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Ingenious COCKER! (Nou to Rest thou'rt Gone
 Noe Art can Show thee fully but thine own
 Thy rare Arithmetick alone can show
 The vast Sums of Thanks wee for thy Labour
 owe

Arithm. 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.

COMPOSED

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

PERUSED and PUBLISHED

By *John Hawkins* Writing-Master near St. Georges Church in Southwark, by the Authors correct Copy, and commended to the World by many eminent Mathematicians and Writing-Masters in and near London.

The Two and Twentieth Edition carefully Corrected, with Additions.

Licenced Sept. 3. 1677. Roger L'Estrange.

L O N D O N,

Printed by *W. Richardson*, for *Eben. Tracey*, at the Three Bibles on London-Bridge. 1702.

50. c. 10.

of 1861

TO his much Honoured
Friends, *Manwaring*
Davies of the *Inner Temple*,
Esquire, and Mr. *Humpbry*
Davies of *St. Mary New-*
ington Butts, in the County
of *Surry*.

John Hawkins, As an
Acknowledgment of Un-
merited Favours, humbly
Dedicateth this *Manual of*
Arithmetick.

A 3

To

To the READER.

Courteous Reader,

I Having the Happiness of an Intimate Acquaintance with Mr. *Cocker* in his Lifetime, 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 Practice 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.

B*Y the sacred Influence of Divine Providence, 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 Arithmetical Mite into the Publick Treasury, beseeching the Almighty to grant the like Blessing 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 complete;
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 designed this Work not extraordinary abstruse or profound,

The Proeme or Preface.

profound, but have by all means possible within the Circumference of my Capacity, endeavour'd to render it extraordinary useful to all those, whose Occasions shall induce them to make use of Number. 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 Arithmetick extant, and so little practised, is to me a greater wonder; knowing that as Merchandise is the Life of the Weal-Publick, so Practical Arithmetick is the Soul of Merchandize. Therefore I do ingenuously profess, that in the beginning of this Undertaking, the numerous Concords 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 Arithmetical Tractate composed; which you may please to implay 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,

The Proeme or Preface.

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 deliver'd with Sincerity. The Examples are built up gradually from the smallest Consideration to the greatest. All the Problems or Propositions are well weighed, pertinent and clear, and not one
of

The Proeme or Preface.

*of them throughout the Traët taken upon trust ;
therefore now,*

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

Edward Cocker.

Courteous

Courteous 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 acceptance; 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 Manual of Arithmetick is recommended to the World by Us whose Names are subscribed, viz.

Mr. John Collens	} Matth.	Mr. William Mason
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		Mr. John Hawkins

And generally Approved by all Ingenious Artists.

A Table

A Table of the Contents of this B O O K.

	Chap.	Page
N otation of Numbers	1	1
Of the natural division of Integers, and the denomination of their parts	2	11
Of the Species or Kinds of Arithmetick	3	19
Of the Addition of Whole Numbers	4	20
Of Subtraction of Whole Numbers	5	29
Of Multiplication of whole Numbers	6	38
Of Division of Whole Numbers	7	47
Of Reduction	8	66
Of comparative Arithmetick, viz. the Relation of Numbers one to another	9	98
The single Rule of 3 Direct	10	102
The single Rule of 3 Inverse	11	123
The double Rule of 3 Direct	12	130
The double Rule of 3 Inverse	13	135
The Rule of 3 composed of 5 Numbers	14	139
Single Fellowship	15	141
Double Fellowship	16	145
Alligation Medial	17	148
Alligation Alternate	18	150
Reduction of Vulgar Fractions	19	158
Addition of Vulgar Fractions	20	168
Subtraction of Vulgar Fractions	21	170
Multiplication of Vulgar Fractions	22	172
Division of Vulgar Fractions	23	173
The Rule of 3 Direct in Vulgar Fractions	24	175
The Rule of 3 Inverse in Vulgar Fractions	25	177
Rules of Practice	26	178
The Rules of Barter	27	195
Questions in Loss and Gain	28	196
Equation of Payments	29	200
Exchange	30	204
Single Position	31	209
Double Position	32	210

C H A P.

C H A P. 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 numbered; 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 manner

A	—	—	B
		C	
D			6
E			o
			—
sum			

A	—	B	—	C
C	E			
6	o			} 6o

ner if we grant D 6 be prolonged to E (○) so that DE (6○) be a continued number making 60, then 6 is augmented by the aid of (○) as to the constituting the number (60) sixty; and furthermore that one or unit is material and a number, and that (○) 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 10000000) and the beginning of that Table is (○) and to it answereth 00000, &c.

5. Hence it is that number is not quantity discontinued, 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 (○) 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.) 0 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 a 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 an-

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 encrease 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 Integers, to (3) three tenth parts of an Unit or 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 five 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	21012	345	678	976	3
nn	m m	nnnn	nnnn	CXUXC	nnnn	nnnn	nnnn	n
nn	nnnn	nnnn	CX		XC	nnnn	nnnn	n
nnn	nnnn	CX				XC	nn	m
nnn	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

B 3

Mul-

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
l. feet.men. inch.

point or prick after the number thus, 5. 5. 26. 347. 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 10 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 the 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 inferior 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 3 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; so $\frac{3}{4}$ is a perfect proper Fraction, but an improper Fraction hath its numerator greater, or at least equal to the denominator; thus $\frac{5}{4}$ 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 $\frac{1}{2}$ l. $\frac{1}{4}$ s. $\frac{1}{8}$ d. 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 $\frac{1}{2}$ of $\frac{1}{4}$ of $\frac{1}{8}$ of a pound sterling were given, we say, that it 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-

according to our last Rule, $\frac{5}{10}$, $\frac{5}{100}$, $\frac{5}{1000}$, $\frac{5}{10000}$, 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 $\frac{5}{100}$, stand thus .5, and .25.

But oftentimes, as in the second and fourth *Fractions* $\frac{5}{100}$ and $\frac{5}{1000}$, 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 $\frac{5}{10}$ be .05, and $\frac{5}{100}$ will be .025, and $\frac{5}{1000}$ will be .0025. 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 a 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 $\frac{1}{2}$ 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 sub-decimating these latter, we run on *ad infinitum*.

28. Let a pound sterling, *Troy-weight*, *Averdupois*

pois-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 *Secnds*, 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 $\frac{1}{4}$ of a farthing; and so will .05 signify one shilling, or five *Secnds*. 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. and 6 d.; for the 3 *Primes* are 6 shillings, and the 7 *Secnds* are 15. 4 d. and $\frac{3}{4}$ of a penny, and the 5 *Thirds* are 1 penny and $\frac{2}{3}$ 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 *Secnds*, and the next decimation is *Thirds*, the next *Fourth*s, &c. As let there be given a Bullet of Lead, or such like, whose weight shall be 50 l. Troy, this call an Unit, Integer, or thing; then with the like weight and matter, make 10 others, 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*, *Secnds*, and *Thirds*, in respect of the Integer containing 50 l. Troy; and that 5 *Primes* is equal to the half mals, and 2 *Primes* and 5 *Secnds* is a quarter of the mals; and therefore 1

of the first division, 2 of the second division, and 5 of the third division, will be equal in weight to $\frac{1}{4}$ a quarter of the mass, and contain 6 l. and 3 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|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, 369, &c.

Proportional, as Single, Multiple, Double, Triple, Quadruple, &c. *Denominate*, as Pounds, Shillings, Pence; *Undenominated*, as 1, 2, 3, &c. *Perfect*, as 6, 28, 406, 8128, 130816, 2096128, &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

Chap. 2. Of Money, Weights, &c.

11

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 Question.

CHAP. II.

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

1. **B**Efore 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 or 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 Coin*, viz.

		And therefore			
		L.	s.	d.	qrs.
1 Farth.	} make	1 Farthing	{	1—20—12—4	
4 Farth.		1 Penny		1—20—12—4	
12 Pence		1 Shilling		1—20—240—960	
20 Shill.		1 Pound		1—12—48	
				1—4	

The first of these Tables, viz. that on the left hand, is plain and easie to be understood, and therefore wants

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 signifies 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 12 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 Tables of Weight, Measure, Time, Motion and Dozen.

Of Troy Weight.

31 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		1 Penny-weight
20 Penny-weight		1 Ounce
12 Ounces		1 Pound Troy-weight

And therefore,

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

Troy-weight serveth only to weigh Bread, Gold, Silver, and Electuaries; it also regulareth and prescribeth a Form how to keep the Mony 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 *Caracts*, and each *Caract* 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 he put 2 *Caracts* 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 *Caracts*, then this Gold is said to be 22 *Caracts* fine, for if it come to be refined the 2 *Caracts* of alloy will fly away, and leave only 22 *Caracts* of pure Gold, the like to be considered of a greater or lesser quantity; and as the fineness of Gold is estimated by *Caracts*, 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 1 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,			
1 pound	} make	12 ounces	1 l. ounce.	drams	scrup. gr.
1 ounce		8 drams	1—12—	8—	3—20
1 dram		3 scruples	1—12—	96—	288—5760
1 scrup.		20 grains	1—	8—	24—480
				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 wei. or 112 l.
20 hundred		1 tun

And therefore,

Tun	C.	qrs.	l.	oun.	dra.	qrs.
1	20	4	28	16	16	4
1	20	80	2240	35840	573440	2293760
1	4	112	1792	28672	114688	
1		28	448	7168	28672	
1			16	256	1024	
1				16	64	
1					4	

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

A Table of the denominative parts of Wooll-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 therefore,

Laſt Sacks Wey Todd Stone Cloves l.
1—12—2—6½—2—2—7

1—12—24—156—312—624—4368

1—2—12—26—52—364

1—6½—13—26—182

1—2—4—28

1—2—14

1—7

Note, that in ſome Counties, the *Wey* is 256 l. *Averdupois*, as is the *Suffolk Wey*; but in *Effex* 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 1 pint of *liquid Measure*) but in regard of the difference between the *Brewers* and the *Farmers* of His Majesty's *Excise* concerning the gauging of *Veffels* occaſion'd 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 35½ ſolid Inches, and the pint *Wine-measure* to contain 28½ cubical or ſolid Inches; from whence is drawn the following *Table*.

The Table of *Liquid Measure*.

35½ cubical Inches	} make {	1 pint beer-measure
28½ cubical Inches		1 pint wine-measure
2 pints		1 quart
2 quarts		1 pottle
2 pottles		1 gallon
8 gallons		1 firkin of ale, ſoap or herr.
9 gallons		1 firkin of beer
10 gallons and a half		1 firkin 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 butt
2 pipes or butts		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 whose division followeth.

The Table of Dry-Measure.

1 pound Troy	}	meas	1 pint.
2 pints			1 quart
2 quarts			1 pottle
2 pottles			1 gallon
2 gallons			1 peck
4 pecks			1 bushel
4 bushels			1 comb
2 combs			1 quarter
4 quarters			1 chaldron
5 quarters			1 wey
2 weys			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 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,

<i>mile</i>	<i>furl.</i>	<i>poles</i>	<i>yards</i>	<i>feet</i>	<i>inches</i>	<i>barly-corns</i>
1	8	40	5 $\frac{1}{2}$	3	12	3
<hr/>						
1	8	320	1760	5280	63360	190080
1	40	220	660	7920	23760	
	1	5 $\frac{1}{2}$	16 $\frac{1}{2}$	198	594	
		1	3	35	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 4 feet; and there are 1056 such Paces in an *English* mile.

2. The parts of the Superficial Measures of Land are such as are mentioned 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

By the foregoing *Table of Long Measure*, you are informed what a Pole, or (which is all one) Perch is; and by this that 40 square Perches are 1 Rood. Now by a square Perch is a superficies very aptly 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 4 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	}	CUMULATIVE	1 Minute
60 Minutes			1 Hour
24 Hours			1 Day natural
7 Days			1 Week
4 Weeks			1 Month
12 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 that they contain, follow, viz.

	days	
January	31	So that the Year containeth 365 Days, and 6 Hours, but the 6 Hours is 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.
February	28	
March	31	
April	30	
May	31	
June	30	
July	31	
August	31	
September	30	
October	31	
November	30	
December	31	

And here note, that as the Hours 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.

C H A P. III.

Of the Species or Kinds of Arithmetick.

1. **A** Rithmetick 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 call'd Logarithmetical) 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 perform'd 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.*

C H A P. IV.

Of Addition of Whole Numbers.

1. **A**ddition 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 to 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 3 given numbers to be 3698.

$$\begin{array}{r}
 3352 \\
 213 \\
 133 \\
 \hline
 3698
 \end{array}$$

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 10, now because it comes to just 10 and no more, I set 0 under the line and carry 1 for the 10 to the next, and say, 1 that

$$\begin{array}{r}
 3678 \\
 2357 \\
 \hline
 6035
 \end{array}$$

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.

$$\begin{array}{r} \text{Numbers to} \\ \text{be added} \end{array} \left\{ \begin{array}{r} 354867 \\ 573846 \\ 785946 \\ 347205 \end{array} \right.$$

Sum 2061864

$$\begin{array}{r} \text{Numbers to} \\ \text{be added} \end{array} \left\{ \begin{array}{r} 748647 \\ 465834 \\ 76483 \\ 648300 \end{array} \right.$$

Sum 1939264

$$\begin{array}{r} \text{Numbers to} \\ \text{be added} \end{array} \left\{ \begin{array}{r} 45346 \\ 38074 \\ 8437 \\ 923 \\ 76 \end{array} \right.$$

Sum 92856

5. If the Numbers given to be added, are contained under divers 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. 09 d. 1 qr. also 15 l. 09 s. 05 d. 0 qr. The Numbers being disposed according to order will stand as in the Margent. Then I being at the denomination of Farthings,

and add them up, saying, 1 and 3 are 4 and 2 make 6, now I consider that 6 Farthings is 1 Penny and 2 Farthings, wherefore I set down the 2 Farthings in its 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, whereof 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, wherefore 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 tens, and proceed, saying, 2 that I carry and 1 is 3, and 3 are 6, and 7 are 13, and 3 make 16 ; 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 *grs.* 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; wheretore 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 5 penny-weight, I set down 9 in its place under the line, and carry 1 to the ounces, saying 1 that I carry and 8 are 9, and 10 are 19, and 7 are 26, and because 26 ounces make 2 pound 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.

Addition of English Money.

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

l.	s.	d.	qrs
48	15	11	1
76	10	07	3
18	00	05	3
24	19	09	2
<hr/>			
168	06	10	1

Addition of Troy-weight.

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

l.	oz.	p.w.	gr.
145	09	12	18
725	08	14	10
380	07	06	13
83	10	16	20
130	00	10	12
74	07	15	00
<hr/>			
1541	08	16	01

Addition

Addition of Apothecaries Weights.

l.	oz.	dr.	sc.	gr.
48	07	1	0	14
74	05	5	2	10
64	10	7	1	16
17	08	1	0	11
34	09	6	1	09
<hr/>				
240	05	6	1	00
<hr/>				

l.	oz.	dr.	sc.	gr.
60	03	4	0	10
48	10	5	2	14
34	08	2	1	15
18	11	2	2	11
160	07	1	2	15
35	02	5	1	07
<hr/>				
358	07	7	0	12
<hr/>				

Addition of Averdupois-weight.

Tun	C.	qrs	l.
75	13	1	15
48	07	3	21
60	11	1	17
21	07	0	25
12	16	0	11
<hr/>			
218	16	0	05
<hr/>			

l.	oun.	dr.
36	10	12
22	11	13
11	07	04
15	04	10
20	00	09
<hr/>		
106	03	00
<hr/>		

Addition of Liquid Measure.

Tun	pipe	bhd	gall.
45	1	1	48
15	0	1	17
38	0	0	47
12	1	0	56
21	1	1	18
<hr/>			
133	1	1	60
<hr/>			

Tuns	bhd	gall.	pts.
30	3	40	4
12	0	28	6
47	5	60	5
57	3	22	3
17	0	09	0
<hr/>			
166	1	26	2
<hr/>			

Addition of Dry Measure.

Chald.	qrs.	busb.	pec.	qrs.	busb.	pec.	gall.
48	3	7	3	17	3	1	1
13	1	4	0	50	1	3	0
54	0	6	2	14	5	3	1
16	3	6	1	40	2	0	1
40	1	6	1	30	0	3	0
173	3	0	3	152	5	3	1

Addition of Long Measure.

yards	qrs.	na.	ells	qrs.	na.
35	3	3	56	1	3
14	1	2	13	3	2
74	2	3	48	2	1
38	0	1	50	1	0
30	1	0	74	0	2
15	0	0	17	1	0
208	1	1	260	2	0

Addition of Land Measure.

Acre	rood	perc.	Acre	rood	perc.
12	3	18	86	1	36
14	0	24	47	3	24
30	2	19	73	2	18
48	3	30	60	0	07
28	1	38	04	2	08
50	3	26	14	1	14
183	3	35	285	3	27

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 26*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 26*l.* 09*s.* 05*d.* 2*qrs.* the same with the first sum; and therefore I conclude that the Operation was rightly performed.

<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>qrs</i>
136	13	04	2
<hr/>			
79	07	10	3
33	18	09	1
15	09	05	0
<hr/>			
265	09	05	2
<hr/>			
128	16	01	0
<hr/>			
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 44 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 Fathers Age at the birth of his first Child, 44
 which was 44, then the difference between the 12
 eldest and the youngest, which is 12 years, and 44
 then the Age of the youngest which is 44, and 100
 then add them all together, and their sum is
 100 the compleat Age of the Father.

Quest. 2. A Man lent his Friend, at several times,
 these several Sums, (*viz.*) at one time 63 *l.* at ano-
 ther 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. *l.*

Set the Sums lent one under another, as 63
 you see in the Margent, and then add them 50
 together, and you will find their Sum to a- 48
 mount to 317 *l.* which is the Total of all the 156
 several Sums lent, and so much is due to the
 Creditor. 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* accord-
 ing to this reckoning.

