A n 16

TREATISE

CONCERNING

GOLD and SILVER,

AND THE

Specifick Gravity thereof;

WITH EASY

RULES,

AND

EXAMPLES

FOR

Trying of Gold and Silver,

AND

For finding their PURITY exactly without Melting, and the WEIGHT and VALUE of both without Weighing or Reckoning either.

All being perform'd by Geometrical Proportion,
By GEORGE RENOLDS.

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and King *Edward* the Iſt, ſince the *Norman* Conqueſt, eſtabliſhed a certain Standard for the Silver Coin, in this Manner: 24 *gr.* make 1 *d.* Weight, 20 *d.* Weight 1 *z.* and 12 *z.* one Pound Sterling; of theſe 12 *z.* 11 *z.* 2 *d.* Weight was to be of fine Silver, and 18 *d.* Weight of Allay the Minter added, ſo that antiently a Pound Sterling of Silver was a Pound *Troy*, whereas now a Pound Sterling is but the third part of the Weight of a Pound *Troy*: For in regard of the advancing of Money in Foreign Countries, Queen *Elizabeth* cauſed the Value of the Ounce *Troy* of coined Silver to be advanced to 5 *s.* and the Sixpence and Shilling proportionably; and ſo it continues throughout all Parts of *Great Britain*, without Alteration; for ſince the Union of the Two Kingdoms, the Coin and its Value in *Scotland* is the ſame with *England*.

No Money in any Mint is made of pure Silver, Silver in its purity being almoſt as ſoft as Lead, and therefore is not ſo fit either for Coin or Utenſils, makes it neceſſary to harden it with Copper, which is therefore call'd *Allay*, becauſe it makes the Silver to abate of its Fineneſs; and Money is ſaid to be more or leſs fine, in proportion to the Quantity of Allay intermix'd with a certain Quantity of pure Silver; thus, of 1 *lb.* of Silver, if 2 *z.* thereof be Copper, the Silver is ſaid to be 10 *z.* fine, and is not ſo Valuable as that which is 11 *z.* fine, for that has but 1 *z.* of Allay in 1 *lb.* of it.

Hence it is evident, that *Britiſh* Silver being 11 *z.* 2 *d.* Weight fine, having but 18 *d.* Weight of Allay in 12 *z.* of Bullion, 1 *lb.* of it is more valuable than 1 *lb.* of that which is 10 *z.* fine, as the *French*, or 9 *z.* fine, as the *Dutch*.

Gold, in its Purity, is likewiſe ſo flexible, that it is not ſo fit either for Coin or Utenſils (except to beat

beat into Leaf-Gold) makes it neceſſary to harden it, by mixing a ſmall Quantity of Silver or Copper therewith; for the Allay of ſome Gold Coin is all Silver, as the Guinea Gold; and ſome all Copper, which renders the Gold Coins ſome more White, and ſome more Yellow.

As the Goldſmiths and Minters eſtimate the Fineneſs of Silver by *Troy* Weight, ſo they diſtinguiſh the Fineneſs of Gold by the *Carrat*, or *Carract*, (which are the ſame) which is not any certain Quantity or Weight, but the Twenty Fourth Part of any Quantity or Weight, and the Carrat, or Carract, is divided into Twenty Four equal Parts, called, *Garrat Grains*, or Grains of a Carract; and the Carrat Grain is divided into divers Parts, as, *Halves*, *Quarters*, &c.

So when a Pound *Troy* is thus divided, the Carract is 10 *d.* Weight, or half an Ounce, and the Grain of a Carract is 10 *gr.*

When the Goldſmiths, or Minters, make Trial of the fineneſs of Gold, (which they call making an Eſſay) they take a ſmall Quantity of ſuch Gold as they intend to try, and weigh it very exactly, and then put it in a Crucible and melt it over a ſtrong Fire, ſo long, that if there be any Allay in it, that Allay may be conſumed and burnt up, and only the pure Gold remain, (which is of ſuch a Nature, and of ſo great Purity, that it will endure the Fire without waſting, although it be kept continually melted, and therefore ſome of the antient Philoſophers have ſuppoſed the Sun to be a Globe of melted Gold); when it is cold they weigh it very exactly again, and if it have not loſt any thing of the firſt Weight, they conclude it is pure Gold; but if it have loſt one Twenty Fourth Part, they

they call it, *Twenty Three Carracts fine*, or One Carract better than the Standard: If the Loss be Two Parts of Twenty Four, they call it *Twenty Two Carracts fine, (which is the Standard for coin'd Gold in* Great Britain:) If it have lost Three Parts of Twenty Four, its *Twenty One Carracts fine*, or One Carract worse than the Standard, *&c.*

CHAP. II.

Concerning Fluids and Solids, and the Specifick Gravity of Solid Bodies; with Rules for finding the Weight and Value of Gold and Silver exactly, without Weighing or Reckoning of either.

THAT the different Gravities of Bodies, whether fluid or solid, arises from their containing a greater or less Quantity of Matter in the same Space, is frequently observ'd and prov'd by Dr. *William James Gravesande*, Professor of *Mathematicks* and *Astronomy* in *Leyden*, and Fellow of the Royal Society of *London*, in his *Mathematical Elements of Physicks*, prov'd by Experiments.

DEFINITIONS.

1. That Body is called a Fluid, whose Parts yield to any Impression whatever, and by yielding are very easily put into Motion among themselves. From whence it follows, that Fluidity arises from the

the Parts not sticking closely together; and their Motion not being hindred by any Roughness of the Superfices of the Parts, as in the Case of Dust.

