, and the Quotient is 14 for the Answer, which is the share of A in the Payment.

6. Again Secondly, If the Errors had been both too big it had had the same Effect, as appeareth by the following work; for first I suppose A paid 20 *l.* then B paid 30 *l.* and C. 50 *l.* which in all is 100, but it should have been no more than 76, wherefore the first Error is 24 too much. Again, I suppose A paid 18 *l.* then B must pay 28 *l.* and C must pay 46 *l.* which in all

20 A 30 B 50 C	320 112 432 20 X 18 8) (14 *facit.* 24 16 8	A 18 B 28 C 46
100 *Sum* 76 *Subtr.*		*Sum* 92 *Subt.* 76
24 *Error*		*Error* 16

s 92 *l.* but it should have been but 76 *l.* wherefore the second Error is 16 too much; then I multiply 20 (the first *Position*) by 16 (the second Error) and the Product is 320; again, I multiply 18 (the second *Position*) by 24 (the first Error) and the Product is 432. Then because the Errors are both too much, I subtract 320 (the lesser Product) from 432 (the greater Product,) and there remaineth 112 for a Dividend; likewise I Subtract 16 (the lesser Error) from 24 (the greater Error,) and the difference is 8 for a Divisor, then perform Division, and the Quotient is 14, (as before) for the Answer.

Again Thirdly, If the Errors had been the one too big, and the other too little, Respect being had to the ... Rule foregoing, the Answer would have been the same; as thus, I take for my first Position 6, and then the Error is 32 too little, then I take

take for my ſecond Poſition 18, and then the error is 16 too much, then I multiply the Poſitions and Errors croſs-wiſe, and the Products are 96 and 576, and becauſe the Errors are unlike.

96 672 576
6 X 18
48) (14
32 16
48

(*viz.*) one too big, and another too little, I add these Products 96 and 576 together, and their Sum is 672 for a Dividend, I likewiſe add the errors 32 and 16 together, and their Sum is 48 for a Diviſor, then having finiſhed Diviſion, I find the Quotient to be 14, which is the Anſwer as was found out at the 2 ſeveral Tryals before.

For proof of the Work I ſay,

	l.
If A *Paid*	14
Then B *Paid* 14 *and* 10 (*that is*)	24
Then C *Paid* 14 *and* 24 (*that is*)	38
The Sum of all is	76

which is the Total value of the Building and equal to the given Number.

Thoſe who deſire to ſee the demonſtration of this Rule, let them read the 7*th* Chapter of Mr. *Kerſey*'s Appendix to *Wingate*'s Arithmetick, *Petiſcus* in the 5th Book of *Trigonometria*, or Mr. *Oughtred* in his *Clavis Mathematica.*

Queſt. 2. Three Perſons, A, B, C, thus diſcourſed together concerning their Age; quoth A, I am 18 years of Age; quoth B, I am as Old as A and ½ C; and quoth C, I am as Old as you both, if your Years were added together. Now I deſire to know the Age of each Perſon? *Anſwer*, A is 18, B is 54, and C is 72 years of Age.

Queſt.

Quest. 3. A Father lying at the point of Death, left to his 3 Sons, *viz.* A, B, C, all his Estate in Money, and Divideth it as followeth, *viz.* to A he gave $\frac{1}{2}$ wanting 44 *l.* to B he gave $\frac{1}{3}$ and 14 *l.* over, and to C he gave the Remainder, which was 82 *l.* less than the share of B, now I demand what was the Sum left, and each man's part? *Answer*, The Sum bequeathed was 588 *l.* and whereof A had 250 *l.* B had 210 *l.* and C had 128 *l.*

Quest. 4. Two persons, *viz.* A and B had each in their hands a certain number of Crowns, and A said to B, if you gave me 1 of your Crowns, I shall have 5 times as many as you; and said B to him again, if you givn me one of yours, then we shall each of us have an equal number, now I demand how many Crowns had each Person? *Answer*, A had 4, and B had 2 Crowns.

Quest. 5. What number is that unto which if I add $\frac{3}{4}$ of it self, and from the Sum, subtract $\frac{1}{8}$ of it self, the Remainder will be 216? *Answer*, 192.

Many more Questions may be added, but these well understood, will be sufficient, (even for the meanest Capacity) for the Resolution of any other Question pertinent to this Rule.

There may be an Objection made, because we have not treated particularly upon Interest and Rebate, but the operation of such Questions being more applicable to Decimals, are omitted, till we come to acquaint the Learner therewith.

Laus Deo Soli.

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