Now to answer to this Question, set down 20
 the several distances given, as you see in 29
 the Margent, and add them together, and 21
 you will find their Sum to amount to 151, 36
 which is the true distance in miles between 25
London and *York*. 20
 151

Quest. 4. There are two numbers, the least where-
 of is 40, and their difference
 is 14, I desire to know what 40
 is the greatest Number, and 14
 also what is the Sum of them
 both? First, set down the
 least, *viz.* 40, and 14 the dif-
 ference, and add them toge-
 ther, and their sum is 54 for
 the greatest number, then I

	40
	14
	<hr/>
greatest	54
least	40
	<hr/>
sum	94

set 40 (the least) under 54 (the greatest) and add them together, and their sum is 94 equal to the greatest and least numbers.

C H A P. V.

Of Subtraction of Whole Numbers.

1. **S**ubtraction 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 superiour number is called the *major number*, and the lower or inferiour 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 lesser 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 below the line will give you the remainder : As for Example, let 364521 be given to be subtracted 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 until I have finished the work, and then I find the Remainder or Difference to be 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 subtract 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 subtract that from the higher number or figure : And thus go on until your Subtraction be finished. As for Example ; Let 437503 be given, from whence it is required to subtract 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 9 from 5 I cannot, but 9 from 15 and there remains 6 ; then 1 I 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 2 from 4 and there rests 2 ; and thus the Work is finished ; And after these numbers are subtracted one from another, the Inequality, Remainder, Excess or Difference, is found to be 283676.

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

From 3475016
Take 738642

From 3615746
Take 5864

Refts 2736374

Refts 3609882

6. If the *Sum* or *Numbers* to be subtracted 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 subtract the lowermost, noting the remainder below the Line; then proceed and pay 1 to the next Denomination for that which you borrowed 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.* 07 *d.* 1 *qr.* be given, from whence let it be required to subtract 57 *l.* 16 *s.* 03 *d.* 2 *qrs.* In order whereunto I place the Numbers as you see in the Margin, 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 one 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

<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>qrs</i>
375	13	07	1
57	16	03	2
<hr/>			
317	17	02	3
<hr/>			

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 3 *l.* 17 *s.* 03 *d.* 3 *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 *Penny-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

<i>l.</i>	<i>oz.</i>	<i>p.w.</i>	<i>gr.</i>
24	05	00	08
17	10	11	20
<hr/>			
06	06	08	12
<hr/>			

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 1 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.*

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 554 *l.* 13 *s.* 10 *d.* and B

hath repaid him 79 *l.* 16 *s.*

08 *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

	<i>l.</i>	<i>s.</i>	<i>d.</i>
Lent	554	13	10
Paid at several Payments	{ 79	16	08
	{ 163	18	11
	{ 241	15	08
	<hr/>		
Paid in all	485	11	03
	<hr/>		
Remains	79	02	07

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.

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

	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>qrs</i>
<i>Borrowed</i>	100	00	00	711	03	00	0
<i>Paid</i>	19	00	06	11	13	00	1
<i>Remains</i>	980	19	06	699	09	11	3

	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>qrs</i>
<i>Borrowed</i>	3300	00	00	2
<i>Paid at several Payments</i>	170	10	00	0
	361	13	10	1
	590	03	04	3
	73	04	11	3
<i>Paid in all</i>	1195	12	22	3
<i>Remains due</i>	2104	07	09	3

Subtraction of Troy-weight.

	<i>l.</i>	<i>oz.</i>	<i>p.w.</i>	<i>gr.</i>
Bought	174	—00	—13	—00
Sold	78	—04	—16	—15
	<hr/>			
Remains	95	—07	—16	—09

	<i>l.</i>	<i>oz.</i>	<i>p.w.</i>	<i>gr.</i>
Bought	470	—10	—13	—00
	<hr/>			
Sold at several Times	60	—00	—00	—00
	35	—10	—18	—00
	16	—07	—09	—08
	48	—04	—00	—00
	61	—11	—12	—23
	23	—00	—00	—00
	<hr/>			
Sold in all	245	—10	—07	—07
	<hr/>			
Rem.unfold	225	—00	—05	—17

Subtraction of Apothecaries Weights.

	<i>l.</i>	<i>oz.</i>	<i>dr.</i>	<i>sc.</i>	<i>gr.</i>		<i>l.</i>	<i>oz.</i>	<i>dr.</i>	<i>sc.</i>	<i>gr.</i>
Bought	12	—04	—3	—0	—00		20	—00	—1	—0	—09
Sold	8	—05	—1	—1	—15		10	—00	—1	—2	—12
	<hr/>						<hr/>				
Remains	3	—11	—1	—1	—05		9	—11	—7	—0	—15
	<hr/>						<hr/>				

Subtraction of Averdupois-weight.

	<i>C.</i>	<i>qrs.</i>	<i>l.</i>		<i>Tun</i>	<i>C.</i>	<i>qrs.</i>	<i>l.</i>	<i>oz.</i>	<i>dr.</i>
Bought	25	—00	—15		15	—07	—01	—10	—10	—05
Sold	16	—02	—20		03	—17	—01	—16	—09	—13
	<hr/>				<hr/>			<hr/>		
Remains	08	—01	—23		11	—09	—03	—22	—00	—08

Subtraction of Liquid Measure.

	Tuns	hhd.	gall.	Tun	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.	busk.	pec.	Chald.	qrs.	busk.	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	2
Remains	95	3	2	166	2	2

Subtraction of Land Measure.

	Acres	roods	per.	Acres	roods	per.
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 remainders 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.

$$\begin{array}{r}
 437503 \\
 153827 \\
 \hline
 283676 \\
 437503 \\
 153827 \\
 \hline
 283676 \\
 \hline
 437503
 \end{array}$$

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. 2 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. 3 qrs. now to prove it, I add the said Remainder 317 l. 17 s. 03 d. 3 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
57	—	16	—	03
				—
317	—	17	—	03
				—
375	—	13	—	07
				—

9. The general effect of Subtraction is to find the differences 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. 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 565 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 565 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 287, and so much is still due to the Creditor ; as per Margent.

565
278
—
287
—

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 1572, and now we account the year of our Lord 1701, 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 1572, from the greater 1701, the remainder will be 129, and so many Years are past since the making of the said things ; as by the Work in the Margent.

1701
1572
—
129
—

Quest. 4. There are three Towns lie in a streight 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 *Tork*, and the Remainder is 102, for the true distance between *Huntington* and *Tork*. See the Work in the Margent.

151
49
—
102
—

C H A P. VI.

Of Multiplication of Whole Numbers.

1. **M**ultiplication 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

Single *Multiplication* is said to 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

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 Product 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 remembering 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

$$\begin{array}{r}
 478 \\
 6 \\
 \hline
 2868
 \end{array}$$

bear 4 in mind for the 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.

In the placing of the product of each
A Caution. 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

underneath them ; then I begin, saying, 7 times 4 is 28, then I set down 8, and carry 2, then 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 have I 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 2 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 before is 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.

Another Example may be this ; Let it be required to multiply 5486 by 465, I dispose of the Multiplicand and Multiplier, according to the Rule, and begin multiplying the first figure of the Multiplier, 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 subscribed 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 Product (being placed the one under the other according 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.

$$\begin{array}{r} 764 \\ 27 \\ \hline \end{array}$$

$$\begin{array}{r} 5348 \\ 1528 \\ \hline \end{array}$$

$$20628$$

$$\begin{array}{r} 5486 \\ 465 \\ \hline \end{array}$$

$$27430$$

$$32916$$

$$21944$$

$$\hline$$

$$2550990$$

$$\hline$$

More Examples in this Rule are these following.

$$\begin{array}{r} 430865 \\ 4739 \\ \hline \end{array}$$

$$\begin{array}{r} 3877785 \\ 1292595 \\ 3016055 \\ 1723460 \\ \hline \end{array}$$

$$\begin{array}{r} 2041869235 \\ \hline \end{array}$$

$$\begin{array}{r} 6400758 \\ 37498 \\ \hline \end{array}$$

$$\begin{array}{r} 38404548 \\ 57606822 \\ 25603032 \\ 44805306 \\ 19202274 \\ \hline \end{array}$$

$$\begin{array}{r} 240002821968 \\ \hline \end{array}$$

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 *Multipli-*

cand 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 *Multipl-*

cand and *Multiplier*, and then it makes 137600000 for the true Product of 32000 by 4300.

$$\begin{array}{r} 32000 \\ 4300 \\ \hline 96 \\ 128 \\ \hline 137600000 \end{array}$$

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. 9. de Arithm.

$$\begin{array}{r}
 327586 \\
 6030 \\
 \hline
 9827520 \\
 1965516 \\
 \hline
 1975343580
 \end{array}$$

$$\begin{array}{r}
 7864371 \\
 20604 \\
 \hline
 31457484 \\
 47186226 \\
 15728742 \\
 \hline
 152037300084
 \end{array}$$

9. 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 to multiply 102 by 1000, annex 4 Cyphers, and it gives 102000 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*,

*Nec est quod aliam expectes
examinandes viam, nam alia
vulgares & falsa sunt, &
nullo innixa fundamento.*

Gemma Frisius.

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

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 Plane) 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 Parallelipedon, Cylinder, or other solid Figures.

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*?

Ans. 364 square *Perches*; for multiplying 28 the length by the breadth, the product is so much.

Quest. 2. There is a square Battle whose Flank is 47 Men, and the Files 19 deep, what number of Men doth that Battle 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? *Ans.* 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.

C H A P. VII.

Of Division of Whole Numbers.

1. **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 parts, 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 contain'd in 12 four times, where 12 is the *Dividend*, and 3 is the *Divisor*, and 4 is the *Quotient*.

3. In *Division* set down your dividend, and draw a 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.

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 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

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 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 by 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.

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.

$$\begin{array}{r}
 6 \overline{) 2184} \\
 \underline{18} \\
 38 \\
 \underline{36} \\
 2
 \end{array}$$

⊕

D

Then

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 dividuall; 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 dividuall (24) and subtract 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 2184 being divided into 6 equal parts, 364 is one of those parts.

$$\begin{array}{r}
 6 \overline{) 2184} \quad (364 \\
 \underline{18} \\
 38 \\
 \underline{36} \\
 24 \\
 \underline{24} \\
 0
 \end{array}$$

$$\begin{array}{r} 6) 2184(364 \\ \underline{18} \\ 38 \\ \underline{36} \\ 24 \\ \underline{24} \\ 0 \end{array}$$

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

7) 2646. (378

$$\begin{array}{r} \dots \\ 21 \\ \hline 54 \\ 49 \\ \hline 56 \\ 56 \\ \hline (0) \end{array}$$

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.

Mandy

$$8) 946 \text{ (118)}$$

...

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 perform'd.

Other Examples are such as follow.

$$8) 73464 \text{ (9183)}$$

....

72

14

8

66

64

24

24

(0)

$$9) 13758 \text{ (1528)}$$

....

9

47

45

25

18

78

72

(6)

D 2

s. But

5. But if the divisor consisteth of more places than one, then 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 a figure more near to the right-hand, and seek how often the first figure on the left side of the divisor is contained 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 the Cases of Division) if after you have multiplied your 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 a 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 a 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 9454 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 in 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 dividend) 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 dividend 94, wherefore I cancel the 4 in the quotient, and instead thereof I put 3 (a Unit lesser) and by it multiply the divisor 34, and the product is 72, which I subtract from 94 the dividend, 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 dividend, now because the dividend 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 dividend) I say 9 times, wherefore I put 9 in the quotient, and thereby multiply the divisor 24, the product (216) I place under the dividend 226, and subtract it from it, and there remaineth 10.

$$\begin{array}{r} 24) 9464 \quad (3 \\ \underline{72} \\ 22 \end{array}$$

$$\begin{array}{r} 24) 9464 \quad (39 \\ \underline{72} \\ 226 \\ \underline{216} \\ 10 \end{array}$$

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 dividend, 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 dividend, 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 dividend, there remaineth 8, and thus the whole Work of this Division is ended, and I find that 9464 being divided by 24,

D 3

or

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

$$385) 1183653 (3$$

1155

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 dividend 1188, and there remains 28. Then

(as before) I draw down the next figure, which is 6, and place it before the remainder 28,

$$385) 1183653 (30$$

1155

so have I 286 for a new dividend, 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 dividend)

286

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

and 0 subtracted from the dividual 286, the remainder is the same; wherefore I draw down the next figure (5) from the dividend, and put it before 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 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 a 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 a 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 before the said remainder 170, and it makes 1703 for a new dividual, then (for the Reason abovesaid) I seek how often 3 is contained 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 (a 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,

$$385 \overline{) 1183653} (307$$

$$1155$$

$$2865$$

$$2695$$

$$(170)$$

$$385 \overline{) 1183653} (3074$$

$$1155$$

$$2865$$

$$2695$$

$$1703$$

$$1540$$

$$(163)$$

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 qualified 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 (29860

.....

55972

275964

251874

240907

223888

170199

167916

Remains (22830)

196374) 473986018 (2413

.....

392748

812380

785496

268841

196374

724678

589122

Remains (135556)

So

So if you divide 47386473 by 58796, 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 Number in the dividend, be divided by the remaining number or numbers in the divisor, observing this Caution, that if after your Division is ended any thing remain, you are to annex thereto, the number or numbers that were cut off from the dividend; and such new found number shall be the Remainder.

Et si Divisor adjunctos tibi habeat Circulos ad dextram, omittis circulis & abscessis totidem ultimis Figuris dividendum in numeris reliquis fac divisio, in fine autem divisionis restituentur sunt tum omni circuli, tum figure abscessa. Ought. Cla. Math. cap. 5. 3.

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 258 remaineth after the Work is ended; as by the Work in the Margin.

$$\begin{array}{r}
 4 \overline{) 46658} \quad 116 \\
 \underline{400} \\
 66 \\
 \underline{64} \\
 26 \\
 \underline{24} \\
 258
 \end{array}$$

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 before the dividend, as there are Cyphers 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.

Divisorus quemcumque numerum per 10. Aufer ex dextra parte unicam, eamque primam figuram : Reliqua enim figura productum ostendunt. Ablatum Residuum, &c. Gem. Eris. 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 Parallelagram, 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, &c. *è 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, & *è 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 96 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 a 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 (the Wages of 7 years) by 7 (the number of years) the quotient will be 124 l. for the Answer. See the Work.

$$7 \overline{) 868} \text{ (124}$$

...

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.

$$9 \overline{) 144} \text{ (16 Inches}$$

...

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 breath of that Furlong will make an Acre.

80)

80) 160 (2 *Perches*

160

(0)

Quest. 5. If there be 893 Men to be made up into a Battle, 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* was 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.

$$\begin{array}{r}
 7654 \\
 3242 \\
 \hline
 15308 \\
 30616 \\
 15308 \\
 22902 \\
 \hline
 24814268
 \end{array}$$

And then if you divide the said product 24814268 by 3242 the multiplier, the quotient will be 7654, equal to the given multiplicand,

$$\begin{array}{r}
 3242 \overline{) 24814268} \quad (7654 \\
 \underline{22694} \\
 21202 \\
 \underline{19452} \\
 17506 \\
 \underline{16210} \\
 12968 \\
 \underline{12968} \\
 (0)
 \end{array}$$

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 to 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.

$$\begin{array}{r}
 7654 \\
 3242 \\
 \hline
 15308 \\
 30616 \\
 15308 \\
 22962 \\
 \hline
 7654) 24814268 (3242 \\
 \quad \dots \\
 \quad 22962 \\
 \hline
 \quad 18522 \\
 \quad 15308 \\
 \hline
 \quad 32146 \\
 \quad 30616 \\
 \hline
 \quad 15308 \\
 \quad 15308 \\
 \hline
 \quad (0)
 \end{array}$$

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 tryal whereof let the last Example be again repeated.

3242) 24814268 (7654

....

22694

21202

19452

17506

16210

12968

12968

(0)

For Proof whereof divide again 24814268 by the Quotient 7654, and the Quotient hence will be equal to the first divisor 3242; see the Work.

7654) 24814268 (3242

....

22962

18522

15308

32146

30616

15308

15308

(0)

Rut in proving *Division* by *Division*, the Learner is to observe this 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 42876 by 755, 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 43876, 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.

Ha sunt igitur quatuor illa Species Arithmetices per quas omnia quaecunque deinceps dicenda sunt vel quae per numeros fieri possibile est, absolvantur Quare eas quisquis es ante omnia perdisces.
Gem. Fil. Arith. par. 1.

C H A P. VIII.

Of Reduction.

1. **R**eduction is that which brings together two or more numbers of different denominations into one denomination ; or it serveth to change or alter Numbers, Money, Weight, Measure of Time, from one denomination to another ; and likewise to abridge Fractions to their lowest Terms. All which it doth for 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,

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*.

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 4378 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 a 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 times 38, where I multiply 38 l. by 20, and that 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 inferiour 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 reducing 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.