2. The Particles, of which Fluids consist, are of the same Nature, and have the same Properties with the Particles of other Bodies. For Fluids are often changed into Solids, when there is a closer Cohesion of their Parts, as in Ice: On the other Hand, Metals, when melted down, gives us Examples of a Solid being changed into a Fluid.

Fluids do also agree with Solids in this, that they consist of heavy Particles, having Gravity proportionable to their Quantity of Matter, wheresoever situated. If that Gravity be not sensible in the Fluid itself, it is because the lower Parts sustain the upper, and keep them from descending; but that the Gravity itself is not therefore destroy'd, appears from hence; that a Fluid contain'd in a Vessel depresses a Ballance, on which the Vessel hangs, in proportion to its Quantity.

3. The Quantity of Matter that is in a Body, considered with regard to the Bulk of that Body, that is, to the Space it takes up, is called its *Density*.

A Body is said to have double or treble, *&c.* the Density of another Body, when being equal in Bulk, it contains double or treble, *&c.* the Quantity of Matter.

4. A Body is said to be Homogeneous, when its of the same Density in every part of it.

5. Heterogeneous, when there are different Degrees of Density in different Parts of it.

6. The Gravity of a Body, consider'd with relation to its Bulk, is called the *Specifick Gravity*. The

Specifick Gravity is ſaid to be double, when the Weight is double, tho' the Bulk is the ſame.

Therefore the Specifick Gravities and Denſities of Bodies that are Homogeneous, are in the ſame *Ratio*, and are to one another as their Weights, when their Bulk is equal. If Homogeneous Bodies be of the ſame Weight, the leſs their Bulk is, the greater will their Denſity be; and while their Weight continues the ſame, their Bulk decreaſes in the ſame Ratio that their Denſity increaſes, therefore in that Caſe the Bulks are reciprocally as the Denſities.

An Enquiry about the different Gravities of Metals, and other Bodies, is not only a Work of Curioſity, but alſo of very good Uſe upon ſeveral Occaſions; therefore ſeveral Authors have given us ſuch Proportions of Difference of their Weights, as they are ſaid to have one to another, ſuppoſing them to be of the ſame Magnitude; ſome of which ſhall be inſerted here.

Firſt, *Henry van Etten*, in his *Mathematical Recreations*, printed *Anno* 1633, ſets down the Proportion of their Weight thus: *Gold* 1875, *Lead* 1165, *Silver* 1040, *Copper* 910, *Iron* 810, *Tin* 750, *Water* 100.

Secondly, *Alſted*, in his *Encyclopædia*, printed 1649, hath them thus: *Gold* 1875, *Quickſilver* 1500, *Lead* 1165, *Silver* 1040, *Copper* 910, *Iron* 806, *Tin* 750, *Honey* 150, *Water* 100, *Oil* 90.

Thirdly, The Ingenious Mr. *Oughtred*, in his *Circles of Proportions*, printed *Anno* 1660, hath their Proportions according to the Experiments of *Marinus Ghetaldi*, in his Tract call'd, *Archimedes Promotus*, thus: *Gold* 3990, *Quickſilver* 2850, *Lead* 2415, *Silver* 2170, *Braſs* 1890, *Iron* 1680, *Tin* 1554.

Fourthly,

Fourthly, In the *Philoſophical Tanſactions* (Number 169 and 199) there is an Account of a great many Experiments of this kind, from whence theſe following are collected, *viz.* *Gold* 18888, *Mercury* 14019, *Lead* 11345, *Silver* 11087, *Copper* 8843, *Hammer'd Braſs* 8349, *Caſt Braſs* 8100, *Steel* 7852, *Iron* 7643, *Tin* 7321, *Pump-Water* 1000. Theſe laſt *Proportions*, being approved of and publiſhed by Order of the *Royal Society*, ſeem to be unqueſtionably true; nevertheleſs, becauſe they differ ſo much from the before-mentioned, (and thoſe from one another) the Ingenious Mr. *Ward*, Profeſſor of the Mathematicks in the City of *Cheſter*, having for his own Satsfaction made ſeveral Experiments of that kind; and having (as it's generally believed) obtained the Proportions of Weight, that one Body bears to another of the ſame Bulk or Magnitude, as nicely as the Nature of ſuch Matter, as can be be contracted or brought into a leſſer Body (*viz.* either by Drying, Hammering, or otherwiſe) will admit of; of which, ſo many as concerns this Treatiſe, are as follows:

A Cubick, or Solid Inch of		Oz. Troy.		Oz. Averdupois.
Pure Gold	is	10.359273	=	11.365602
Standard Gold		9.962625	=	10.930422
Quickſilver		7.384411	=	8.101753
Lead		5.984010	=	6.553885
Pure Silver		5.850035	=	6.418324
Standard Silver		5.556769	=	6.096569
Roſe Copper		4.747121	=	5.208369
Plate Braſs		4.404273	=	4.832116
Caſt Braſs		4.272409	=	4.630300
Steel		4.142127	=	4.544505
Common Iron		4.031361	=	4.422979
Block Tin		3.861519	=	4.236638
Sea-Water		0.542742	=	0.594894
Common clear Water		0.527458	=	0.578697

This Table contains the *Specifick Gravity*, or *Weight* of a *Cubick* or *Solid Inch* of various ſorts of Bodies, both in *Troy* and *Averdupois* Ounces, and in decimal Parts of an Ounce.

From hence it will be eaſy to determine the Weight of any propoſed Quantity of the ſame Matter, without weighing of it; and when its Weight is found, its Value may readily be found, and this is done by putting the propoſed Quantity into a Veſſel fill'd full with common clear Water, or with Sea-Water, and weighing the Water that runs over the Veſſel; for which Purpoſe, this is

The RULE.