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 superiour denomination, and when it is so 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 125720 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 125720 farthings. See the whole Work as it followeth.

$$\begin{array}{r}
 1. \\
 20 \overline{) 2640} \quad (132 \\
 \underline{00} \\
 60 \\
 \underline{00} \\
 60 \\
 \underline{00} \\
 40 \\
 \underline{00} \\
 40 \\
 \underline{00} \\
 (0)
 \end{array}$$

$$4) \begin{array}{r} 126720 \\ \dots\dots \end{array} \begin{array}{r} 12) \quad 210) \quad 1. \\ (31680 \quad (2640 \quad (132 \\ \dots\dots \quad \dots \end{array}$$

<u>12</u>	<u>24</u>	<u>2</u>
6	76	6
4	72	6
<u>27</u>	<u>48</u>	<u>4</u>
24	48	4
<u>32</u>	(0)	(0)
32		
<u>(0)</u>		

7. when the number given to be reduced, consisteth of divers denominations, as *pounds, shillings, pence and farthings*, or of *hundreds, quarters, pounds and ounces, &c.* then you are to reduce the highest (or greatest) denomination into the next inferiour, and add thereunto the number standing in that denomination which your greatest or highest number is reduced to; then reduce that Sum into the next inferiour Denomination, adding thereto the number standing in that denomination; do so until you have brought the number given into the denomination proposed. As if it were required to reduce 48 *l.* 13 *s.* 4 *d.* into pence; first, I bring 48 *l.* into shillings, by multiplying it by 20, and the product is 960 shillings, to which I add the 13 shillings, and they make 973, then I multiply 973 by 12, to bring the shillings into pence, and they make 11676 pence, to which I add the 4 pence, and they make 11680 pence for the Answer. See the Work done.

	l.	s.	d.
	48	13	10
	20		
	<hr/>		
	960	<i>(hillings)</i>	
Add	13		
	<hr/>		
Sum	973	<i>(hillings)</i>	
	12		
	<hr/>		
	1946		
	973		
	<hr/>		
	11676	<i>pence</i>	
Add	10		
	<hr/>		
Sum	11686	<i>pence</i>	

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 remaineth 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 *hillings*, and the quotient is 99 *hillings*, and there is a remainder of 7, which is 7 *pence*.

And then I divide 99 *hillings* (the last quotient) by 20, to bring it into *pounds*, and the quotient is 4 *l.* and there remaineth 19 *hillings*; so that I conclude that in 4783 (the proposed number of *farthings*) there is 4 *pounds*, 19 *hillings*, 7 *pence*, 3 *farthings*. View the following Operation.

$$\begin{array}{r}
 \begin{array}{r}
 12) \\
 4) 4783 \text{ (1195 (9) 9 (4 pounds} \\
 \dots \dots \dots
 \end{array} \\
 \hline
 \begin{array}{r}
 4 \quad 108 \quad 8 \\
 \hline
 7 \quad 115 \text{ (19) shillings} \\
 4 \quad 108 \\
 \hline
 38 \text{ rem. (7) pence} \\
 36 \\
 \hline
 23 \quad \text{Facit } 4-19-7-3 \\
 20/
 \end{array}
 \end{array}$$

Rem. (3) farthings

More Examples in Reduction of Coin.

Quest. 1. In 438 l. how many shillings? *Facit* 8760 shillings; for by multiplying 438 by 20, the product amounteth to so much. See the Work.

$$\begin{array}{r}
 438 \text{ pounds} \\
 20 \\
 \hline
 \end{array}$$

Facit 8760 shillings

Quest. 2. In 467 l. how many pence? First, multiply the given number of pounds (467) by 20 to bring it into shillings, and it makes 9340 shillings, then multiply the shillings by 12, and it produceth 112080 pence; thus,

$$\begin{array}{r}
 467 \text{ pounds} \\
 20 \text{ shillings} \\
 \hline
 9340 \text{ shillings} \\
 12 \\
 \hline
 112080 \\
 9340 \\
 \hline
 \end{array}$$

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.

$$\begin{array}{r}
 467 \text{ pounds} \\
 240 \\
 \hline
 18680 \\
 934 \\
 \hline
 \text{Facit } 112080 \text{ pence}
 \end{array}$$

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.

$$\begin{array}{r}
 5673 \text{ pounds} \\
 20 \\
 \hline
 113460 \text{ shillings} \\
 12 \\
 \hline
 226920 \\
 113460 \\
 \hline
 1361520 \\
 4 \\
 \hline
 \text{Facit } 5446080 \text{ farthings.}
 \end{array}$$

Or this 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.

5673

5673 pounds	20 shillings
960	12
<hr/>	<hr/>
340380	240 pence
51057	4
<hr/>	<hr/>
<i>Facit</i> 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
<hr/>	<hr/>
113460 shillings	48 farthings
48	
<hr/>	
907680	
453840	
<hr/>	
<i>Facit</i> 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 shown, 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 number to amount to 440479 farthings, *viz.*

	l.	s.	d.	qrs
	458	16	7	3
	20			
<hr/>				
Add	9160	<i>shillings</i>		
	16			
<hr/>				
Sum	9176	<i>shillings</i>		
	12			
<hr/>				
	18352			
	9176			
<hr/>				
	110112	<i>pence</i>		
Add	7			
<hr/>				
Sum	110119	<i>pence</i>		
	4			
<hr/>				
	440476	<i>farthings</i>		
Add	3			
<hr/>				
Sum	440479	<i>farthings</i>		

This last Question (or any other of this kind, *viz.* where the number given to be reduced consisteth of several denominations) may be more concisely resolved thus, *viz.* when you multiply the *pounds* by 20, to bring them into *shillings*, to the product of the first Figure, add the Figure standing in the place of Units in the denomination of *shillings*, but because the first figure in the Multiplier is (0) I say 0 times 8 is nothing, but 6 is 6, which I put down for the first figure in the product, then because this multiplier is 0, I go on no further with it, for if I should, the whole product would be 0, but proceed, and when I come to multiply by the second figure in the multiplier, and to the product of it, I add the figure standing in the place of Tens in the denomination of *shillings* which

is

is. (1) 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 you now 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.

$$\begin{array}{r}
 \text{l.} \quad \text{s.} \quad \text{d.} \quad \text{qrs} \\
 458-16-7-3 \\
 20 \\
 \hline
 9176 \text{ shillings} \\
 12 \\
 \hline
 18359 \\
 9176 \\
 \hline
 110119 \text{ pence} \\
 4 \\
 \hline
 \text{Facit } 440479 \text{ farthings}
 \end{array}$$

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.

$$\begin{array}{r}
 \begin{array}{r}
 12) \\
 4) 4375866 \quad (1093966 \quad (9116|3 \quad (4548 \\
 \dots\dots\dots \quad \dots\dots \quad \dots\dots
 \end{array} \\
 \begin{array}{r}
 4 \qquad \qquad 108 \qquad \qquad 8 \\
 \hline
 37 \qquad \qquad 13 \qquad \qquad 11 \\
 36 \qquad \qquad 12 \qquad \qquad 10 \\
 \hline
 15 \qquad \qquad 19 \qquad \qquad 11 \\
 12 \qquad \qquad 12 \qquad \qquad 10 \\
 \hline
 38 \qquad \qquad 76 \qquad \qquad 16 \\
 36 \qquad \qquad 72 \qquad \qquad 16 \\
 \hline
 26 \qquad \qquad 46 \qquad \qquad (3) s. \\
 24 \qquad \qquad 36 \\
 \hline
 26 \qquad \qquad (10) d. \\
 24 \\
 \hline
 (2) qrs.
 \end{array}
 \end{array}$$

$$\begin{array}{r}
 \text{Facit } 4558 \text{ l. } 3 \text{ s. } 10 \text{ d. } 2 \text{ qrs.}
 \end{array}$$

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.

$$\begin{array}{r}
 4386 \text{ pounds} \\
 20 \\
 \hline
 87720 \text{ shillings} \\
 3 \\
 \hline
 \text{Facit } 263160 \text{ groats}
 \end{array}$$

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.

$$\begin{array}{r}
 4386 \text{ pounds} \\
 60 \text{ groats in } 20 \text{ s.} \\
 \hline
 \text{Facit } 263160 \text{ groats in } 4386 \text{ l.}
 \end{array}
 \qquad
 \begin{array}{r}
 20 \\
 3 \\
 \hline
 60
 \end{array}$$

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.

$$4) 43758 \begin{array}{c} 2|0 \\ (1093|9 \end{array} \begin{array}{c} l. \\ (546-19-6 \end{array} \begin{array}{c} s. \\ \\ \\ \end{array} \begin{array}{c} d. \\ \\ \\ \end{array}$$

$$\begin{array}{r} 4 \\ \hline 37 \\ 36 \\ \hline 15 \\ 12 \\ \hline 38 \\ 36 \\ \hline \end{array} \quad \begin{array}{r} 10 \\ \hline 9 \\ 8 \\ \hline 13 \\ 12 \\ \hline (19) s. \\ \hline \end{array}$$

(2) three-pences or 6 d.

This Question might have been otherwise resolved thus, viz. first multiply the given number of three pences 43758, by three the number of pence in three pence, and the product (viz. 131274) is the number of pence equal to the given number of three-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 work, viz. 546 l. 19 s. 6 d.

$$\begin{array}{r} 43758 \\ 3 \\ \hline 12) 131274 \end{array} \begin{array}{c} 2|0 \\ (1093|9 \end{array} \begin{array}{c} l. \\ (546-19-6 \end{array} \begin{array}{c} s. \\ \\ \\ \end{array} \begin{array}{c} d. \\ \\ \\ \end{array}$$

$$\begin{array}{r} 12 \\ \hline 112 \\ 108 \\ \hline 47 \\ 36 \\ \hline 114 \text{ re. } (19) s. \\ 108 \\ \hline \end{array} \quad \begin{array}{r} 10 \\ \hline 9 \\ 8 \\ \hline 13 \\ 12 \\ \hline \end{array}$$

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 three-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 $13\frac{1}{2}$ d. 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 makes 2297112, which I divide by 27, (because there are 10 many half-pence in $13\frac{1}{2}d.$ and the quote gives 85078 pieces of $13\frac{1}{2}d.$ and 6 half-pence remain over and above : Observe the Work following.

$$\begin{array}{r} \text{l.} \quad \text{s.} \\ 4785-13 \\ 20 \end{array}$$

$$\begin{array}{r} \text{d.} \\ 13\frac{1}{2} \\ 2 \end{array}$$

95713 shillings
24 half-pence in a shilling

27 half-pence

$$\begin{array}{r} 382852 \\ 191426 \end{array}$$

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. 9. 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.

$ \begin{array}{r} 540 \\ 52 \\ \hline 1080 \\ 2700 \\ \hline 24 \overline{) 28080} \quad \text{l.} \\ \quad \dots \\ \quad 24 \\ \quad \hline \quad 40 \\ \quad 24 \\ \quad \hline \quad 168 \\ \quad 168 \\ \quad \hline \quad (0) \end{array} $	$ \begin{array}{r} \text{s.} \quad \text{d.} \\ 4 \quad 4 \\ \hline 12 \\ \hline 52 \text{ pence} \end{array} $
--	--

The foregoing Question might have been otherwise wrought, thus, *viz.* Multiply (540) your given number of Dollars, by 12 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.

$$\begin{array}{r}
 \begin{array}{r}
 540 \\
 13 \\
 \hline
 1620 \\
 540 \\
 6|0) 702|0 \text{ (117 l.} \\
 \dots \\
 6 \\
 \hline
 10 \\
 6 \\
 \hline
 42 \\
 42 \\
 \hline
 (0)
 \end{array}
 \end{array}
 \begin{array}{r}
 \text{s. - d.} \\
 4-4 \\
 3 \\
 \hline
 13
 \end{array}$$

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.

547386

$ \begin{array}{r} 547386 \\ \underline{\quad 9 \quad} \\ 24) \quad 4926474 \quad (20326 \overline{) 9} \quad (10263 \\ \dots\dots\dots \quad \dots\dots\dots \\ \begin{array}{r} 48 \\ \underline{\quad} \\ 126 \\ 120 \\ \underline{\quad} \\ 64 \\ 48 \\ \underline{\quad} \\ 167 \\ 144 \\ \underline{\quad} \\ 234 \\ 216 \\ \underline{\quad} \end{array} \end{array} $	$ \begin{array}{r} d. \\ 4\frac{1}{2} \\ \underline{\quad 2 \quad} \\ 9 \text{ half-pence} \end{array} $ <table style="width: 100%;"> <tr> <td style="width: 33%;"></td> <td style="width: 33%; text-align: center;">l.</td> <td style="width: 33%; text-align: center;">s.</td> <td style="width: 33%; text-align: center;">d.</td> </tr> <tr> <td colspan="4" style="text-align: center;">Facit 10263—9—9</td> </tr> </table> <table style="width: 100%;"> <tr> <td style="width: 33%;"></td> <td style="width: 33%; text-align: center;">l.</td> <td style="width: 33%; text-align: center;">s.</td> <td style="width: 33%; text-align: center;">d.</td> </tr> <tr> <td></td> <td style="text-align: center;">12</td> <td style="text-align: center;">12</td> <td></td> </tr> <tr> <td></td> <td style="text-align: center;">6</td> <td style="text-align: center;">6</td> <td></td> </tr> <tr> <td></td> <td style="text-align: center;">(9) s.</td> <td></td> <td></td> </tr> </table>		l.	s.	d.	Facit 10263—9—9					l.	s.	d.		12	12			6	6			(9) s.		
	l.	s.	d.																						
Facit 10263—9—9																									
	l.	s.	d.																						
	12	12																							
	6	6																							
	(9) s.																								

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 pounds
240 pence

6
4
2

175440
8772

Sum 12 pence

12) 1052640 (87720
.....

96

92
84

86
84

d. d. d.
Facit 87720 pieces of 6—4—2

24
24

(0)

So that I conclude by the operation that 87720 six pences, and 87720 groats, and 87720 two-pences are just as much as (or equal to) 4386 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 Segments as you please, the Rectangle (or Product) comprehended under the two whole right lines (or numbers given) shall be equal to all the Rectangles (or Products) contained under the whole line (or number) and 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 may 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-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.

<p>l.</p> <p>148</p> <p>240 pence in a l.</p> <hr style="width: 100px; margin-left: 0;"/> <p>5920</p> <p>296</p> <hr style="width: 100px; margin-left: 0;"/> <p>35520 pence in 148 l.</p> <p style="margin-left: 100px;">2</p> <hr style="width: 100px; margin-left: 0;"/> <p>71040 half-pence</p>	<p>d.</p> <p>13½</p> <p>12</p> <p>9</p> <p>6</p> <p>4</p> <hr style="width: 100px; margin-left: 0;"/> <p>Sum 44</p> <p style="margin-left: 100px;">2½</p> <hr style="width: 100px; margin-left: 0;"/> <p>89 half-pence.</p>
--	---

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 Numbers 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.

	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.
	Pieces of $13\frac{1}{2}$ make	44	17	09
	Pieces of 12 make	39	18	00
798	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?

Multiply 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 2780013 Grains, which is the Number required, or Answer to the Question. See the whole Work 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.

24) 2780013 (115833 (5791 (482
.....

24

10

48

38

15

99

24

14

96

140

18

31

120

18

24

200

3

Rem. (7) ounces

192

2

81 Rem. (13) penny-weight

72

93

l. oz. p.w. gr.

72

Facit 482—7—13—21

Quest. 15. A Merchant sent 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.

2 <i>l.</i> 4 <i>oz.</i>
2 — 4
12
—
28
20
—
560 penny-weights
16 Ingots
—
3360
560
—
1248) 8960 (7 Vessels of each
8736
—
224
Rem. (224) penny-weights

2 <i>l.</i> 8 <i>oz.</i> 00 <i>p.w.</i>
2 — 08 — 00
1 — 06 — 00
0 — 10 — 10
0 — 01 — 18
—
Sum 5 — 02 — 08
12
—
62
20
—
1248 <i>p.w.</i>

The Proof of the Work is as followeth, viz.

		l.	oz.	p.w.
7 {	Bowls of 2—08—00 per Bowl is	18	08	00
	Tank. of 1—06—00 per Tank. is	10	06	00
	Salts of 0—10—10 per Salt is	06	01	10
	Spoons of 0—01—18 per Spoon is	01	01	06
	224 penny-weight remaining is	00	11	04
		<hr/>		
		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

Facit 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.

16)	84992	28)	5312	4)	189	C. qr. l.
	(47—1—20
	80		28		16	
	49		251		29	
	48		224		28	
	19		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.

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

42) 490 (11

42

70

42

Facit 11 parcels of each;

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 43 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 Hogheads if you divide them by 63, and the Quote will be 9 Hogheads, and 45 Gallons. See the Work.

$$\begin{array}{r}
 34 \\
 18 \\
 \hline
 272 \\
 34 \\
 \hline
 63 \overline{) 612} \text{ (9 bbs)} \\
 \underline{557}
 \end{array}$$

Rem. (45) gallons
Facit 9 bbs 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.

$$\begin{array}{r}
 12 \\
 4 \\
 \hline
 43 \\
 63 \\
 \hline
 144 \\
 288 \\
 \hline
 14 \overline{) 3024} \text{ (216)} \\
 \underline{28} \\
 22 \\
 14 \\
 \hline
 84 \\
 84 \\
 \hline
 (\bullet)
 \end{array}$$

facit 216 rundl.

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?

$$\begin{array}{r}
 151 \text{ miles} \\
 8 \text{ furlongs in a mile} \\
 \hline
 1208 \text{ furlongs} \\
 40 \text{ poles in a furlong} \\
 \hline
 48320 \text{ poles} \\
 11 \text{ half-yards} \\
 \hline
 48320 \\
 48320 \\
 \hline
 531520 \text{ half-yards} \\
 18 \text{ inches in half a yard} \\
 \hline
 4252160 \\
 531520 \\
 \hline
 9567360 \text{ inches} \\
 3 \text{ barley-corns in an inch} \\
 \hline
 \end{array}$$

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 barley-corns in an inch

Facit 4105728000 barley-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

Reduction of Time.

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

<i>years</i>	<i>weeks</i>	<i>days</i>	<i>hours</i>	<i>min.</i>
28	24	4	16	30
<i>52 weeks in a year</i>				
<hr/>				
60				
142				
<hr/>				
1480	<i>weeks</i>			
7				
<hr/>				
10364	<i>days</i>			
24				
<hr/>				
41462				
20729				
<hr/>				
248752	<i>hours</i>			
60				
<hr/>				
14925150	<i>minutes</i>			

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 but 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.