As the Weight of a Cubick Inch of common clear Water, or of Sea-Water, is to the Weight of a Cubick or Solid Inch of the propoſed Quantity, ſo is the Weight of the Water that runs over the Veſſel (fill'd with Water to the Brim) by the putting the propoſed Quantity into it, to the ſaid Quantity, i. e. to the Weight of the ſaid Quantity.

To find the Weight and Value of any Quantity of Gold or Silver, equal in Fineneſs to the Standard of *Great Britain*, without weighing or reckoning it.

The RULE is,

As the Weight of a Cubick Inch of common clear Water, or of Sea-Water, is to the Weight of a Cubick Inch of Standard Gold or Silver; ſo is the Weight of the Water that runs over the Veſſel, by putting in of the Gold or Silver into the Water (when the Veſſel is brim full of Water) to the Weight of the Gold or Silver put into the Veſſel.

Secondly, As the Weight of 1 z. of Gold or Silver is in Proportion to its Value, ſo is the Weight of any other

other Quantity of Gold or Silver in proportion to its Value.

EXAMPLE First.

Suppoſe a Quantity of Silver, of the Coin of *Great Britain*, put into a Veſſel fill'd to the Brim with common clear Water, and the Quantity of Silver cauſeth 94.9217 z. *Troy* Weight of the Water to run over the Veſſel; the Queſtion is, What is the Weight and Value of the Silver put into the Veſſel?

To perform this Operation, ſay, As .527458 z. *Troy* (the Weight of one Inch of common clear Water) is to 5.556769 z. *Troy* (the Weight of one Cubick Inch of Standard Silver) ſo is 94.9217 z. *Troy* (the Water that run over the Veſſel when the Silver was put into it) to 999.9999 z. *Troy*, the Weight of the Silver put into the Water, which does not want $\frac{1}{10000}$ z. of being 1000 z. and therefore may truly be reckoned 1000 z. which is equal to 1000 Crowns, or 250 *l.* Sterling. See the Operation following,

z. z. z. z.
As .527458 : 5.556769 :: 94.9217 : 999.9999.

EXAMPLE Second.

Suppoſe a Quantity of Standard Silver, of the Coin of *Great Britain*, when put into a Veſſel fill'd to the Brim with common clear Water, cauſeth 128.57158 z. *Troy* of the Water to run over the Veſſel; what is the Weight and Value of the Silver put into the Veſſel?

ANSWER.

The Weight is 1354$\frac{1}{2}$ z. *Troy*, and its Value 338 *l.* 12 *s.* 6 *d.*

As .527458 z. *Troy* (the Weight of 1 Inch of common clear Water) is to 5.556769 z. *Troy* (the Weight of one Cubick Inch of Standard Silver) ſo is 128.57158 z. *Troy* (the Weight of the Water that run over the Veſſel by the putting in of the Silver) to 1354.5 z. *Troy*, the Weight of the Silver put into the Water. And,

As 1 z. *Troy* of Standard Silver is to 5 *s.* Sterling, (its Value) ſo is 1354.5 z. *Troy*, of the ſame Silver, to 6772.5 *s.* Sterling, its Value, which is equal to 338 *l.* 12 *s.* 6 *d.* Sterling.

z.	z.	z.	z.
As .527458 :	5.556769 ::	128.57158 :	1354.5

z.	*s.*	z.	*s.*
As 1 :	5 ::	1354.5 :	6772.5

By the Rules and Examples aforegoing, ſuch as are not acquainted with the Rule by which the Weight and Value of Silver is found, (call'd *The Golden Rule*, or *The ſingle Rule of Three in a direct Proportion)* who can do no more than Multiply and Divide, and yet deſire to perform Operations of this kind exactly, may remember what follows, and they will do what they deſire with the greateſt Exactneſs, *viz.* That there are always three Numbers made uſe of in the Operation, and the firſt of the three (which is ſtill writ neareſt the Left Hand) muſt always be .527458 z. *Troy*, (which is the Weight of one Cubick Inch of common clear Water,) the ſecond 5.556769 z. *Troy* (which is the Weight of one Cubick Inch of Standard Silver) and the Weight of the Water that runs over (by putting the Silver into the Veſſel fill'd to the Brim) muſt be the third Number; the Numbers being ſo plac'd, multiply the ſecond and third Numbers into one another, and divide their Product by their firſt Number, the Quotient

Quotient or fourth Number will be the Weight of the Silver put into the Water in Ounces *Troy*.

But if the Silver be put into a Veſſel fill'd up to the Brim with Sea-Water, then 0.542742 z. *Troy* (the Weight of one Cubick Inch of Sea-Water) muſt be the firſt Number; and 5.556769 z. *Troy* (the Weight of one Cubick Inch of Standard Silver) the ſecond; and the Weight of the Water that runs over the Veſſel, by the putting in of the Silver, the third Number; which being multiplied into the ſecond Number, and the Product divided by the firſt Number, the Quotient (which is the fourth Number) will be the Weight of the Silver put into the Veſſel, in Ounces *Troy*, as the ſecond Number was.

To find the Value of the Silver put into the Water, the Weight being found.

Make 1 z. *Troy* the firſt, 5 *s.* the ſecond Number, and the Weight of the Silver whoſe Value is ſought the third Number; which being multiplied into the ſecond, the Product (which is the fourth Number) will be the Value of the Silver in Shillings Sterling; divide the Product by Twenty, and the Quotient will be Pounds Sterling.

When the Water that runs over is weighed, it will be moſt convenient to weigh it with Pound-weights, Ounces, Penny-weights, Grains, half Grains, and quarter Grains, and reduce all the Pound-weights to Ounces, and make the Penny-weights, Grains, *&c.* a vulgar Fraction of an Ounce; then reduce the vulgar Fraction to a decimal Fraction, by the reſpective Rule in the Introduction, and make the Ounces, and that decimal Fraction of an Ounce, the third Number, and proceed according to the Directions aforegoing.

EXAMPLES *of* GOLD.

EXAMPLE First.

Suppose a Quantity of Gold, of the Coin of *Great Britain*, put into a Vessel fill'd to the Brim with common clear Water, and the Gold put into the Water causeth 7.1143 z. *Troy* of the Water to run over; the Question is, What is the Weight and Value of the Gold put into the Water?

ANSWER.

Its Weight is 134.37487 z. *Troy* equal to 134 z. 7 *dw.* 12 *gr.* and its Value 525 *l.* Sterling, equal to 500 Guineas.

To resolve this Question, say,

As .527458 z. *Troy* (the Weight of one Cubick Inch of common clear Water) is to 9.962625 z. *Troy* (the Weight of a Cubick Inch of Standard Gold of *Great Britain*) so is 7.1143 z. *Troy* (the Weight of the Water that run over the Vessel, when the Gold was put into it) to 134.37487 z. *Troy*, the Weight of the Gold put into the Water.

The Weight of the Gold being known; to find its Value, say,

As 1 z. *Troy* of Standard Gold, is to 78.1395 *s.* (equal to 3 *l.* 18 *s.* 1.674 *d.* Sterling) so is 134.37487 z. *Troy* of the same Gold, to 10499.985144365 *s.* equal to 524 *l.* 19 *s.* 11 *d.* 3.28 *qd.* which does not want one Farthing of 525 *l.* Sterling. See the Operations below.

z. z. z. z.
As .527458 : 9.962625 :: 7.1143 : 134.37487, and

As

z. s. z. s.
As 1 : 78.1395 :: 134.37487 : 10499.985.

Note, 78.1395 *s.* or 3 *l.* 18 *s.* 1 *d.* 2.696 *qd.* is the Value of 1 z. *Troy* of Standard Gold, at the Rate of one Guinea for 21 *s.* a Guinea weighing 5 *dw.* 9 *gr.* and

dw. *gr.* *s.* z. *l.* *s.* *d.* *qd.*
As 5 .. 9 : 21 :: 1 : 3 .. 18 .. 1 .. 2.696 equal to 78.1395. *s.*

EXAMPLE Second.

Suppose a Quantity of Standard Gold of *Great Britain*, put into a Vessel fill'd to the Brim with common clear Water, causeth 12 z. 1 *dw.* 21.264 *gr.* of the Water to run over the Vessel, the Vessel remaining full to the Brim with the Water; the Question is, What is the Weight and Value of the Gold put into the Water?

ANSWER.

The Weight is 228.437 z. *Troy*, equal to 228 z. 8 *dw.* 18 *gr.* very near; and the Value 892 *l.* 10 *s.* Sterling, equal to 850 Guineas.

To resolve this Question, say,

As .527458 z. *Troy* (the Weight of one Cubick Inch of common clear Water) is to 9.962625 z. *Troy* (the Weight of a Cubick Inch of Standard Gold) so is 12.0943 z. *Troy*, (equal to 12 z. 1 *dw.* 21.264 *gr.* the Weight of the Water that run over the Vessel

Veſſel, by the putting in of the Gold into it) to 228.437 z. *Troy*, (the Weight of the Gold put into the Water) which wants but $\frac{1}{100}$ *gr.* of being 228 z. 8 *dw.* 18 *gr.* and

As 1 z. *Troy* is to 78.1395 *s.* (which is equal to 3 *l.* 18 *s.* 1 *d.* 2.696 *qd.* the Value of 1 z. *Troy* of Standard Gold) ſo is 228.437 z. to 17849.9529615 *s.* which does not want 3 *qd.* of 850 Guineas. See the Operations below.

z. z. z. z.
As .527458 : 9.962625 :: 12.0943 : 228.437

z. *s.* z. *s.*
As 1 : 78.1395 :: 228.437 : 17849.9529615

If the Reader, who can do no more than Multiply and Divide, deſire to find the Weight and Value of Standard Gold: For the finding the Weight, this is

The RULE.

Write .527458 z. Troy *(the Weight of one Cubick Inch of common clear Water) in the firſt Place*; 9.962625 z. Troy *(the Weight of one Cubick Inch of Standard Gold) in the ſecond Place, and the Weight of the Water that runs over, in the third Place: The Numbers being ſo placed, multiply the ſecond and third Numbers into one another, and divide their Product by the firſt Number, and the Quotient, which is the fourth Number, will be the exact Weight of the Gold put into the Water.* To find its Value, this is

The

The RULE.

Write 1 z. *in the firſt Place, and* 78.1395 *s. in the ſecond, and the Weight of the Gold, whoſe Value is ſought, in the third Place; and multiply the ſecond and third Numbers into one another, and the Product will be the Value of the Gold (whoſe Weight is writ in the third Place) in Shillings.*

By what has been ſaid for finding the Weight of Gold and Silver in *Troy* Weight, the Reader will readily perceive how it is to be found in *Averdupois* Weight.

This will be of excellent Uſe to try the Purity of ſolid Gold and Silver without melting, if the Weight be exactly known, which is what has been chiefly intended, and moſt of what is writ in this Chapter is only an Introduction to it.

CHAP. III.

To try the Purity of Gold and Silver, and to find the Value of both after Tryal.