		<i>weeks days hou.</i>
		24—4—16
		7
		<hr/>
	<i>days hou.</i>	172
28	365—6	24
8766	24	<hr/>
<hr/>	<hr/>	694
172	1466	345
172	730	<hr/>
197	<hr/>	4144 <i>hours</i>
228	8766 <i>hours in a year</i>	
<hr/>		
249592 <i>hours</i>		
60		
<hr/>		

14975520 *minutes in 28 years and 4144 hours.*

So you see that according to the method first used to resolve this Question, the Hours contained in the given time are 248752, but according to the last, best, or true Method, they are 249592, which exceeds the former by 840 hours.

But for most occasions it will be sufficient to multiply the given years by 365, and to the product add the days in the odd time, if there be any, and then there will be only a loss of 6 hours in every year, which may be supplied by taking a fourth part of the given years, and adding it to the contained days, and you have your desire.

Quest. 25. In 438657540 minutes, how many years?
Facit 834 years, 4 days, 19 hours.

610) 438657540 (8766) years days hours
 7310959 (834—4—19

$$\begin{array}{r}
 42 \\
 \hline
 18 \\
 18 \\
 \hline
 6 \\
 6 \\
 \hline
 \end{array}
 \qquad
 \begin{array}{r}
 70128 \\
 \hline
 29815 \\
 26298 \\
 \hline
 35179 \\
 35064 \\
 \hline
 \end{array}$$

$$\begin{array}{r}
 57 \\
 54 \\
 \hline
 35 \\
 30 \\
 \hline
 54 \\
 54 \\
 \hline
 \end{array}
 \qquad
 \begin{array}{r}
 24) 115 (4 \text{ days} \\
 \hline
 96 \\
 \hline
 (19) \text{ hours}
 \end{array}$$

(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 1700 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 14902200 hours, and that by 60, and the product is 894132000 minutes. See the Work.

1700 years

8766 hours in a year

$$\begin{array}{r}
 10200 \\
 10200 \\
 11900 \\
 13600 \\
 \hline
 \end{array}$$

14902200 hours in 1700 years.
 60

894132000 min. in 1700 years

F

Note

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. *Cockers* Decimal Arithmetick, which is (with great care and pains) now published, together with his Logarithmical 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 Mystrious Art, &c.

C H A P. IX.

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

1. **C**omparative 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.

*Boetium Arith.
lib. 1. cap. 21.*

2. Re-

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. Mathematic. lib. 2. cap. 11, & 12.*

4. The relation of Numbers is 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. Mathematic. 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.

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.

$$\begin{array}{r} 64 \\ 4) 8 \quad (2 \\ \hline 128 \\ 1 \\ \hline 1) 127 \quad (127 \end{array}$$

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 subtract the first Term 4, and the remainder is 4092, which I divide by the quote less 1 (viz. 3) and the quote is 1364, for the total sum of all the Terms, as per Margent.

$$\begin{array}{r} 1024 \\ 16) 64 \quad (4 \\ \hline 4096 \\ 4 \\ \hline 3) 4092 \quad (1364 \end{array}$$

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.

$$\begin{array}{r} 486 \\ 6) 18 \quad (3 \\ \hline 1458 \\ 2 \\ \hline \end{array}$$

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

$$2) 1456 \quad (728$$

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 32, 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 Extreams.

F 3

Also

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*.

C H A P. X.

The Single Rule of Three Direct.

1. **T**HE *Rule of Three* (not undeservedly call'd 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 *Proportionals*, viz. 3, 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

sought (*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 the 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 forementioned 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 the forementioned 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

F. 4.

by

by the third, and divide the product thereof by the first, (or which is all one) multiply the third term (or 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 :

$$\begin{array}{ccccccc} & \text{yds} & & \text{s.} & & \text{yds} & & \text{s.} \\ \text{If } 4 & \text{---} & 12 & \text{---} & 6 & \text{---} & 18 \\ & & 6 & & & & \end{array}$$

$$\begin{array}{r} 4 \overline{) 72} \text{ (18 shillings)} \\ \underline{4} \\ 32 \\ \underline{32} \\ 0 \end{array}$$

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 or 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.

$$\begin{array}{r}
 \begin{array}{ccc}
 \text{C.} & \text{l.} & \text{C.} \\
 \text{If } 7 & \text{---} 21 & \text{---} 16 \\
 & 16 & \\
 & \text{---} & \\
 & 126 & \\
 & 21 & \\
 & \text{---} & \\
 & 7) 336 & (48 \text{ l.} \\
 & 28 & \\
 & \text{---} & \\
 & 56 & \\
 & 56 & \text{Fac. 48 l.} \\
 & \text{---} & \\
 & (0) &
 \end{array}
 \end{array}$$

8. If when you have divided the product of the second and third numbers by the first, any thing remains 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 remains, 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 the 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 $\frac{2}{13}$ 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.* 03 *d.* 24 $\frac{2}{13}$ *qrs.* which Fraction is 10 thirteenths of a Farthing. See the Operation as followeth.

$$\begin{array}{r} \text{yds} \quad \text{l.} \quad \text{yds} \\ 13 \text{ } \overline{) 21} \text{ } 27 \\ 27 \end{array}$$

147

42

$$13) 567 \text{ (40 l.)}$$

52

47

39

Remains (8)

Multiply 20

$$3) 160 \text{ (12 s.)}$$

13

30

26

Remains (4)

Multiply 15

$$13) 48 \text{ (3 d.)}$$

39

Remains (9)

Multiply 4

$$13) 36 \text{ (2 } \frac{1}{13} \text{ qrs.)}$$

26

Remains (10) Facit 43—12—3—2 $\frac{1}{13}$

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 according to the last Rule, and you will find it to amount to 921 s. 10 d. 1 $\frac{2}{13}$ qrs. and by the 5th Rule

Rule of the 8th Chapter. 921 s. may be reduced to 46 l. 1 s. So that then the whole worth or value of the 478 l. will be 46 l. 1 s. 10 d. $1\frac{3}{4}$ qrs. the whole Work followeth.

l. s. l.
If 14—27—478
27

3346
956
14) 12906 (921 (46 l.
... ..
126 8
30 12
28 12
26 (1) s.
14

Remains (12)
Multiply 12
24
12

14) 144 (10 d:
14

Remains (4)
Multiply 4

14) 16 ($1\frac{3}{4}$ qr.
14

Remains (2)

l. s. d. qr.
Facit 46—1—10— $1\frac{3}{4}$

9. In the Rule of Three it many times happeneth, that although the first and third numbers be Homogeneous (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 denominations) 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 shillings, 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.

$$\begin{array}{r}
 \begin{array}{cccc}
 \text{oz.} & \text{l.} & \text{s.} & \text{oz.} \\
 15 & 3 & 15 & 86
 \end{array} \\
 \hline
 20 \\
 \hline
 75 \\
 86 \\
 \hline
 450 \\
 600 \\
 \hline
 210 \quad \text{l.} \quad \text{s.} \\
 15) 6450 (430 (21-10 \\
 \dots \dots \\
 60 \quad 4 \\
 \hline
 45 \quad 3 \\
 45 \quad 2 \\
 \hline
 (0) \quad (10) \text{ s.}
 \end{array}$$

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 20640 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 foregoing, 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?

$$\begin{array}{r} 12 \\ \hline 56 \end{array}$$

$$\begin{array}{r} 4 \\ \hline 31 \\ 28 \\ \hline 252 \\ 63 \\ \hline 882 \\ 56 \text{ second number} \end{array}$$

$$\begin{array}{r} 5292 \\ 4410 \\ \hline 8) 49392 \end{array} \quad \begin{array}{r} 12) \\ 6174 \end{array} \quad \begin{array}{r} 210) \\ 514 \end{array} \quad \begin{array}{r} 1. \quad s. \quad d. \\ 25-14-6 \end{array}$$

$$\begin{array}{r} 48 \\ 13 \\ 8 \\ \hline 59 \\ 56 \\ \hline 32 \\ 32 \\ \hline \end{array} \quad \begin{array}{r} 60 \\ 17 \\ 12 \\ \hline 54 \\ 48 \\ \hline \end{array} \quad \begin{array}{r} 4 \\ 11 \\ 10 \\ \hline (14) s. \\ (6) d. \end{array}$$

$$\begin{array}{r} 1. \quad s. \quad d. \\ (0) \quad \text{Facit } 25-14-6 \end{array}$$

Chap. 10. of Three Direct.

III

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. qrs. l.
If 3—1—14 cost 9—9 what will 6—3—20 cost?

4
—
13
28
—

108
27
—

378 pounds

20
—
189

4
—
27
28
—

216
56
—

776 pounds
189 second number

6984
6208
776

378) 146664 (388 2|0 l. s.
19—8

1134 2

3326 18
3024 18

3024 (8) s.
3024

(0)

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, 2238 days equal to 6 years, 48 days. See the Work.

$\begin{array}{r} \text{s.} \quad \text{d.} \quad \text{w.} \quad \text{l.} \quad \text{s.} \\ \text{If } 13-4 \text{ require } 4 \text{ what will } 53-06 \\ \underline{12} \quad \quad \quad \underline{7} \quad \quad \quad \underline{20} \end{array}$

$\begin{array}{r} 30 \\ 13 \\ \hline \end{array} \quad \quad \quad 28 \text{ days} \quad \quad \quad \begin{array}{r} 1066 \\ 12 \\ \hline \end{array}$

160 pence

$\begin{array}{r} 2132 \\ 1066 \\ \hline \end{array}$

12792 pence

28 second number

$\begin{array}{r} 102336 \\ 25584 \\ \hline \end{array} \quad \begin{array}{r} 365 \\ 1610 \end{array} \quad \begin{array}{r} 35817 \\ \dots \end{array} \quad \begin{array}{r} 6 \\ 2238 \end{array} \quad \begin{array}{r} (6 \text{ years}) \\ 2190 \end{array}$

$\begin{array}{r} 32 \\ \hline \end{array} \quad \text{Rem. (48) days}$

$\begin{array}{r} 38 \\ 32 \\ \hline \end{array}$

$\begin{array}{r} 61 \\ 48 \\ \hline \end{array}$

$\begin{array}{r} \text{ye.} \quad \text{days} \\ \text{Facit } 6-48\frac{2}{3} \end{array}$

$\begin{array}{r} 137 \\ 128 \\ \hline \end{array}$

Remains (96)

Quest. 9. 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 one 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.

$$\begin{array}{r}
 \text{days} \quad \text{l.} \quad \text{day} \\
 \text{If } 365 \longrightarrow 73 \longrightarrow 1 \\
 \quad \quad \quad 20 \\
 \hline
 365 \overline{) 1460} \quad (4 \text{ s.} \\
 \quad \underline{1460} \quad \text{Facit 4 s. per day} \\
 \hline
 (0)
 \end{array}$$

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 the 14 pieces.

yd s. d. yds
If 1 cost 13—6½ what will 392 cost?
12 323 the second number

32
13

162
2

half-pence 323

1960
784
1176

24) 127400 (530 8 (265—8—4
... ..
120 4

74 13
72 12

10
200 10
192

(8) shillings

Facit 265l. 8s. 4d. Rem. (8) ½ pence, or 4d.

Quest. 11. A Draper bought 420 yds of broad Cloth, and gave for it after the rate of 14 s. 10 d. ¼ 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 250l. 5 s. 0 d. See the Operation.

1. Ell

Ell		Yards	
1		420	
5		4	
<hr/>		<hr/>	
5 qrs		1680 qrs	
qrs	s.	qrs	
If 5	14	1680	
	12	715	
<hr/>		<hr/>	
28		8400	
15		1680	
<hr/>		<hr/>	
178 d.		11760	
4		9600	
<hr/>		<hr/>	
715 qrs		5) 1201200	(240240) (250 h
	
		10	192
		<hr/>	<hr/>
		20	482
		20	480
		<hr/>	<hr/>
		12	48) 240 (5 s
		10	240
		<hr/>	<hr/>
		20	(0)
		20	
		<hr/>	
		(0)	
l.	s.		
Facit	250—5		

Quest. 12. A Draper bought of a Merchant 50 pieces of Kerseys, each piece containing 34 Ells *Flemish* (the Ell *Flemish* being 3 quarters of a yard) to pay after the 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, then proceed, as in the last Question, and the Answer you will find to be 102000 pence, or 425 l. Behold the Operation, as followeth.

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

First, Find the weight of the 4 *bhds*, which you may do by reducing the weight of one of them into pounds, and multiply them by 4 (the number of *bhds*) 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.

					<i>C.</i> <i>qrs</i> <i>l.</i>		
					6	2	14
					<hr/>		
					4		
					<hr/>		
					26		
					<hr/>		
					28		
					<hr/>		
					212		
					<hr/>		
					53		
					<hr/>		
					742 <i>l.</i> in 1 <i>bhd</i>		
					<hr/>		
					4 <i>hogheads</i>		
					<hr/>		
					2968 <i>l.</i> in 4 <i>bhds</i>		
					<hr/>		
					12) 210		
					<hr/>		
					15423 (128) 5 (64 <i>l.</i>		
					<hr/>		
					12 12		
					<hr/>		
					34 8		
					<hr/>		
					24 8		
					<hr/>		
					102 (5) <i>shillings</i>		
					<hr/>		
					96		
					<hr/>		
					03		
					<hr/>		
					60		
					<hr/>		
					(3) <i>pence</i>		
					<hr/>		
					336		
					<hr/>		
					336		
					<hr/>		
					(0)		
					<hr/>		
					1 <i>s.</i> <i>d.</i>		
					<i>Facit</i> 64—5—3		

Quest.

Quest. 15. A Draper bought of a Merchant 8 packs of Cloth, each pack containing 4 parcels, and each parcel 10 pieces, and in each pieces 26 yards, and gave after the rate of 4 *l.* 16 *s.* for 6 yards, now I desire to know how much he gave for the whole?

Answer, 6656 *l.*

First, find out how many yards there were in the 8 packs, as by the following Work you will find there 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	
				26	
				1920	
				640	
				8320 yds	

yds	l.	s.	yds
If 6	4	16	8320
	20		96
	95		49920
			74880
			210
6)	798720		(133120 (6656 l.

	6		12
	19		13
	18		12
	18		11
	18		10
	7		12
	6		12
	12		(0)
	12		
	(0)		

Facit 6656 *l.*

By

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 Fraills 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 yd. 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 19½ Ells *English* per piece.

Quest. 20. A Draper bought 242 Yards of Broadcloth, 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.* ⅔ 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 ⅔ *d.* 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 gallon? *Answer*, at 4 s. 6 $\frac{1}{2}$ $\frac{1}{4}$ 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 years 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. 6 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 $\frac{1}{2}$ $\frac{2}{3}$ 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, the other 5 miles a day, how far are they distant the 9th day after their departure? *Answer*, 81 Miles.

Quest.

Quest. 32. A flying every day 40 miles is pursued the 4th day after by B, posting 50 miles a day, now the Question is in *More's Arithm.* how many days, and after how many miles Travel will A be overtaken? *Chap. 7. Ex. 35.*

Answer, B overtakes him in 12 days, when they have travelled 600 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 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 1) 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 have 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 multiply 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 72, 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 you have divided the product of the second and third numbers by the first, such remainder in proving the same, must be added to the product of the first and fourth Numbers, whose Sum will be equal to the Product of the second and third, (the second number being of the same denomination with the fourth, and the first of the same denomination with the third.)

So the fourth Question of this Chapter, being again repeated, viz. If 14 *l.* of Tobacco cost 27 *s.* what will 478 *l.* cost at that rate? The Answer (or fourth number) was 46 *l.* 01 *s.* 10 *d.* 1 *qr.* $\frac{1}{2}$, which is thus proved, viz. bring the fourth number into farthings, and it makes 44249, which multiplied by the first number 14, produceth 619488 (the second which remaineth being added thereto) then (because I reduce my fourth number into farthings,) I reduce my second (viz. 27 *s.*) into farthings, and they are 1296, which multiplied by the third number 478, their product is 619488 equal to the product of the first and fourth Numbers. Wherefore I conclude the Operation to be true. This is an infallible way to prove the Rule of Three Direct, and it is deduced from the 12th Section of the 9th Chapter of this Book.

Thus much concerning The Single Rule of Three Direct, and I question not but by this time the Learner is sufficiently qualified to resolve any Question pertinent to this Rule, not relying upon Fractions, or Geometrical Magnitudes. Those that are desirous to see the Demonstration of this Rule, let them read the sixth Chapter of (the ingenious) Mr. Kersey's Appendix to Wingate's Arithmetick. Or the sixth Chapter of Mr. Oughtred's (incomparable) *Clavis Mathematica*: By both which Authors this Rule is largely demonstrated, being grounded upon the 19th Prop. of the 7th, and the 19th Prop. of the 9th of Euclid. Elem.

C H A P. XI.

The Single Rule of Three Inverse.

1. **T**HE 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 second, 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. Math. 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 3 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 4th term sought in an Inverted Proportion. The same order being observ'd 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 Extream

stream 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 belongs 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 6th Rule of the 10th 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.

<i>lab.</i>	<i>days</i>	<i>lab.</i>
8	12	16
	8	
	—	
16)	96	(6 days
	96	
	—	
	(0)	
	<i>Facit</i> 6 days.	

Quest. 2. If when the measure (*viz.* a peck) of Wheat cost 2 shillings, the penny 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 10th 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 increaseth, 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

18) 240 (13 p.w.

..

18

60

54

(6)

24

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.

s. pieces s.
If 12—240—20
12

480
240

2|0) 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.

grs.—long—grs
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 Courtesie 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, multi-
ply

ply 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 1000 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 Cloth, 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,* 1666 $\frac{2}{3}$ quarters of yards, or 4166 $\frac{2}{3}$ yards.