THERE is not any Metal that is ſo ponderous or weighty as Gold, therefore, if a Pound-weight or an Ounce of it be put into a Veſſel fill'd to the Brim with Water, it will cauſe leſs of the Water to run over than a Pound or an Ounce of any other Metal will do, if it be put into the ſame Water; and there

there is not any thing, except Gold, Quickſilver and Lead, that is ſo weighty as pure Silver, or Standard Silver, which can hardly be mixed with Lead or Quickſilver, without being readily diſcovered; and pure Silver, or Standard Silver, if 1 *lb.* or 1 *z.* of it be put into a Veſſel fill'd to the Brim with Water, will cauſe leſs of the Water to run over the Veſſel, than the ſame Weight of Silver, that has more than 18 *dw.* of Copper, Braſs, or Block-Tin in 1 *lb.* weight of it, and proportionably to any greater or leſſer Weight.

To find by putting any piece of ſolid Gold or Silver Plate, or any Quantity of Gold or Silver Coin, (whoſe Weight is known) that differs from the Standard, into a Veſſel fill'd with Sea-water, or with common clear Water, how much it is better or worſe than the Standard, which hath 22 Carracts of pure Gold and 2 Carracts of Allay in 1 *z.* or in any other Weight that is divided into 24 equal Parts, and 11 *z.* 2 *dw.* of pure Silver and 18 *dw.* of Allay in 1 *lb.*

Before this can be done, ſuch as deſire to make Experiment muſt know how to find the Quantity of Water that would run over a Veſſel, by the putting in of any ſuppoſed Weight of Standard Gold or Silver into a Veſſel, fill'd to the Brim with common clear Water, or with Sea-water; for which purpoſe, this is

The RULE.

Firſt, *Divide the Number of Ounces and decimal Parts of an Ounce (if there be any thing over Ounces) in the ſuppoſed Weight of Gold or Silver that is equal to the Standard, by the Ounces and decimal Parts of an Ounce that is in one Cubick Inch of Standard Gold or Silver, the Quotient will be the Cubick Inches of Water that would run over the Veſſel by the putting in of the ſuppos'd Quantity of Standard Gold or Silver.*

Secondly,

Secondly, To find the Weight of the Water that runs over, by the putting in of the ſuppoſed Quantity of Standard Gold or Silver, this is

The RULE.

As one Cubick Inch is to .527458 z. Troy, *(the Weight of one Cubick Inch of common clear Water) ſo is the Cubick Inches of Water that would run over, by the puting in of the ſuppoſed Quantity of Standard Gold or Silver, to the Weight of that Water.*

EXAMPLE First.

Suppoſe 2000 *z. Troy* of Standard Silver, put into a Veſſel fill'd to the Brim with common clear Water; it is required how much the Water that runs over will weigh?

ANSWER.

189.8434 *z. Troy.*

Divide the 2000 *z.* of Standard Silver by 5.556769 *z. Troy* (the Weight of one Cubick Inch of Standard Silver) the Quotient will be 359.92138, the Cubick Inches of Water that would run over the Veſſel, by the putting in of the 2000 *z. Troy* of Standard Silver.

To find the Weight of the Water that would run over, ſay,

As one Cubick Inch of Water is to .527458 *z. Troy,* (its Weight) ſo is 359.92138 Inches of Water to 189.8434 *z. Troy,* the Weight of the Water. See the Operations following.

5.556769)

z. z. *Inches.*
5.556769) 2000.000000000 (359.92138

Inch. z. *Inches.* z.
As 1 : .527458 :: 359.92138 : 189.8434, *&c.*

EXAMPLE Second.

Suppoſe 228.4375 z. *Troy* of Standard Gold put into a Veſſel fill'd to the Brim with common clear Water; it is required what the Water would weigh that would run over by the putting in of the Gold?

ANSWER.

12.0943 z. *Troy.*

Divide the 228.4375 z. *Troy* of Standard Gold by 9.962625 z. *Troy* (the Weight of one Cubick Inch of Standard Gold) the Quotient will be 22.92944, the Cubick Inches in 228.4375 z. *Troy* of Standard Gold.

To find the Weight of the Water that would run over, by the putting in of the Gold, ſay,

As one Cubick Inch of Water is to .527458 z. *Troy*, its Weight, ſo is 22.92944 (the Cubick Inches of Water that would run over, by the putting in the 228.4375 z. *Troy* of Standard Gold) to 12.0943 z. *Troy*, the Weight of that Water. See the Operations following.

z. z. *Inches.*
9.962625) 228.43750000000 (22.92944

Inch

Inch z. *Inches.* z.
As 1 : .527458 :: 22.92944 : 12.094316, *&c.*

To find how much any piece of ſolid Gold or Silver Plate, or any Quantity of coin'd Gold or Silver, that differs from the Standard, is better or worſe than the Standard, the exact Weight thereof being given. This is

The RULE.

Firſt, *Find the Weight of the Water that would run over, by the putting a Quantity of Standard Gold or Silver into Water, that is exactly equal in Weight to the Gold or Silver you intend to try.*

Secondly, *Say, If the putting ſo much Gold that is 22 Charracts fine into Water, cauſeth ſo much of the Water to run over; How fine is that Gold that cauſeth ſo much Water to run over, the Weight being exactly the ſame with that which is 22 Carracts fine?*

Note, If the Gold to be tried cauſed more Water to run over than ſo much of Standard Gold, it is worſe than the Standard; if it cauſeth leſs to run over, it is better than the Standard.

EXAMPLE Firſt.

Suppoſe 134 z. 7 *dw.* 12 *gr.* of Standard Gold (that is Gold 22 Carracts fine) be put into a Veſſel fill'd to the Brim with common clear Water, it will cauſe 7.1143 z. *Troy* of that Water to run over; How fine is that Gold that 134 z. 7 *dw.* 12 *gr.* thereof cauſeth 8 z. *Troy* of the ſame Water to run over?

ANSWER

ANSWER.

19.564325 Carracts fine.

z.	*Carracts.*	z.
7.1143	22	8
22		
142286		
142286		
8) 156.514600		
Anſ. 19.564325 *Carracts.*		

More Water than 7.1143 z. runs over, therefore the Gold is worſe than the Standard, and ſo is leſs than 22 Carracts fine; therefore the greater Extreme is the Diviſor, and the Operation is perform'd by the Rule of Three Inverſe.

To find how much the 134 z. 7 *dw.* 12 *gr.* of Gold 19.564325 Carracts fine is leſs valuable than ſo much of pure Gold, *i. e.* Gold 24 Carracts fine; ſubſtract 19.564325 from 24, the Difference will be 4.435675 Carracts of pure Gold.

Therefore ſay,

If 24 Carracts of Gold be worth 4 *l.* Sterling, what will 4.435675 Carracts of the ſame Gold be worth? That is, if 1 z. of Gold 24 Carracts fine be worth 4 *l.*

ANSWER.

.7392 *l.* = to 14 *s.* 9½ *d.* and ſo much 1 z. of Gold of 19.564325 Carracts fine, is leſs valuable than 1 z. of pure Gold.

Subſtract

Subſtract 14 *s.* 9¼ *d.* from 4 *l.* the Difference will be 3 *l.* 5 *s.* 2¾ *d.* which is the Worth of 1 z. of Gold 19.564325 Carracts fine.

To find the Worth of the 134 z. 7 *dw.* 12 *gr.* of Gold, 19.564325 Carracts fine, ſay,

If 1 z. of Gold be worth 3 *l.* 5 *s.* 2¾ *d.* what is 134 z. 7 *dw.* 12 *gr.* of the ſame Gold worth?

The Anſwer will be 438 *l.* 5 *s.* 2 *d.* See the Operation following:

z.	*l.*	*s.*	*d.*	z.	*dw.*	*gr.*	*l.*	*s.*	*d.*
1 :	3 ..	5 ..	2¾ ::	134 ..	7 ..	12 :	438 ..	5 ..	2

EXAMPLE Second.

Suppoſe 228 z. 8 *dw.* 18 *gr.* of Gold, 22 Carracts fine (that is Standard Gold) be put into a Veſſel fill'd to the Brim with common clear Water, it will cauſe 12 z. 1 *dw.* 21¼ *gr.* of that Water to run over; the Queſtion is, How fine is that Gold that the putting in of 228 z. 8 *dw.* 18 *gr.* into the ſame Water, cauſeth 11½ z. of that Water to run over?

ANSWER.

23.1369 Carracts fine.

Turn the 1 *dw.* 21¼ *gr.* into the Decimal Part of an Ounce, it will be .0943 z. and the Operation will be as follows:

z.	*Carracts.*	*z.*
12.0943	22	11.5

22

24 1886
241 886

Carracts.

11.5) 266.07460 (23.1369
230 ....

360
345

157
115

424
345

796
690

1060
1035

25

Leſs Water than 12 *z.* 1 *dw.* 21¼ *gr.* or (which is the ſame) than 12.0943 *z.* runs over, therefore the third Term is the Diviſor, and ſo the Operation is perform'd by the ſingle Rule of Three Inverſe; for that Gold that cauſes leſs Water to run over than ſo much of Standard Gold, muſt be more Carracts fine than Standard Gold.

To

To find how much the 228 *z.* 8 *dw.* 18 *gr.* of Gold, that cauſes 11½ *z.* of the Water to run over, is finer than ſo much of Standard Gold.

Subſtract 22 Carracts from the 23.1369 Carracts in Quotient, the Difference will be 1.1369 Carract; and ſo much 1 *z. Troy* of that Gold that is 23.1369 Carracts fine is better than Standard Gold; therefore ſay,

If 24 Carracts of pure Gold be worth 4 *l.* What will 1.1369 Carract of the ſame Gold be worth?

A N S W E R.

.18948 *l.* = to 3 *s.* 9½ *d.* very near.

Secondly, Say,

If 1 *z. Troy* of Gold be .18948 *l.* better than the Standard, How much will 228 *z.* 8 *dw.* 18 *gr.* of the ſame Gold be better, or more valuable, than ſo much of Standard Gold?

A N S W E R.

43.2843375 *l.* = to 43 *l.* 5 *s.* 8¼ *d.* very near; and ſo much more valuable is the 228 *z.* 8 *dw.* 18 *gr.* of that Gold that cauſeth 11½ *z.* of the Water to run over than ſo much of Standard Gold. See the Operations following.

Carracts.	*l.*	*Carracts.*	*l.*
As 24	: 4 ::	1.1369	: .18948

z.	l.	z.	l.
As 1	: .18948	:: 228.4375	: 43.2843375.

z.	z.	dw.	gr.
Note, 228.4375 is equal to	228	-- 8	-- 18

EXAMPLES *of* *SILVER follow.*

EXAMPLE First.

Suppose 1000 z. *Troy* of Standard Silver (that is Silver that has 11 z. 2 *dw.* of pure Silver, and 18 *dw.* of Copper in 1 *lb.* Weight) be put into a Vessel fill'd to the Brim, with common clear Water, it will cause 94.9217 z. *Troy* of that Water to run over; It is required how fine that Silver is that will cause 100 z. *Troy* of the same Water to run over, when 1000 z. *Troy* is put into the Water?

ANSWER.

210.726174 *dw.* fine.