Quest. 14. 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 days is 16 hours long? *Answer,* in 18 days.

Quest. 16. Borrowed of my Friend 64 l. for 8 months, and he hath occasion another time for 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. 4 d.

4. 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 measure 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 those 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 foregoing 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 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.

C H A P. XII.

The Double Rule of Three Direct.

WE have already delivered the *Rules 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 given more than 3 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 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, 12, and 6; for it is said, if (or suppose) 100 *l.* 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 required, 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 forementioned 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, 100—6—75 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 signify pounds principal) and then the Numbers will stand as you see in the Margent.

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* 12—6—9 in the Demand which hath the same Denomination with the first, viz. 9 months, and then they will stand as in the Margent.

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 this,

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 third Rule of the eleventh Chapter I find to be *Direct*, and by the 7th and 8th Rules of the 10th 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 fourth number (thus found) I put in the middle between the two lowest numbers of the five, after they are placed according to the seventh 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

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 12—5—9 according to the second method, viz. as 100 75 you see in the Margent.

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 *l.* 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 *l.* 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 *l.* 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 *l.* 50 miles at that rate? *Answer*, 36 *s.* 9 *d.*

Quest. 3. A Regiment of 936 Soldiers eat up 351 quarters of Wheat in 168 days, I demand how many quarters of Wheat 11232 Soldiers will eat in 56 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.

C H A P. XIII.

The double Rule of Three Inverse.

1. **T**HE 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, will stand as followeth.

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

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 11th Chapter) is *Inverse*, and the answer will be found (by the 2d Rule of the 11th Chapter) to be 133 *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 I say,

$$\begin{array}{r}
 \begin{array}{ccc}
 m. & l. & m. \\
 \text{If } 12 & \text{---} 100 & \text{---} 9
 \end{array} \\
 \quad \quad \quad 12 \\
 \quad \quad \quad \text{---} & l. & s. & d. \\
 9) 1200 & (133 & \text{---} 6 & \text{---} 8 \\
 \quad \quad \quad \dots & & & \\
 \quad \quad \quad 9 & & & \\
 \quad \quad \quad \text{---} & & & \\
 \quad \quad \quad 30 & & & \\
 \quad \quad \quad 27 & & & \\
 \quad \quad \quad \text{---} & & & \\
 \quad \quad \quad 30 & & & \\
 \quad \quad \quad 27 & & & \\
 \quad \quad \quad \text{---} & & & \\
 \quad \quad \quad (3) & & & \\
 \quad \quad \quad 20 & & & \\
 \quad \quad \quad \text{---} & & & \\
 9) 60 & (6 s. & & \\
 \quad \quad \quad 54 & & & \\
 \quad \quad \quad \text{---} & & & \\
 \quad \quad \quad (6) & & & \\
 \quad \quad \quad 12 & & & \\
 \quad \quad \quad \text{---} & & & \\
 9) 72 & (8 d. & & \\
 \quad \quad \quad 72 & & & \\
 \quad \quad \quad \text{---} & & & \\
 \quad \quad \quad (0) & & &
 \end{array}$$

Then

Then I say,

<i>l.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>
If 6	133	6	8	3	7	6
240	20			20		
<hr/>						
1440 <i>d.</i>	2666			67		
	12			12		
<hr/>						
	5340			140		
	2666			67		
<hr/>						
	32000			810 <i>d.</i>		
	810					
<hr/>						
	320000					
	256					
<hr/>						
1440	2592000	0	240	1800	0	75 <i>l.</i>
.....						
144	168					
<hr/>						
1152	120					
1152	120					
<hr/>						
(0)	(0)					

So that by the foregoing 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. 4. If 48 l. serve 12 Students 8 Weeks, how many Weeks will 288 l. serve 4 Students? *Answer,* 144 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,* 35 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 satisfied 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.

C H A P. XIV.

The Rule of Three composed of five Numbers.

1. **T**HE Rule of Three Composed, 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 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 the 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 675, for the third term. Then I say, as 1200 is to 6, so is 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.

3. 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 serve for thy farther Experience.

CHAP. XV.

Single Fellowship.

- F**ELLOWSHIP 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 Gain or Loss, 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 Mans 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.*

$$\begin{array}{r} 12 \\ 8 \\ \hline 20 \end{array}$$

(the Stock of A) require? Multi-

ply and Divide by the 7th Rule of the ninth Chapter, and the Answer is 3 *l.* for the share of A in the 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.*

$$\begin{array}{r} \text{l.} \quad \text{l.} \quad \text{l.} \\ \text{If } 20 \text{ --- } 5 \text{ --- } 12 \\ \quad \quad 12 \end{array}$$

$$\begin{array}{r} 20 \overline{) 60} \quad (3 \text{ l.} \\ \underline{60} \end{array}$$

$$\begin{array}{r} \text{l.} \quad \text{l.} \quad \text{l.} \\ \text{If } 20 \text{ --- } 5 \text{ --- } 8 \\ \quad \quad 8 \end{array}$$

$$\begin{array}{r} 20 \overline{) 40} \quad (2 \text{ l.} \end{array}$$

Quest. 2. Three Merchants, viz. A, B, and C, enter upon a joint 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 Accounts) that they have gained in all 264 *l.* now I desire to know each Man's particular share in the gains?

First, I add their particular stocks together, and their Sum is 429 *l.* then I 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 that

$$\begin{array}{r} \text{l.} \\ 78 \\ 117 \\ 234 \\ \hline \text{Sum } 429 \end{array}$$

$$\begin{array}{r} \text{l.} \\ \text{The Gain of } \left\{ \begin{array}{l} \text{A} \\ \text{B} \\ \text{C} \end{array} \right\} \text{ is } \left\{ \begin{array}{l} 48 \\ 72 \\ 144 \end{array} \right\} \\ \hline \text{Sum } 264 \end{array}$$

Quest.

Quest. 3. Four Partners, viz. A, B, C, and D, between them built a Ship which cost 1730 *l.* of which A paid 346 *l.* B 519 *l.* C 692 *l.* and D 173 *l.* and her Freight for a certain Voyage is 370 *l.* which is due to the Owners or Builders, I demand each Man's Share therein according to his Charge in building her.

Answer,

	<i>l.</i>
A	74
B	111
C	148
D	37

Sum 370

Quest. 4. A, B, and C, enter Partnership for a certain time, A put into the common stock 364 *l.* B put in 482 *l.* C put in 500 *l.* and they gained 867 *l.* now I demand each Man's Share in the Gain proportionable to his Stock.

Answer,

	<i>l.</i>	<i>s.</i>	<i>d.</i>
A	234	09	3 $\frac{1}{4}$
B	310	09	5 $\frac{1}{4}$
C	322	01	3 $\frac{1}{4}$

Sum 867—00—0

5. To prove the Rule of *Single Fellowship*, add each Man's particular Gain or Loss together, and if the total Sum is equal to the general Gain or Loss, then is the Work rightly performed, but otherwise it is Erronious. Example, In the first Question of this Chapter, the *Answer* was that the Gain of A was 3 *l.* and the Gain of B 2 *l.* which added together make 5 *l.* equal to the total Gain given.

IF

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 make 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.

C H A P. XVI.

Double Fellowship.

1. **D**ouble Fellowship is when several Persons enter into *Partnership* for unequal time, that is, when every Man's *particular Stock* hath 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 ones *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 4 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

A

B

gained

gained 70*l.* now I demand each Man's share in the 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.* 40*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 so is 300 (the product of B his Stock and time) to 50*l.* (the share of B in the gains.) And so much ought each to have for his share.

1.	1.
40	75
3	4
<hr/>	<hr/>
A 120	B 300
	420
	<hr/>
	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 4 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 of 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 continu- }
 ed 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) 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 multipli'd together produce

1336

The Sum of the product of th: Money and Time of C is

2950

B

4466

A

4688

The Total Sum of all the product is

12104

Then I say, as 12104 is to 1436 (the total gain) so is 4688 to the share of A in the gains, &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 }	556	03	6
{ B }	529	16	9
{ C }	349	19	3
Sum	1436	00	0

Quest. 3. Three Graziers, A, B, and C, take a piece of Ground for 46 l. 10 s. in which A put in 12 Oxen for 8 months, B put in 16 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 } shall pay {	18	00
B } {	15	00
C } {	13	10
	46	10

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 among *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.

C H - A P. XVII.

Alligation Medial.

1. **T**HE 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 proportion is,

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 minglcth 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 one 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.	s.
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 the 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 bushel worth?

bush.	l.	s.	bush.
96	14	8	1

20
96) 288 (3s.

288

(0).

Facit, 3s. per Bushel.

Quest. 2. A Vintner minglcth 15 Gallons of Canary at 8s. per Gallon, with 20 Gallons of Malaga at 7s. 4d. per Gallon, with 10 Gallons of Sherry at 6s. 8d. per Gallon, and 24 Gallons of White-wine at 4s. 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 6s 2d. 2qrs. $\frac{4}{5}$.

Quest. 3: A Grocer hath mingled 3 C. of Sugar at 36 s. per C. with 3 C. of Sugar at 3 l. 14s. 8d. per C. and with 6 C. at 1 l. 17 s. 04 d. per C. I desire to know the price of an hundred weight of that mixture?
Answer, 2 l. 11 s. 4 d.

3. The proof of this Operation 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 3s. 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,* 14l. 8s. which is the total value of the several simples, wherefore the Work is right.

C H A P. XVIII.

Alligation Alternate.

1. **A**lligation Alternate is when there are given the particular prices of several simples, and thereby we discover such quantities of those simples, as being mingl'd 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 springing from it, as in the following example.

Quest. 1. A certain Farmer is desirous to mix 20 bushels of Wheat at 5s. or 60d. per bushel, with Rye at 3s. or 36d. per bushel, and with Barley at 2s. or 24d. per bushel, and Oats at 1s. 6d. 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 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.

$$32 \left\{ \begin{array}{l} 60 \text{ pence.} \\ 36 \\ 24 \\ 18 \end{array} \right.$$

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,

$$32 \left\{ \begin{array}{l} 60 \\ 36 \\ 24 \\ 18 \end{array} \right. \curvearrowright$$

2. Or thus,

$$32 \left\{ \begin{array}{l} 60 \\ 36 \\ 24 \\ 18 \end{array} \right. \curvearrowright$$

3. Or thus,

$$32 \left\{ \begin{array}{l} 60 \\ 36 \\ 24 \\ 18 \end{array} \right. \curvearrowright$$

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

$$32 \left\{ \begin{array}{l} 60 \\ 36 \\ 24 \\ 18 \end{array} \right. \curvearrowright \begin{array}{l} 14 \\ 8 \\ 4 \\ 28 \end{array}$$

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*, $11\frac{2}{7}$ bushels of Rye.

Again, if 14 bushels of Wheat require 4 bushels of Barley, what will 20 bushels of Wheat require? *Answer*, $5\frac{2}{7}$ 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 $11\frac{2}{7}$ bushels of Rye, and $5\frac{2}{7}$ 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 differences 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
		18		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 70 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 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 $29\frac{2}{3}$ bushels of Barley. As 22 is to 32, so is 20 to $29\frac{2}{3}$ 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 3d. Rule of the 17th Chap.

The Proof of Alternation partial.

Quest. 2. A Grocer hath 4 sorts of Sugar, viz. of 12d. per l. of 10d. per l. of 6d. per l. and of 4d. per l. and he would have a composition worth 8d. 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 4th Rule of this Chapter, which will then stand one of these three ways, viz.

First.

12	4
10	2
6	2
4	4

Second.

12	2
10	4
6	4
4	2

Third

12	2, 4	6
10	2, 4	6
6	4, 2	6
4	4, 2	6

24

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 8d. per l.

l.

As 12 is to 4, so is 144 to 48 l. at 12d. per l.

As 12 is to 2, so is 144 to 24 l. at 10d. per l.

As 12 is to 2, so is 144 to 24 l. at 6d. per l.

As 12 is to 4, so is 144 to 48 l. at 4d. per l.

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 l. at 4 d. per l. will make a composition of Sugar containing 144 l. worth 8 d. per l.

But as the branches are linked in the second order, the answer 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 said quantity, and to bear the said 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.

Quest. 3 A Vintner hath four sorts of Wine, viz. Canary at 10s. per Gallon, Malaga at 8s. per Gallon; Rhenish-wine at 6s. per Gallon; and White-wine at 4s. per Gallon, and he is minded to make a Composition of them all of 60 Gallons that may be worth 5 shillings per Gallon, I desire to know how much of each he must have?

The numbers of terms being ranked according to the second Rule of this Chapter, the branches will be linked as followeth, and will admit of no other manner of coupling, because there is but one branch that is lesser than the Root; therefore all the rest must be linked unto it; and the differences between the Root and the three first branches, viz. 10, 8, and 6, which are 5, 3, and 1, must be set a-

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

gainst 4, because they are all coupled with it, and the difference between the Root, (viz. 5.) and 4, which is 1, must be set against the three other, because it is linked to them all; so I find 1 Gallon of Canary, 1 Gallon of Malaga, 1 Gallon of Rhenish-wine, and 9 Gallons of White-Wine, prized as above being mingled together, will be worth 5s. per Gallon, the sum being 12 Gallons, but there must be 60 Gallons; wherefore I say,

As 12 is to 1, so is 60 to 5 Gallons of Canary.

As 12 is to 1, so is 60 to 5 Gallons of Malaga.

As 12 is to 1, so is 60 to 5 Gallons of Rhenish.

As 12 is to 9, so is 60 to 45 Gallons of White-wine.

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 5s. per gallon, which was required.

Quest. 4. A Goldsmith hath Gold of 4 several sorts of fineness, viz. of 24 Carets fine, and of 22 Carets fine, of 20 Carets fine, and of 15 Carets 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 Carets 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.

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, 3	10
		0	5, 3	8

Sum 56

Thirdly thus,

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

Sum 41

Fourthly thus,

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

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 the understanding of Alligation.

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.m. of 24 Carects fine, 10 oz. of 22 Carects fine, 9 oz. 10 p.m. 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. **W**hat a Vulgar Fraction is, and its parts and several kinds, hath been already shewed in the

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 the Fraction 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.
defn. 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 $18\frac{3}{7}$, for the Answer, as followeth.

$$\begin{array}{r} 18\frac{1}{2} \\ 7 \\ \hline \end{array}$$

129
facit

$$\begin{array}{r} 129 \\ 7 \\ \hline \end{array}$$

2. Reduce $183\frac{1}{2}$ to an improper fraction, *facit* $367\frac{1}{2}$
 3. Reduce $36\frac{1}{2}$ to an improper fraction, *facit* $73\frac{1}{2}$.

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 *Vide Chap. 1. defn. 23.*
for Example.

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 $15\frac{0}{12}$ which is equal to 15, as was required, as per Margent.

$$\begin{array}{r} 15 \\ 12 \\ \hline 30 \\ 15 \\ \hline 180 \end{array}$$

2. Reduce 36 into an improper fraction whose denominator shall be 26, *facit* $936\frac{0}{26}$.

3. Reduce 135 into an improper fraction whose denominator shall be 16, *facit* $2160\frac{0}{16}$.

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 $4\frac{36}{8}$ into its equivalent mixt number, divide the Numerator 36 by the denominator 8, and the quotient is 4, and 4 remains, which put for a numerator over the divisor 8, the Answer is $54\frac{4}{8}$, as followeth,

$$8) 436 \text{ (} 54\frac{4}{8} \text{)}$$

40

36

facit $54\frac{4}{8}$

32

4

2 Reduce $2\frac{42}{7}$ to a mixt number, facit $23\frac{1}{7}$.

3. Reduce $1\frac{12}{3}$ to a mixt number, facit $14\frac{2}{3}$.

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 of the one, and half of the other as often as may be, and when either of them falls 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 halving still 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 I conclude $\frac{4}{7}$ thus found to be equal in value to the given *fraction* $\frac{1}{1}\frac{2}{2}$.

2. What is $\frac{1}{1}\frac{1}{1}\frac{1}{2}$ in its lowest terms? Answer $\frac{7}{8}$.

3. What is $\frac{1}{1}\frac{1}{1}\frac{1}{2}$ in its lowest terms? Answer $\frac{1}{1}\frac{1}{2}$.

There is yet another way more excellent than the former to reduce a *fraction* into its lowest terms, and that is by finding *Vide Ought. Cla.* 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, which will divide both numerator and denominator, and reduce them into their lowest terms at one Work.

Example.

4. Reduce $\frac{1}{1}\frac{2}{2}\frac{1}{1}$ 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 $\frac{1}{1}\frac{2}{2}\frac{1}{1}$ equal to $\frac{3}{4}$.

5. Reduce $\frac{5}{7}\frac{1}{1}\frac{1}{2}$ into its lowest terms by a common measurer, *facit* $\frac{1}{1}\frac{1}{2}$.

6. Reduce $\frac{3}{1}\frac{1}{1}\frac{1}{2}$ into its lowest terms by a common measurer, *facit* $\frac{1}{1}\frac{1}{2}$.

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.* $\frac{1}{1}\frac{1}{1}\frac{1}{2}$ will be found to be reduced to $\frac{1}{1}\frac{1}{2}$, by

by cutting off the two Cyphers from the numerator and denominator, with a dash of the Pen thus, $\frac{14}{4} \frac{00}{00}$, and $\frac{4}{5} \frac{00}{00}$, will be $\frac{4}{5}$, thus $\frac{4}{5} \frac{00}{00}$, &c.

V. To find the Value of a Fraction in the known parts of Coyn, Weight, &c.

The Rule is,

Multiply the *numerator* by the parts of the next inferior *denomination* that are equal to an Unit of the same *denomination* with the *Fraction*; then divide that Product by the *denominator*, and the quote gives you its value in the same parts you multiplied by, and if any thing remain multiply it by the parts of the next inferior *denomination*, and divide as before, do so till you can bring it no lower, and the several quotients will give you the value of the *Fraction* as was required, and if any thing at last remain, place it for a *numerator* over the former *denominator*; some few Examples will make the Rule plain.