Reduce the 11 z. 2 *dw.* to *dw.* it will be 222 *dw.* and the Operation will be as follows.

z.	dw.	z.
94.9217	—— 222	—— 100
222		
1898434		
1898434		
1898434		
100) 21072.6174	dw. :	(210.726174

More

More Water than 94.9217 z. runs over, therefore the 1000 z. of Silver, that causeth 100 z. of Water to run over, hath less pure Silver in 12 z. than 222 *dw.* which is the pure Silver 12 z. of Standard Silver hath in it, therefore the fourth Number must be less than 222 *dw.* which is the second Number.

To find how much the 1000 z. of Standard Silver is more valuable than 1000 z. of that Silver that causeth 100 z. *Troy* of the Water to run over.

First, Substract 210.726174 *dw.* in the Quotient, from 222 *dw.* the Difference will be 11.273826 *dw.* and so much 1 *lb.* or 12 z. *Troy* of that Silver that is 11 z. 2 *dw.* or 222 *dw.* fine, is better or finer than 1 *l.* or 12 z. of that which is 210.726174 *dw.* fine.

Secondly, To find how much the 1000 z. of Standard Silver is more valuable than 1000 z. of that which is 210.726174 *dw.* fine, say,

If 12 z. of Silver be 11.273826 *dw.* worse than the Standard, how much will 1000 z. be worse than the Standard?

ANSWER.

939.4855 *dw.* = to 46.974275 z. which at 5 *s.* 1½ *d.* the Ounce, is worth 12 *l.* 0 *s.* 8¾ *d.* Sterling, and so much the 1000 z. of Standard Silver is more valuable than the 1000 z. of that which would cause 100 z. of Water to run over. See the following Operation.

z.	dw.	z.	dw.
12 :	11.273826 ::	1000 :	939.4855.

EXAM-

EXAMPLE Second.

Suppoſe 1354½ z. *Troy* of Standard Silver be put into a Veſſel fill'd to the Brim, with common clear Water, it will cauſe 128.57158 z. *Troy* of that Water to run over; I demand the Fineneſs of that Silver that cauſeth 120 z. *Troy* of the ſame Water to run over, when 1354½ z. *Troy* thereof is put into it?

ANSWER.

237.85742 *dw.* fine

z.	*dw.*	z.
128.57158	222	120

222

25714316
25714316
25714316

120) 28542.89076 (237.85742 *dw.*
240.....

454
360

942
840

1028
960

689
600

890

890
840

507
480

276

Becauſe leſs Water than 128.57158 z. runs over, therefore the 1354½ z. of Silver that cauſeth 120 z. of Water to run over, hath more *dw.* of pure Silver in 12 z. of it, than 222 *dw.* which is the pure Silver 12 z. of Standard Silver hath in it, therefore the fourth Number muſt be greater than the ſecond, and the leſſer Extream (which is the third Number) the Diviſor, and the Operation perform'd by the ſingle Rule of Three Inverſe.

Subſtract 222 *dw.* from 237.85742 *dw.* the Difference will be 15.85742 *dw.* and ſo much 12 z. of that Silver, that cauſeth 120 z. of Water to run over, is better than 12 z. of Standard Silver.

To find how much the 1354½ z. *Troy* of Silver, that cauſeth 120 z. *Troy* of Water to run over, is more valuable than ſo much of Standard Silver; obſerve the Operations following, *viz.*

z.	*dw.*	z.	*dw.*
As 12	: 15.85742	:: 1354.5	: 1789.906825

= to 89½ z. very near.

z.	*d.*	z.	*d.*
As 1	: 61.5	:: 89.4953141	: 5503.9618171

= to 22 *l.* 18 *s.* 8 *d.*

By

By the Operations above it appears, that the 1354½ z. of Silver, that cauſeth 120 z. of the Water to run over, hath 89½ z. very near of pure Silver in it more than 1354½ z. of Standard Silver hath in it, which at 5 *s.* 1½ *d.* or 61½ *d.* the Ounce is worth 22 *l.* 18 *s.* 8 *d.* very near, and ſo much of the 1354½ z. of Silver, that is 237.85742 *dw.* fine is more valuable than ſo much of Standard Silver.

Such as are well acquainted with Reduction, though they cannot perform any thing beyond it, may perform any Operation that is of the ſame kind with thoſe in this Chapter, if they obſerve carefully what follows, *viz.* for Gold.

Make the Weight of the Water, that would run over by the putting in a Quantity of Standard Gold, equal in Weight to the Gold to be try'd, the firſt Number, 22 Carracts the ſecond, and the Weight of the Water that runs over, by the putting in the Gold to be try'd, the third Number; then multiply the firſt and ſecond Numbers into one another, and divide their Product by the third Number, the Quotient, which is the fourth Number, will be the Fineneſs of the Gold you try in Carracts, or in Carracts and part of a Carract.

To find how much the Gold tryed is leſs valuable than ſo much of pure Gold.

Make 24 Carracts the firſt Number, 4 *l.* Sterling the ſecond Number, and the Difference between the fourth Number in the Quotient, in the firſt Operation, and 24 Carracts the third Number; then multiply the ſecond and third Numbers into one another, and divide their Product by the firſt Number, the Quotient, which is the fourth Number, will be the Value

Value of the Difference between 1 z. of the Gold tried and 1 z. of pure Gold in Sterling Money, *viz.* it will be of the Denomination the ſecond Numbe is of.

For Silver.

Make the Weight of the Water that would run over, by the putting in of a Quantity of Standard Silver, equal in Weight to the Quantity of Silver to be try'd, the firſt Number, 222 *dw.* the ſecond, and the Weight of the Water that runs over, by putting in of the Silver to be try'd, the third Number; then multiply the firſt and ſecond Numbers into one another, and divide their Product by the third Number, the Quotient, which will be the fourth Number, will be the *dw.* of pure Silver in 1 *lb.* or 12 z. *Troy* of the Silver you try.

To find how much 1 *lb.* or 12 z. *Troy*, of the Silver try'd, is leſs or more valuable than ſo much of Standard Silver.

Make 222 *dw.* the firſt Number, 3 *l.* Sterling the ſecond, and the Difference between the fourth Number, in the Quotient, in the firſt Operation, and 222 *dw.* the third Number; then multiply the ſecond and third Numbers into one another, and divide their Product by the firſt Number, the Quotient, which is the fourth Number, will be the Value of the ſaid Difference of that Denomination the ſecond Number is of.

Note, When coin'd Gold or Silver equal to the Standard is mentioned, that Gold or Silver is underſtood to be equal to the Standard not only in Fineneſs but in Weight, which is 1 z. *Troy* each Crown, and 5 *dw.* 9 *gr.* each Guinea, and proportionably for other

Pieces of Gold or Silver Coin, which it will not fail to be unleſs it be Counterfeit, or by long or much Uſage it come to be lighter, or being clog'd by ſomething ſticking to it, it is come to be weightier and of more bulk: For that *Britiſh* Coin may not want of the Weight and Purity required, it is moſt wiſely and carefully provided, that once every Year the chief Officers of the Mint appear before the Lords of the Council, in the Star-Chamber at *Weſtminſter*, with ſome Pieces of all ſorts of Monies coined the foregoing Year, taken at adventure out the Mint, and kept under ſeveral Locks by ſeveral Perſons 'till that Appearance, and then by a Jury of 24 judicious Goldſmiths, every Piece is moſt exactly weighed and aſſay'd. If this be conſtantly practis'd, it will be impoſſible for any of the Coin of *Great Britain* to want any thing of the Weight and Purity required.

I do not queſtion but another Way may be invented for Trying of Gold and Silver, and finding their Purity exactly, without melting, and that by finding their ſpecifick Gravity; the *Theorem* upon which that Practice is grounded, was (for what I know) firſt delivered by the moſt ſagacious *Archimedes*, whoſe Commentators have buſied themſelves in demonſtrating it in a Mathematical and Phyſical Way, tho' I have not heard that any of them have preſcribed Rules by which it may be done to a nice Exactneſs.

Archimedes's Propoſition is this, *That a Body heavier than Water, weighs leſs in Water than in the Air, by the Weight of as much Water as is equal to it in Bulk or Magnitude.* Tho' the Way of weighing of Solids in Water hath been delivered by the ingenious *Marinus Ghetaldus*, and out of him by ſome few other Authors; yet, ſince their Books are ſcarce, and the Knowledge of this Way is known but to very few, before I conclude, I ſhall for the Satisfaction of the Ingenious Reader,

Reader, who perhaps hath never ſeen any of them, write down in this Tract

The Way of Weighing ſinking Bodies in Water.

THE ſolid Body, given to be examin'd, is to be ty'd about with a Horſe-hair of a competent length, which Hair, at its other End, is to be faſtened to one of the Scales of a Tender, and exactly equilibrated Ballance, ſo that the propoſed Body being exactly weighed in the Air, (which near to the Superficies of the Earth hath the ſame Proportion to Water that 850 hath to 1) *(a)* and then immerſed in a Glaſs or other fit Veſſel, almoſt full of fair Water, may hang freely in that Liquor, being on every Side encompaſſed by it. This done, you muſt put into the oppoſite Scale as many Weights as will ſerve to bring the Body hanging in the Water to an exact *Æquilibrium* with the Counterpoiſe, and conſequently the Beam of the Ballance to a Horizontal ſituation. Then take out the Weights newly imploy'd, which gave you the Weight of the Body in the Water, and deducting it from the Weight formerly taken of the ſame Body in the Air, and by the Remainder, which will be the difference of theſe two, divide the whole Weight of the given Body in the Air, and the Quotient will ſhew the Proportion, in ſpecifick Gravity, between the examin'd Solid, and as much Water as is juſt equal to it in Bulk.

A Horſe-hair is made choice of, becauſe it's ſaid to be equiponderant to ſo much Water; and tho' it has been found not to be ſtrictly ſo, yet a Horſe-hair is fitter to be imployed in theſe Tryals than any String, and its ſpecifick Weight differs ſo little from that of Water, that the Difference may be ſafely enough

(a) Sir Iſaac Newton's *Mathematical Principles of Natural Philoſophy.*

neglect-

neglected; and if the Solid propoſed be too heavy to be ſuſtained by a ſingle Horſe-hair, two may be twiſted, or (if need be) more of them.

There remain yet two Remarks, which muſt be pretermitted, if Men will avoid ſome Errors, that are but too often ſlipt into by the Makers of Hydroſtatical Tryals. *Firſt*, Take notice, that the Body to be examined hang freely in the Water, ſo that no part of it touch the Bottom or the Sides of the Veſſel, or reach above the upper Surface of the Water contained in it; for if any of theſe Circumſtances be not taken care of, the true Weight of the Solid will be ſomewhat altered; and if any Corner, or other part of the Body, (and the like may be ſaid of the Horſe-hair 'tis tyed with) tho' but a ſmall one, appear above the Surface of the Water: that extant Portion being not at all ſuſtained by the Liquor, adds more or leſs to the Weight, that the immerſt Body ſhould have.

Care alſo muſt be had, that as nothing but the Water do touch the hanging Body, ſo no part of the Water may touch the Scale whence it hangs. There remains yet ſeveral other Remarks which might be uſefully mentioned, but I ſhall mention no more at preſent, ſeeing I have already ſhewed as exact, and, I preſume, a more expeditious Way of Trying of Gold and Silver, than can be done by finding their ſpecifick Gravity.

F I N I S.