1. What is the value of $\frac{27}{29}$ l. *Sterling*? To answer this Question I multiply the *numerator* 27 by 20 (the shillings in a pound) the product is 540, which I divide by 29 (the *denominator*) and the quotient is 18s. and there remains 18, which I multiply by 12 pence, and the product (216) I divide by the denominator 29, the quotient is 7d. and 13 remains, which I multiply by 4 Farthings, the product is 52, which I still divide by 29, the quotient is 1 Farthing, and there remaineth 23, which I put for a numerator over the denominator 29, so I find the value of $\frac{27}{29}$ l. to be 18s. 7d. 1qr. $\frac{23}{29}$, as by the following Operation, and after the same manner are the values of the *Fractions* in the several Examples following found out.

$\frac{27}{12}l.$

27
Multiply 20

29) 540 (18s. 7d. $1\frac{2}{3}gr.$

29

250

232

Remains (18)

Multiply 12

36

18

29) 216 (7d.

203

Remains (13)

Multiply 4

$gr.$

29) 52 ($1\frac{2}{3}$

29

Remains (23)

s. d. $gr.$

Facit 18s. 7d. $1\frac{2}{3}gr.$

2. What is the value of $\frac{1}{4}l.$ Sterling? Facit 14s. 8d.

3. What is the value of $\frac{1}{2}l.$ Sterling? Facit 4s.

1d. $\frac{1}{12}gr.$

4. What is $\frac{1}{2}C.$ weight? Facit 3 qrs. 1l. 5oz. $\frac{1}{2}gr.$

5. What is $\frac{1}{4}l.$ Troy weight? Facit 3oz. 5p.w.

22 $\frac{1}{3}gr.$

6. What is $\frac{1}{3}$ of a year? Answer, 299 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 shewed 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.*

L. Reduce $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{1}{2}$ 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 $\frac{1}{4}$ equal to $\frac{1}{4}$ by the fourth Rule foregoing.

5	3
3	2
—	—
15	6
8	5
—	—
120	30

Facit, $\frac{1}{4}$ or $\frac{1}{4}$ or $\frac{1}{4}$.

2. What is $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{1}{2}$? *Answer,* $\frac{1}{5}$ or $\frac{1}{5}$ or $\frac{1}{5}$ in its least terms.

3. What is $\frac{1}{2}$ of $\frac{1}{3}$ of $\frac{2}{3}$? *Answer,* $\frac{1}{9}$.

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 3th Rule foregoing.

Exam-

Example.

What is the value of $\frac{1}{4}$ of $\frac{1}{2}$ of $\frac{1}{4}$ of a pound?

Answer, 11s. 3d.

VII. To reduce Fractions of unequal Denominators to 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 $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, and $\frac{1}{8}$, 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. $\frac{1}{5}$, and I multiply 4 (into all the Denominators except its own, viz.) into 4, 6, and 8, which produceth $\frac{24}{960}$ equal to $\frac{1}{5}$, then multiply the Numerator 5 into the denominators 4, 5, and 8, the product is $\frac{40}{960}$ equal to $\frac{1}{6}$. Then multiply the numerator 7 into the denominators 4, 5, and 6, the product is $\frac{280}{960}$ equal to $\frac{7}{8}$, and the work is done; so that for $\frac{3}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, and $\frac{7}{8}$, I have $\frac{720}{960}$, $\frac{24}{960}$, $\frac{40}{960}$, $\frac{280}{960}$.

2. Reduce $\frac{1}{12}$, $\frac{1}{14}$, and $\frac{1}{16}$, into a common denominator, *faciunt* $\frac{14}{168}$, $\frac{12}{168}$, and $\frac{10}{168}$.

VIII.

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 6th 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 $\frac{3}{4}$ of a penny is?

To resolve this, I consider that 1d. is $\frac{1}{20}$ of a shilling, and a shilling is $\frac{1}{20}$ of a pound; wherefore $\frac{3}{4}$ d. is $\frac{3}{4}$ of $\frac{1}{20}$ of $\frac{1}{20}$ of a pound, which by the said 6th Rule I find to be $\frac{3}{1600}$ of a l. 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 $\frac{1}{12}$ of $\frac{1}{20}$ l. equal to $\frac{1}{150}$ l. Troy.

3. When a Fraction is to be brought from a greater to a lesser denomination, then 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 $\frac{3}{4}$ 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 4, it makes 225 of a penny, equal to $\frac{3}{4}$ l.

Quest. 4. What parts of 32 Ounce Troy is $\frac{1}{2}$ l.? Answer, $\frac{7}{8}$ oz.

C H A P. 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 all the given Fractions; and if it be improper, reduce it to a whole or mixt number, by the 3^d. Rule of the 19th. 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 $1\frac{23}{12}$, or $1\frac{1}{2}$.

2. But if the fractions to be added have unequal Denominators, then reduce them to a common Denominator by the 7th Rule of the 19th 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 $\frac{3}{8}$, $\frac{7}{8}$, $\frac{9}{8}$, and $\frac{11}{8}$?

The fractions reduced to a common Denominator are $\frac{3880}{8000}$, $\frac{4100}{8000}$, $\frac{4120}{8000}$, and $\frac{4430}{8000}$, the sum of their Numerators is 15800, which put over the common Denominator, makes $\frac{15800}{8000}$ or $\frac{158}{80}$, equal to the mixt number $3\frac{14}{10}$, or $3\frac{7}{5}$ for the sum required.

Quest. 3. What is the sum of $\frac{11}{12}$, $\frac{3}{4}$, and $\frac{1}{6}$?

Answer, $1\frac{1}{2}$.

3. 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 $13\frac{1}{2}$ and $24\frac{1}{2}$?

First

First add the *fractions* $\frac{3}{4}$ and $\frac{5}{8}$, the sum is $1\frac{11}{8}$, then add this Integer 1, to 13 and 24, their sum is 38, and put after it the *fraction* $\frac{11}{8}$ it is $38\frac{11}{8}$ for the *Answer*, or it is $38\frac{3}{2}$.

Quest. 5. What is the sum of $48\frac{1}{2}$, $64\frac{1}{4}$, and $130\frac{3}{4}$? *facit*, $243\frac{18}{4}$, or $243\frac{9}{2}$.

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 2d. Rule of this Chapter. Example,

Quest. 6. What is the sum of $\frac{1}{4}$, $\frac{5}{8}$, and $\frac{7}{8}$ of $\frac{1}{4}$ of $\frac{5}{8}$?

Reduce $\frac{7}{8}$ of $\frac{1}{4}$ of $\frac{5}{8}$ into a simple *fraction*, and it is $\frac{10}{128}$, which reduced with the other two, and added are $2\frac{60}{128}$.

Quest. 7. What is the sum of $\frac{1}{2}$ and $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$?

Answer, $1\frac{1}{2}$.

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 $\frac{1}{4}$ l. and $\frac{5}{8}$ s.?

Of the given *Fractions* here; one is of a pound and the other the *Fraction* of a shilling; and before you can add them together, you must reduce $\frac{5}{8}$ s. to the *Fraction* of a pound as the other is (by the 8th Rule of Chapter 19.) and it makes $\frac{5}{16}$ l. then $\frac{1}{4}$ l. and $\frac{5}{16}$ l. will be found to be $\frac{9}{16}$ l. or $\frac{3}{4}$ l. by the 7th Rule of Chapter 19, and in its lowest terms $\frac{3}{4}$ 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 $\frac{1}{4}$ l. to the *Fraction* of a shilling, which you would have found to have been $\frac{5}{8}$ s. which added to $\frac{5}{8}$ s. by the said 17th Rule of the last Chap. the sum is 15 s. $\frac{2}{4}$, which is equal to the sum found as before, viz. $\frac{3}{4}$ l. for (by the 5th Rule of Chapter 19.) the value of $\frac{3}{4}$ l. will be found to be 15 s. 10 d. and so will 15 s. $\frac{2}{4}$ be found to be just as much.

Quest. 9. What is the Sum of $\frac{1}{2}l.$ $\frac{1}{2}s.$ and $\frac{1}{2}d.$ *Answer,* $\frac{2}{3}l.$ $\frac{1}{3}s.$ or $\frac{2}{3}l.$ or in its lowest terms $\frac{1}{3}l.$

C H A P. XXI.

Subtraction of Vulgar Fractions.

I. **T**HE 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 $\frac{1}{2}$ and $\frac{1}{3}$? The given *fractions* are reduced to $\frac{2}{6}$ and $\frac{2}{6}$, 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 $\frac{1}{2}$ and $\frac{1}{3}$.

Quest. 2. What is the difference between $\frac{1}{2}$ and $\frac{1}{3}$ of $\frac{1}{4}$?

Reduce the compound *fraction* of $\frac{1}{2}$ of $\frac{1}{4}$ to a simple *fraction*, then proceed as before, and the answer is $\frac{1}{8}$ equal to $\frac{1}{8}$.

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*, & 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, $47\frac{3}{10}$; 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 join $\frac{3}{10}$ and it makes $47\frac{3}{10}$ for the excess.

Quest. 4. Subtract $\frac{1}{2}$ from 57. makes $56\frac{1}{2}$

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 $54\frac{5}{7}$.

First, Subtract $\frac{3}{7}$, viz. $\frac{1}{2}$ from $\frac{5}{7}$, viz. $\frac{4}{7}$, the remainder is $\frac{4}{7}$, then 26 from 54 remaineth 28, to which annex $\frac{4}{7}$, it makes $28\frac{4}{7}$ 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 $22\frac{1}{2}$.

The *fractions* reduced are, viz. equal to $\frac{3}{4}$, and $\frac{1}{2}$ equal to $\frac{2}{4}$, now I should subtract $\frac{3}{4}$ from $\frac{2}{4}$, 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. $\frac{23}{4}$, 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 $\frac{23}{4}$ it is $14\frac{23}{4}$ for the remainder or difference between $14\frac{3}{4}$ and $22\frac{1}{2}$.

Quest. 7. Subtract $36\frac{1}{2}$ from $74\frac{4}{5}$, facit $37\frac{3}{10}$.

C H A P. XXII.

Multiplication of Vulgar Fractions.

1. **I**F the Multiplicand and Multiplier are simple (or single) Fractions, 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 $\frac{18}{33}$ by $\frac{21}{37}$? *fac.* $\frac{378}{1221}$.
2. If the Fractions to be multiplied are mixt numbers, reduce them to improper Fractions by the 1st Rule of the 19th Chapter, then proceed as before.

Quest. 3. What is the product of $48\frac{3}{4}$ by $13\frac{5}{8}$?
The given mixt numbers being reduced to improper Fractions, are $48\frac{3}{4}$ equal to $24\frac{3}{4}$, and $13\frac{5}{8}$ equal to $10\frac{5}{8}$, now $24\frac{3}{4}$ multiplied by $10\frac{5}{8}$ according to the first Rule of this Chapter, produceth $250\frac{15}{8}$ or $672\frac{3}{4}$.

Quest. 4. What is the product of $430\frac{5}{10}$ by $18\frac{3}{7}$?
facit, $5142\frac{4}{7}$ 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 $\frac{2}{3}$ of $\frac{4}{5}$ of $\frac{3}{4}$ of $\frac{5}{6}$?
The Compound Fraction $\frac{2}{3}$ of $\frac{4}{5}$ of $\frac{3}{4}$ reduced is $\frac{2}{5}$ or $\frac{2}{5}$, which multiplied by $\frac{5}{6}$ produceth $\frac{2}{6}$, which in its lowest terms is $\frac{1}{3}$ 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 $\frac{1}{2}$ of $\frac{2}{3}$ by $\frac{2}{3}$ of $\frac{1}{2}$?
Answer, $\frac{1}{3}$, in its lowest terms $\frac{1}{3}$.

Quest. 7. What is the product of $\frac{2}{3}$ of $\frac{4}{5}$ by $\frac{2}{3}$ of $\frac{5}{6}$?
Answer,

Answer, $\frac{6}{1}$ or $\frac{6}{1}$ or in its least terms $\frac{6}{1}$.

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 $\frac{2}{11}$? *Answer*, $\frac{72}{11}$ or $29 \frac{8}{11}$.

C H A P. 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 $\frac{3}{5}$ divided by $\frac{5}{8}$?

Answer, $\frac{24}{25}$ or $1 \frac{4}{25}$, 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 $\frac{24}{25}$ is the quotient sought.

Quest. 2. What is the quotient of $\frac{1}{2}$ divided by $\frac{2}{3}$?

Answer, $\frac{3}{4}$ equal to $\frac{3}{4}$ 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 $\frac{3}{7}$ divided by $\frac{2}{3}$ of $\frac{3}{4}$? *Answer,* $\frac{3}{2}$ or $\frac{3}{2}$, first reduce $\frac{2}{3}$ of $\frac{3}{4}$ into a simple Fraction, and it is $\frac{1}{2}$, by which $\frac{3}{7}$ being divided, the Quotient is $\frac{3}{2}$, equal in its least terms to $\frac{3}{2}$. 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. foregoing.

Quest. 4. What is the quote of $\frac{3}{4}$ of $\frac{3}{4}$ divided by $\frac{2}{3}$ of $\frac{3}{4}$?

Answer, $\frac{3}{4}$ or $\frac{3}{4}$ or $\frac{3}{4}$ or $\frac{3}{4}$ 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. 5. What is the quote of $12\frac{3}{4}$ divided by $21\frac{1}{4}$?

Answer, $\frac{2}{3}$ or $\frac{2}{3}$, for $12\frac{3}{4}$ is equal to $\frac{51}{4}$, and $21\frac{1}{4}$ is equal to $\frac{85}{4}$, and the quote of $\frac{51}{4}$ divided by $\frac{85}{4}$ is as before $\frac{2}{3}$.

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 $\frac{3}{5}$?

Answer, $4\frac{2}{3}$ which is equal to $13\frac{1}{3}$, being reduced as is before directed. See the Work in the Margent.

Quest. 7. What is the quotient of $\frac{3}{5}$ divided by 8? *Answer,* $\frac{3}{40}$, as per Margent.

2
5

C H A P.

C H A P. XXIV.

The Rule of Three Direct in Vulgar Fractions.

1. **A**S 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, that they be reduced to simple of the same value.

3. If there are given mixt numbers, reduce them to improper Fractions by the first Rule of Chap. 19.

4. If any of the three terms is a whole number, make it an improper Fraction by constituting a Unit for its denominator.

Having reduced your Fraction as is directed in the 4. 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 1st 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 is 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 $\frac{5}{7}$ l. what will $\frac{7}{8}$ yards cost?

Having placed the given Fractions according to the 6 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 240 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,

yds.	l.	yds.	l.
3	5	9	180
4	8	10	240
	l.		l.
facit	180	equal to	3
	240		4

the product is 180 for a Numerator, which Numerator 180 and denominator 240 make $\frac{3}{4}$ l. for the Answer, equal to $\frac{3}{4}$ l. or 15 s.

Quest. 2. If $\frac{2}{3}$ l. buy $\frac{1}{2}$ yds of Cloth, what will $\frac{1}{12}$ yds cost at that rate?

Answer, $\frac{1}{12}$ l. equal to $\frac{1}{12}$ l. or 14 s. 8 d.

Quest. 3. If $\frac{7}{8}$ l. cost $\frac{3}{4}$ s. what will $\frac{2}{3}$ s. buy?

Answer, $\frac{2}{3}$ l. equal to $1\frac{1}{3}$ l.

Quest. 4. If $\frac{1}{3}$ of an Ell of Holland cost $\frac{1}{3}$ of a pound, how much will 12 Ells cost at that rate?

Answer, $2\frac{2}{3}$ equal to 7 $\frac{1}{3}$ l.

In resolving the last question and the two next, observe the third Rule of this Chapter foregoing.

Quest. 5. If $\frac{2}{7}$ of a C. cost 284 s. what will 7 $\frac{1}{2}$ C. cost at that rate?

Answer, 2366 $\frac{2}{3}$ s. or 118 l. 6 s. 8 d.

Quest. 6. If 3 $\frac{1}{2}$ yds of Velvet cost 3 $\frac{1}{2}$ l. how much will 10 $\frac{1}{2}$ yds cost at that rate?

Answer, 11 $\frac{3}{4}$ l.

Quest. 7. If 3 yds of Broad Cloth cost 2 $\frac{1}{2}$ l. what will 14 $\frac{1}{2}$ yds cost?

Answer, 13 l. 9 s. 4 d.

In working the last question and the 4 next, observe the 4th Rule of this Chap. foregoing.

Quest. 8. If 14 l. of Pepper cost 14 s. 6 $\frac{3}{4}$ d. I demand the price of 73 $\frac{1}{4}$ l.

Answer, 3 l. 16 s. 7 $\frac{3}{8}$ d.

Quest. 9. If 1 l. of Cochinele cost 1 l. 5 s. what will 36 $\frac{1}{2}$ l. cost?

Answer, 45 l. 17 s. 6 d.

Quest.

Quest. 10. If one yard of Broad-Cloth cost $15\frac{1}{4}s.$ what will 4 pieces, each containing $27\frac{3}{4}$ yards at that rate?

Answer, $85l. 14s. 3\frac{1}{4}d.$

Quest. 11. A Mercer bought $3\frac{1}{2}$ pcs of silk, each pc. qt. $24\frac{2}{3}$ Ells at $6s. 0\frac{3}{4}d.$ per Ell, I demand the value of $3\frac{1}{2}$ pcs at that rate?

Answer, $26l. 3s. 4\frac{3}{4}d.$

In resolving the 4 next questions observe the 8th Rule of Chapter 19.

Quest. 12. If $\frac{2}{3}$ of an ounce of silver cost $2s.$ I demand the price of $11\frac{2}{3}l.$ at that rate?

Answer, $35l.$

Quest. 13. If $5\frac{1}{2}l.$ of Gold is worth $205l. 14s. 3\frac{2}{7}d.$ what is 1 grain worth at that rate?

Answer, $1\frac{2}{3}.$

Quest. 14. If $\frac{3}{4}$ yards of Silk is worth $\frac{3}{4}$ of $\frac{1}{2}l.$ what is the price of $15\frac{2}{3}$ Ells *Flemish*?

Answer, $9l. 12s. 6d.$

Quest. 15. If $\frac{2}{3}$ of $\frac{1}{4}$ of a pound of Cloves cost $6s. 2\frac{2}{3}d.$ what cost the C. weight at that rate?

Answer, $69l. 6s. 8d.$

Note that when the Answers to the Questions in this and the next Chap. are given in Fractions, they are given in their lowest terms.

C H A P. XXV.

The Rule of Three Inverse in Fractions.

1. **I**T hath been already taught (in the third Rule of the 11th Chap.) how to discover when the 4th proportional number (to the 3 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 the 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 second and first Fractions, and the product is a new numerator, which new Fraction thus found is the answer to the question.

Quest. 1. If $\frac{1}{4}$ of a yard of Cloth that is 2 yds wide will make a Garment, how much of any other Drapery that is $\frac{1}{2}$ of a yard wide will make the same Garment?

Answer, $2\frac{1}{2}$ yards.

Quest. 2. Lent my Friend 46*l.* for $\frac{4}{7}$ of a year, how much ought he to lend me for $\frac{2}{3}$ of a year?

Answer 63*l.*

Quest. 3. If $\frac{1}{3}$ of a yard of Cloth that is $2\frac{1}{4}$ yards wide will make any Garment, what breadth is that Cloth, when $1\frac{1}{4}$ yards will make the same Garment?

Answer, $\frac{2}{3}$ 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 $10\frac{1}{2}$ ounces, what will it weigh when the bushel cost $8\frac{1}{2}$ s.?

Answer, $5\frac{1}{8}$ Ounces.

Quest. 6. If 12 Men can mow $24\frac{1}{2}$ Acres in $10\frac{1}{2}$ days, in how many days will 6 men do the same?

Answer, in $21\frac{1}{2}$ days.

C H A P. XXVI.

Rules of Practice.

1. **I**N 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 be an Unit (or 1) that 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 speediness in finding a Resolution to such kind of Questions.

2. The chiefest Question resolvable 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 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 half 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, half of 16 is 8, and then half 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 18s. so that I find it to be 2182 *l.* 18 *s.* as per Margent.

$$\begin{array}{r} 4365 \overline{)8} \\ \hline \end{array}$$

<i>l.</i>	<i>s.</i>
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 shilling, the second containing the Aliquot parts of a pound.

	<i>d.</i>		<i>s.</i>
The even parts of a shilling.	6	is	$\frac{1}{2}$
	4		$\frac{1}{3}$
	3		$\frac{1}{4}$
	2		$\frac{1}{6}$
	$1\frac{1}{2}$		$\frac{1}{8}$
	$1\frac{1}{3}$		$\frac{1}{12}$
	$1\frac{1}{4}$		$\frac{1}{16}$
	$1\frac{1}{6}$		$\frac{1}{24}$

	<i>l.</i>	<i>d.</i>		<i>l.</i>
The even parts of a pound.	10	00	is	10
	6	08		6
	5	00		5
	4	00		4
	3	04		3
	2	06		2
	2	00		2
	1	08		1
	1	00		1
	1	00		1

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.
$\frac{1}{3}$	2456
$\frac{1}{30}$	30 7
	l. s.
	15 — 7 facit

$\frac{1}{3}$	8347 l. at 2 qrs.
$\frac{1}{3}$	2782 — 2 qrs.
$\frac{1}{30}$	34 7 — 9d. $\frac{1}{2}$
	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 8th. of that for shillings, as before, &c.

Examples.

$\frac{1}{2}$	4736 l. at 3 qrs.
$\frac{1}{8}$	2368
$\frac{1}{20}$	29 5
	l. s.
	14 — 16 facit

$\frac{1}{2}$	5425 l. at 3 qrs.
$\frac{1}{8}$	2712 — 3 qrs.
$\frac{1}{20}$	33 9
	l. s. d. qrs.
	16 — 19 — 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 30 Rule of this Chapter. Example, Let it be required to find the value of 438 l.

at 3d. per l. I consider 3d. is $\frac{3}{4}$ of a shilling, and 438l. will cost so many 3 pences, wherefore I divide 438 by 4 the denominator of $\frac{3}{4}$, and the quote is 109 shillings, and 2 remains, which is 2 three-pences or 6d. the whole value is 3l. 9s. 6d. as by the following work appeareth.

$$\begin{array}{r|l} \frac{3}{4} & 438 \text{ l. at } 3 \text{ d.} \\ \hline \frac{1}{20} & 10|9-6 \\ \hline & \text{l. s. d.} \\ & \text{facit } 5-9-6 \end{array}$$

More Examples follow.

$$\begin{array}{r|l} \frac{1}{2} & \text{l. d.} \\ & 357 \text{ at } 6 \text{ per l.} \\ \hline \frac{1}{20} & 178| \\ \hline & \text{facit } 89 \text{ l. } 9 \text{ s.} \end{array}$$

$$\begin{array}{r|l} \frac{1}{6} & \text{l. d.} \\ & 5316 \text{ at } 2 \text{ per l.} \\ \hline \frac{1}{20} & 88|6 \\ \hline & \text{facit } 44 \text{ l. } 6 \text{ s.} \end{array}$$

$$\begin{array}{r|l} \frac{3}{4} & \text{l. d.} \\ & 438 \text{ at } 4 \text{ per l.} \\ \hline \frac{1}{20} & 14|6 \\ \hline & \text{facit } 7 \text{ l. } 6 \text{ s.} \end{array}$$

$$\begin{array}{r|l} \frac{1}{3} & \text{l. d.} \\ & 6389 \text{ at } 1\frac{1}{2} \text{ per l.} \\ \hline \frac{1}{20} & 79|8-7 \text{ d. } \frac{1}{2} \\ \hline & \text{facit } 39 \text{ l. } 18 \text{ s. } 7 \text{ d. } \frac{1}{2} \end{array}$$

$$\begin{array}{r|l} \frac{1}{4} & \text{l. d.} \\ & 879 \text{ at } 3 \text{ per l.} \\ \hline \frac{1}{20} & 21|9-9 \text{ d.} \\ \hline & \text{facit } 10 \text{ l. } 19 \text{ s. } 9 \text{ d.} \end{array}$$

$$\begin{array}{r|l} \frac{1}{12} & \text{l. d.} \\ & 88 \text{ at } 1 \text{ per l.} \\ \hline \frac{1}{20} & 6|8-2 \text{ d.} \\ \hline & \text{facit } 3 \text{ l. } 8 \text{ s. } 2 \text{ d.} \end{array}$$

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 accordingly, and added together, as if it were *5d.* which is *3d.* and *2d.* viz. $\frac{1}{4}$ and $\frac{1}{2}$ of a shilling, first take $\frac{1}{4}$ of the given number, and then $\frac{1}{2}$ 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 *7d.* is $\frac{1}{2}$ and $\frac{1}{4}$, so *9d.* is $\frac{1}{2}$ and $\frac{1}{4}$, and *10d.* is $\frac{1}{2}$ and $\frac{1}{4}$, and *11d.* is $\frac{1}{2}$ and $\frac{1}{4}$ and $\frac{1}{4}$ of a shilling, or else many times your work may be shortened 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 *5d. per l.* now I may divide it thus, viz. into *4d.* and *1d.* and *4d.* being $\frac{1}{2}$ of a shilling, and *1d.* being $\frac{1}{4}$ of *4d.* I first take $\frac{1}{2}$ of *439 l.* and it gives *146 s. 4 d.* and for the *1 d.* I take $\frac{1}{4}$ of *146 s. 4 d.* which is *36 s. 7 d.* which in all comes to *9 l. 2 s. 11 d.* Examples follow.

	l.	d.
	439	at 5 per l.
$\frac{1}{2}$	146	— 4
$\frac{1}{4}$	36	— 7
	18	2 — 11
	9 l. 2 s. 11 d. facit	
	ells	d.
	387	at 7 per ell
$\frac{1}{2}$	195	— 8
$\frac{1}{4}$	146	— 9
	34	2 — 5
	176 2 s. 3 d. facit	

	yds	d.
	417	at 9 per yd
$\frac{1}{2}$	208	— 6
$\frac{1}{2}$	104	— 3
	31	2 — 9
	15 l. 12 s. 9 d. facit	
	ells	d.
	386	at 10
$\frac{1}{2}$	193	
$\frac{1}{2}$	128	— 8
	32	1 — 8
	16 l. 1 s. 8 d. facit	

	yds.	d.
	836	at 8 per yd
$\frac{1}{3}$	278	— 8
$\frac{1}{3}$	278	— 8
	5517	— 4
	27l. 17s. 4d.	facit

	l.	d.
	534	at 11
$\frac{1}{3}$	178	
$\frac{1}{3}$	178	
$\frac{2}{4}$	133	— 6
	4819	— 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 peny farthing, peny three farthings, 2d. 1qr. or 2d. 3qrs. or 3d. 3qrs. 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, 3470l. at 1d. 1qr. per l. first I work for the peny by dividing 3470 by 12, for 1d. is $\frac{1}{12}$ of a shilling, and the quote is 289 s. 2d. then I conceive that 1 farthing is the $\frac{1}{4}$ of a peny, and the value of one farthing will be $\frac{1}{4}$ of the value at 1 peny, and therefore I take $\frac{1}{4}$ of 289 s. 2d. which is 72 s.

	l.	qrs.
$\frac{1}{12}$	3470	at 5
$\frac{1}{4}$	289	— 2
	72	— 9 — 2
$\frac{1}{2}$	361	— 5 — 2
	18	— 1 — 5 $\frac{1}{2}$

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.	d.
$\frac{1}{12}$	4360	at $1\frac{1}{4}$
$\frac{1}{4}$	363	— 4
	90	— 10
	45	4 — 2
	l.	s. d.
	22	— 14 — 2 facit

	yds	d.
$\frac{1}{8}$	573	at $1\frac{3}{4}$
$\frac{1}{6}$	71	— $7\frac{1}{2}$ d.
	11	— $11\frac{1}{4}$
	8	3 — $6\frac{3}{4}$
	l.	s. d.
	facit 4	— 3 — $6\frac{3}{4}$

$\frac{1}{8}$	485	l. at $2\frac{1}{4}$ d.
$\frac{1}{8}$	80	— 10 d.
	10	— $1\frac{5}{8}$
	9	0 — $11\frac{3}{4}$
	4	l. 10 s. $11\frac{1}{4}$ d.

$\frac{1}{2}$	520	yds at $7\frac{1}{2}$
$\frac{1}{4}$	260	
	65	
$\frac{1}{2}$	32	5
	16	l. 5 s. facit

$\frac{1}{6}$	654	l. at $2\frac{1}{2}$ d.
$\frac{1}{4}$	109	
	27	— 3 d.
	13	6 — 3
	6	l. 16 s. 3 d.

$\frac{1}{2}$	137	yds at $10\frac{1}{2}$ d.
$\frac{1}{2}$	68	— 6 d.
$\frac{1}{2}$	34	— 3
$\frac{1}{2}$	17	— $1\frac{1}{2}$
$\frac{1}{20}$	11	9 — $10\frac{1}{2}$ d.
	5	l. 19 s. $10\frac{1}{2}$ facit

Case. 4.

11. When the price of the Integer is 2s. then cut off the figure in the place of Units of the given number, and double it for shillings, and the figures on the other hand are pounds, Example, 436 yds at 2s. 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 there value is 43l. 12s. as per Margent.

$$\begin{array}{r} 43|6 \\ \hline 43\text{l. } 12\text{s.} \end{array}$$

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 8s. per yd? To resolve which I take $\frac{1}{2}$ of 8s. (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 8s. per yd. is 214 l. 8s. as per Margent. More Examples follow.

56 yds at 6s. per yd.	420 yds at 12s. per yd.
16l. 16s. facit.	252l. facit.
123 yds at 4s. per yd.	326 yds at 14s. per yd.
24l. 12s. facit.	228l. 4s. facit.
48 ells at 8s. per ell.	48 yds at 16s. per yd.
19l. 4s. facit.	38l. 8s. facit.
84 yds at 10s. per yd.	52 yds at 18s. per yd.
42l. facit.	46l. 19s. 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 $\frac{1}{2}$ of the given number of Integers according to the 3 Rule of this Chapter, and add them together, and you have your desire. Examples follow.

<i>yds.</i>	<i>s.</i>	<i>ells</i>	<i>s.</i>
422	at 3 per yard	431	at 13
<hr/>		<hr/>	
l.	s.	l.	s.
42	— 4	258	— 12
21	— 2	21	— 11
<hr/>		<hr/>	
63	— 6 facit.	280	— 03 facit
<i>ells.</i>	<i>s.</i>	<i>ells.</i>	<i>s.</i>
516	at 7 per ell.	324	at 17 per ell.
<hr/>		<hr/>	
l.	s.	l.	s.
154	— 16	259	— 04
25	— 16	16	— 04
<hr/>		<hr/>	
180	— 12 facit	275	— 08 facit

14. Except when the given price of the Integer is *ss.* for then it is sooner answered by taking $\frac{1}{4}$ of the given number whose value is sought, as in the following Example.

$\left \frac{1}{4} \right $	<i>yds</i>	<i>s.</i>
	436	at 5 per yard.
<hr/>		
	109 l.	facit

$\left \frac{1}{4} \right $	<i>ells</i>	<i>s.</i>
	206	at 5 per ell.
<hr/>		
	51 l.	— 10s. 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 6s. 8d. per yard? Here I consider that 6s. 8d. 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. 8d. per yd, amounts to 128 l. as per Margent, still observing the 7th Rule of the 9th Chapter.

$$\begin{array}{r} \frac{1}{3} \overline{) 384} \\ 128 \text{ l. facit.} \end{array}$$

More Examples follow.

$$\begin{array}{r} \frac{1}{3} \overline{) 438 \text{ ells at } 6 \text{ s. } 8 \text{ d.}} \\ 146 \text{ l. facit.} \\ \frac{1}{8} \overline{) 525 \text{ at } 3 \text{ s. } 4 \text{ d.}} \\ 87 \text{ l. } 10 \text{ s. facit.} \end{array}$$

$$\begin{array}{r} \frac{1}{8} \overline{) 443 \text{ yds at } 2 \text{ s. } 6 \text{ d.}} \\ 55 \text{ l. } 7 \text{ s. } 6 \text{ d. facit.} \\ \frac{1}{12} \overline{) 726 \text{ yds at } 1 \text{ s. } 8 \text{ d.}} \\ 60 \text{ l. } 10 \text{ s. facit.} \end{array}$$

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. 6s. 6d. 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.

$$\begin{array}{r} \text{yds} \quad \text{s.} \quad \text{d.} \\ 386 \text{ at } 8-8 \\ \hline \frac{1}{4} \overline{) 128 \text{ l.}} - 13-4 \\ \frac{1}{8} \overline{) 38} - 12-0 \\ \hline 167 \text{ l. } 5 \text{ s. } 4 \text{ d. facit} \\ \text{ells} \quad \text{s.} \quad \text{d.} \\ \text{s. } 427 \text{ at } 8-6 \\ \hline 6 \overline{) 128 \text{ l.}} - 2-0 \\ \frac{1}{8} \overline{) 53} - 7-6 \\ \hline 181 \text{ l. } 9 \text{ s. } 6 \text{ d. facit} \end{array}$$

$$\begin{array}{r} \text{ells} \quad \text{s.} \quad \text{d.} \\ 540 \text{ at } 5-4 \\ \hline \frac{1}{4} \overline{) 54 \text{ l.}} - 0 \\ \frac{1}{8} \overline{) 90} - 0 \\ \hline 144 \text{ l. facit.} \\ \text{yds} \quad \text{s.} \quad \text{d.} \\ \frac{1}{3} \overline{) 386 \text{ at } 14-8} \\ 4 \\ \hline 154 \text{ l.} - 8-0 \\ 128 - 13-4 \\ \hline 283 \text{ l. } 1 \text{ s. } 4 \text{ d. facit.} \end{array}$$

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 is the price of the Integer, and then for the pence work by the 8th 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 6s. the product is 2352 shillings, then for the 9d. I divide it into 6d. and 3d. and work for them by the 8th Rule foregoing, and at last add the shillings together, they make 2646 s. and by the 3d. Rule they are reduced to 132 l. 6 s. the value of 392 yds at 6 s. 9d. per yard. See the work following.

yds.	s.	d.
392	at 6	— 9
6		
<hr/>		
2352		
$\frac{1}{2}$	196	
$\frac{1}{3}$	98	
$\frac{1}{6}$	264	6
<hr/>		
132 l. 6 s. facit.		

Other Examples follow.

s.	l.	s.	d.
	480	at 4	— 10
	4		
<hr/>			
4	1920		
$\frac{1}{2}$	240		
$\frac{1}{3}$	160		
<hr/>			
	232	0	
<hr/>			
116 l. facit.			

s.	ells.	s.	d.
	732	at 12	— 7
	12		
<hr/>			
$\frac{1}{3}$	8784		
$\frac{1}{4}$	244		
	183		
<hr/>			
	921	1	
<hr/>			
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.

Example.

ys.	s.	d.
438 at 8	—	6 $\frac{1}{2}$
8		
<hr/>		
3504		
219		
27	—	4 $\frac{1}{2}$ d.
<hr/>		
37510	—	4 $\frac{1}{2}$
<hr/>		
fac. 187 l. 10 s. 4 $\frac{1}{2}$ d.		

ells	s.	d.
370 at 14	—	2 $\frac{1}{4}$
14		
<hr/>		
1480		
370		
<hr/>		
5180		d.
61	—	8
19	—	5
7	—	8 $\frac{1}{2}$
<hr/>		
52614	—	9 $\frac{1}{2}$
<hr/>		
fac. 263 l. 4 s. 9 d. $\frac{1}{2}$.		

ells	s.	d.
136 at 9	—	2 $\frac{1}{2}$
9		
<hr/>		
1224		0
22		8
5		8
<hr/>		
12512	—	4
<hr/>		
fac. 62 l. 12 s. 4 d.		

ells	s.	d.
431 at 2	—	4 $\frac{1}{2}$
2		
<hr/>		
862		
107		9 d.
53		10 $\frac{1}{2}$.
<hr/>		
10213	—	7 $\frac{1}{2}$
<hr/>		
facit 51 l. 3 s. 7 $\frac{1}{2}$ d.		

Case.

Case. 6.

19. When the given value of the Integer is pounds, then multiply the Number of Integers, whose value is sought by the price of the Integer, and the product is the answer in pounds.

Examples.

C. l.
42 at 2 per C.

84 l. facit.

C. l.
30 at 3 per C.

90 l. facit.

C. l.
13 at 8 per C.

104 l. facit.

C. l.
48 at 12 per C.

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 beforegoing, then add the Numbers produced from them both, and the Sum is the value sought.

Examples.

	C.	l.	s.
	46	at 2—4	
2l.	92	s.	
4s.	9—4		
	101 l.	4 s.	facit.
	gross	l.	s.
	58	at 3—7	
3 l.	174	s.	
6 s.	17—8		
1 s.	2—18		
	194 l.	6 s.	facit

	gross	l.	s.
	82	at 4—10	
4 l.	328		
10s.	41		
	369 l.	facit	
	gross	l.	s.
	26	at 3—15	
3 l.	78		
14 s.	18—4		
1 s.	1—6		
	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 18th 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 19th 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.
	213	at	1—13—4 $\frac{1}{2}$	
	639			
	213			
13 s.	2769		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.
416	at	2—9—3 $\frac{3}{4}$	
3744			
104			
26			
387	4		
193	l.	14 s.	
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 d.	
6		1 $\frac{1}{2}$ d.	
76	6		
38	—6		
144		3 l.	
182	l.	6 s.	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 the 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 $\frac{1}{4}$ 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 26l. 4 s. 3 d. as by the work in the Margent.

yds	s.	d.
116 $\frac{1}{2}$ at 4	—	6
<hr/>		
11 l.	12 s.	2 s.
14	— 10 d.	2 s. 6 d.
2	— 3	$\frac{1}{2}$ yd.
<hr/>		
26	— 4	— 3 facit.

Other Examples follow.

324 $\frac{1}{4}$ yds. at 4 s. 10 d.

1296	—	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.

228 ells at 12 s. 11 d.

2736	—	12 s.
76	—	4 d.
76	—	4 d.
37	—	3 d.
6	— 5 $\frac{1}{2}$ d.	$\frac{1}{2}$ ell.
2	— 2 $\frac{3}{4}$ d.	$\frac{1}{4}$ ell.

295 | 4 — 8 $\frac{1}{4}$ d.

145 l. 14 s 8 $\frac{1}{4}$ d. facit.

720 $\frac{1}{2}$ yds. at 6 s. 8 d.

240 l. 3 s. 4 d. facit.

C. qrs. l.	l.	●	℥.
28—3—14 at 1	—	10	
28 l.	—	1 l.	
14 l.	—	10 s.	
60—15 s.	—	$\frac{1}{2}$ C.	
7 s. 6 d.	—	$\frac{1}{4}$ C.	
3 s. 9 d.	—	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 hath been delivered here are sufficient for the practical Arithmetician in all cases whatsoever.

C H A P. XXVII.

The Rule of Barter.

1. **B**arter 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 2l. 16s. per C. and B hath Cotton at 9d. 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 Practice foregoing, how much the Pepper is worth, saying,

If 1 C. cost 2l. 16s. what will 13 C. 3 qrs. 14 l. cost?

Answer, 38 l. 17 s.

Secondly, By the Rule of 3 say, If 9d. buy 1l. of Cotton, how much will 38l. 17s. buy?

Answer, 9½ C. and so much Cotton must B give to A for 13 C. 3 qrs. 14 l. of Pepper at 2l. 16s. per Cent. when the Cotton is worth 9d. 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 make his gain in barter equal to that of A?

Answer, 8 l. 8 s.

Say, by the Rule of Three, 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 yds 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 50 l. 8 s. per Tun, and A giveth B 21 C. 2 qrs. 11 $\frac{1}{2}$ l. of Ginger for his 4 Tun of Brandy, I desire to know how B sold his Ginger in barter per C. and how much it was worth in ready Money.

Answer,

Answer, For 5*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 8*l.* 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.*

C H A P. 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 *yd.* 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 gain 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 yard to gain 10 l. 6 s. 8 d. in the whole Sale of the 124 yds? 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. 4 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 d. 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. 8 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.* 1*3s.* and gained after the rate of 12*l.* 10*s.* per 100*l.* I demand how much it cost him per C? *Answer,* 18*l.* 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.* 1*3s.* 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*l.* 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 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.* $2\frac{1}{2}$ 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 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 Tuns 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 400*l.* so is 1 Gall. to 3*s.* 11*d.* $2\frac{1}{2}$ 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 $\frac{7}{11}$ the price it all cost him, then to find how much per Tun, I say,

As 8 is to 454 $\frac{7}{11}$ *l.* so is 1 to 56 $\frac{2}{11}$, or 56 *l.* 16 *s.* 4 *d.* 1 $\frac{1}{11}$ *qr.* per Tun.

C H A P. XXIX.

Equation of Payments.

1. **E**quation of Payments, is that Rule amongst Merchants whereby we reduce the times for payment of several Sums of Money, to an equated time for the payment of the whole Debt without damage to Debtor 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.* 4 months, and the rest at 6 months, now they agree to make one payment of the total Sum, the question is what the equated time for payment without damage to Debtor or Creditor?

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 $3\frac{2}{3}$ months for the time of paying the 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 product (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 this Rule is thus manifest, if the interest of that Money 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.

In the last Quest. 600 l. should have been paid at 4 months, but it is not discharged till 6 months (that is two months after it is due) wherefore its interest for 2 months at 6 per Cent. 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.* should 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.* (accounting 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 8 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,

$$\begin{array}{r} \frac{1}{3} \text{ Multiplied by 2 mon. produceth } \frac{2}{3} \\ \frac{1}{3} \text{ Multiplied by 4 mon. produceth } 1\frac{1}{3} \\ \frac{1}{3} \text{ Multiplied by 8 mon. produceth } 2\frac{2}{3} \end{array}$$

The Sum of the Products 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 90*l.* then $\frac{1}{3}$ of it is 30*l.* for each payment, *viz.* at 2, 4, and 8 months, then

$$\begin{array}{r} 30 \text{ l. Multiplied by 2 mon. produceth } 60 \\ 30 \text{ l. Multiplied by 4 mon. produceth } 120 \\ 30 \text{ l. Multiplied by 8 mon. produceth } 240 \end{array}$$

The Sum of the Products is 420

which divided by 90 (the whole Debt) quotient $4\frac{2}{3}$ or $4\frac{2}{3}$ months as before.

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, and 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 money 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 proceed 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 $4\frac{1}{2}$ 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, $\frac{1}{4}$ at 6 months, and the rest at 8 Months; now I demand the equated time for the payment of it all?

Answer $3\frac{1}{2}$ 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,

Answer, $6\frac{1}{2}$ months.

Quest. 8. A is indebted to B 420*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 allotted 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 2*s*.

Then by the Rule of Three, say,

As 2*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.

C H A P. XXX.

E X C H A N G E.

1. **T**HE 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 Countrys 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 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 kinds) or of more.

3. In Questions where there is a comparison made between two things (whether they be Moneys, 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* deliver'd 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 10th Chapter, which being done, the given numbers will stand thus;

<i>l.</i>	<i>Crowns</i>	<i>l.</i>
1	$3\frac{1}{3}$	370

and being reduced according to the Rules of the 24th Chapter, will stand thus;

<i>l.</i>	<i>Crowns</i>	<i>l.</i>	<i>Crowns</i>
As $\frac{1}{3}$ is to $1\frac{2}{3}$	so is	370 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 $4\frac{1}{3}$ *Ducats per l. Flemish*. I demand how many *Ducats* he ought to receive?

The proportion is as followeth.

<i>l.</i>	<i>Ducats</i>	<i>l.</i>	<i>Ducats</i>
As $\frac{1}{3}$ is to $1\frac{2}{3}$	so is	587 to	2817 $\frac{1}{3}$

So I find he ought to receive 2817 $\frac{1}{3}$ *Ducats* at *Naples*, for the 587 *l. Flemish* delivered at *Amsterdam*.

Quest. 4. A Merchant at *Florence* delivereth 3478 *Ducatons*, to receive the value at *London* in pence, the Exchange $53\frac{1}{2}$ pence *Sterling per Ducatoon*. I demand how much *Sterling* he ought to receive?

The

The Proportion for Resolution is,

Duc.	d.	Duc.	d.
As $\frac{1}{2}$	is to $107\frac{1}{2}$	so is	$347\frac{1}{2}$ to 186073

which is equal to 775*l.* $6\frac{1}{2}$ for the Answer.

I might here (according to the Custom of Arithmetical Writers) lay down Tables for the Reduction of Foreign Coyns to *English*; but by Reason of their Instability (for they continue not at a constant standard, as our Sterling Money doth, but are sometimes raised, and sometimes depressed) I shall forbear.

4. When there is a comparison made between more than two different Coyns, Weights or Measures, there ariseth ordinarily two different cases from such a comparison.

1. When it is required to know how many pieces of the first Coyn, Weight or Measure, are equal in value to a known number of pieces of the last Coyn, Weight or Measure.

2. When it is required to find out how many pieces of the last Coyn, Weight or Measure, are equal in value to a given Number of the first sort of Coyn, Weight or Measure.

An Example of the first Case may be this, VIZ.

Quest. 4. If 150 pence at *London* are equal to 3 Ducats at *Naples*, and $4\frac{1}{2}$ Ducats at *Naples* make $34\frac{1}{2}$ shillings at *Brussels*; then how many pence at *London* are equal to 138 shillings at *Brussels*? *Facit*, 960 *d.*

This question may be resolved at two single Rules of Three; for first, I say,

If $\frac{1}{2}$ Ducats at *Naples* make 150 pence at *London*, how many pence will $4\frac{1}{2}$ Ducats make?

Answer, 240 pence.

By the foregoing Proportion, we have discovered that $4\frac{1}{2}$ Ducats at *Naples* make 240 pence at *London*;

London: And by the Tenour of the Question we see that $4\frac{2}{3}$ Ducats at *Venice* make $34\frac{1}{2}$ shillings at *Brussels*, therefore 240d. 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 shillings at *Brussels* to 960 pence at *London*, which is the Answer to the Question.

An Example of the second Case may be thus, V I Z.

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.* of *Averdupois* weight at *London*.

Answer, $129\frac{2}{3}$ pounds at *Dantzick*.

This Question is likewise answered at 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 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 $129\frac{2}{3}$ *l.* at *Dantzick*.

By which I find that $129\frac{2}{3}$ 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 before-mentioned, 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 two said 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 $4\frac{4}{7}$ Ducats at Naples make $34\frac{1}{2}$ shillings at Brussels, then how many pence at London are equal to 138 shillings at Brussels?

The terms being placed according to the 7th Rule will stand as followeth.

	A	B	
<i>Pence at Lond.</i>	150	3	<i>Ducats at Na.</i>
<i>Ducats at Na.</i>	$4\frac{4}{7}$	$34\frac{1}{2}$	<i>Shill. at Bruss.</i>
<i>Shill. at Bruss.</i>	138		

having thus placed the Terms that in either 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 $4\frac{4}{7}$ produceth $300\frac{6}{7}$, which multiplied by 138 produceth $49680\frac{6}{7}$ for a dividend, then in the Column under B there are 3 and $34\frac{1}{2}$, which multiplied together produce $207\frac{1}{2}$ for a divisor; then having divided $49680\frac{6}{7}$ by $207\frac{1}{2}$, 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 l. at Dantzick, then how many pounds at Dantzick are equal to 112 l. *Averdupois* weight at London.

The terms being disposed according to the 7th Rule foregoing will stand thus,

	A	B	
<i>l. at Lond.</i>	40	36	<i>l. at Amsterdam</i>
<i>l. at Amst.</i>	90	116	<i>l. at Dantzick</i>
		112	<i>l. at London.</i>

whereby I find that the Terms under B multiplied together produce 467712 for a dividend, and the Terms under A, viz. 40 and 90 produce 3600 for a divisor, and Division being finished, the quotient giveth $129\frac{1}{2}\frac{1}{2}$ pounds at Dantzick for the Answer.

CHAP. XXXI.

Single Position.

1. **N**egative 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; now I demand the number of Crowns he had about him? *Answer,* 60 Crowns.

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 50 years of Age, which added together, make 165.

C H A P. XXXII.

Double Position.

1. **T**HE Rule of Double Position is when 2 false Positions are assum'd to give a Resolution to the question propounded.

2. When any Question is stated in double Position make such a Cross as followeth.

$$\begin{array}{cc} a & b \\ & X \\ d & c \end{array}$$

3. Then make choice of any number you think may be convenient for your working, which call your first position, and place it at that end of the Cross at *a*, then work with this position (as if it were the true number

number sought) according to the nature of your question, then having found out your error, either too much or too little, place it on that side the Cross at *d*, then make choice of another number of the same denomination with the first Position (which call your second Position) and place it on that side of the Cross at *b*; then work with this Position as with the former, and having found out your error, either too much or too little, place it on that side of the Cross at *c*, and then the Positions will stand at the top of the Cross, and the errors at the bottom, each under his correspondent Position, and then multiply the errors into the positions cross-wise, that is to say, multiply the first position by the second error, and the second position by the first error, and put each product over its position.

4. Having proceeded so far, then consider 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 lesser product from the greater, and set the remainder for a dividend, then subtract the lesser error from the greater, and let the remainder be a divisor, then the quotient arising by this Division, is the answer to the question.

5. But if the errors are unlike, that is one too much and the other too little, then add the products of the positions and errors together, and their sum shall be a dividend, then add the errors together, and their sum shall be a divisor, and the quotient arising hence is the Answer; which two last Rules may be kept in memory by this Verse following, *viz.*

*When Errors are of unlike kinds
Addition doth ensue,
But if alike Subtraction finds
Dividing work for you.*

Quest. 1. A, B and C build a House which cost 76 l. of which A paid a certain Sum unknown, B paid

B 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 second 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 'tis 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
	6	X	9
56	12)		(14
	32		20
76		12	
56			
			Sam 44
20			76
			44
			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 5*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 his 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 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				A 18
30 B				B 28
50 C				C 46
<hr/>				<hr/>
100 Sum	320	112	432	Sum 92
76 Subtr.	20	X	18	Subtr. 76
	8)		(14 facit	
	24	X	16	
		8		
<hr/>				<hr/>
24 Error				Error 16

is 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 5th 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,

$$\begin{array}{r}
 96 \quad 672 \quad 576 \\
 6 \quad \times \quad 18 \\
 48 \quad \quad \quad (14 \\
 32 \quad \quad \quad 16 \\
 \hline
 48
 \end{array}$$

(viz) one too big, and another too little, I add the 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 two several Tryals before.

For proof of the Work I say,

$$\begin{array}{r}
 \text{If A paid} \text{-----} 1. \\
 \text{Then B paid 14 and 10 (that is)-----} 24 \\
 \text{Then C paid 14 and 24 (that is)-----} 38 \\
 \hline
 \end{array}$$

$$\text{The Sum of all is-----} 76$$

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 7th Chap. 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 $\frac{1}{2}$ 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 give me one of your Crowns I shall have five times as many as you; and said B to him again, if you give 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 $\frac{1}{2}$ of it self, and from the Sum subtract $\frac{1}{3}$ 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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THere is lately brought from *Chily*, a Province in *America*, a most excellent natural *Balsam*, found by several eminent Persons to excel that of *Peru* and *Tolu*, in curing of divers Diseases hath given Demonstration. 'Tis a remedy that no Man under the Sun can Compose, being a most Odoriferus and Natural *Balsam*. It cures most Diseases in Human Bodies; particularly helps all Pains coming from Cold, chiefly pains in the Stomach, want of Appetite: Corroborating & strengthening the whole Body. 'Tis a wonderful Remedy for all inward Sores, Bruises, or Ulcers of the Lungs, Reins, Bladder, or Womb, &c. It helps Shortness of Breath, Cough, or Consumption, or Wheezings: 'Tis good in most Diseases of the Head: as Falling-Sickness, Apoplexy, Palsie, Trembling Convulsions, Head-ach, and Giddiness of the Head; and strengthens the Brain and Nerves. It kills Worms and helps the Stone, and is a good provoker of Urine, and brings away the Sand and Gravel, which oftentimes obstructs the Urine. It helps all Fluxes of the Belly; and 'tis a wonderful thing for most Diseases of the Ears, especially Deafness. And outwardly applied, Cures all manner of Green-Wounds, Ulcers and Fistula's. And Cures most Diseases in Women. It is only to be had of *Eben. Tracey*, at the *Three Bibles on London Bridge*, at 1s. 6d. the Ounce. The Bottles are Sealed with the *Balsam-Tree*.

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1711 (cured April 28. 1753)

