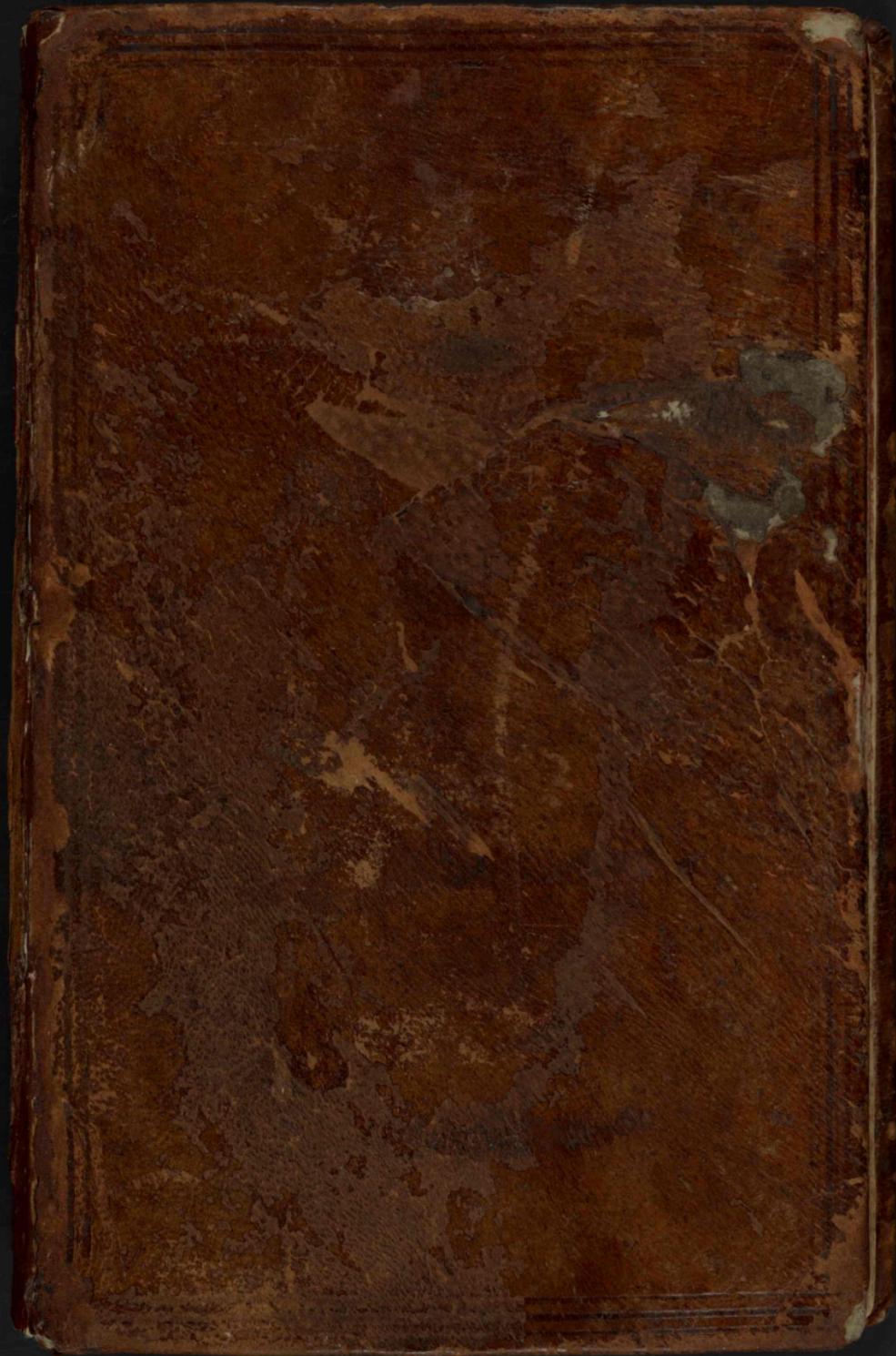


MATHEMATICA

RECREATIONS



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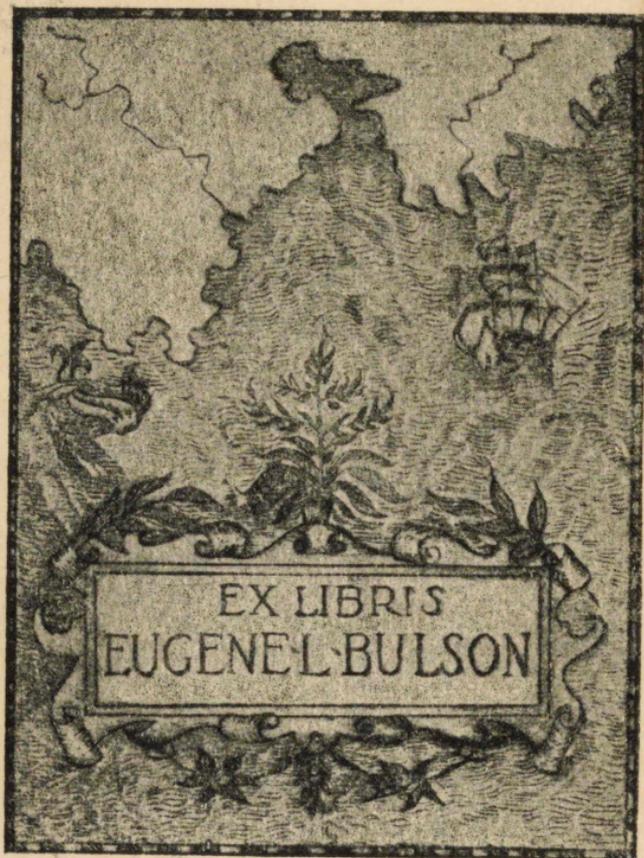


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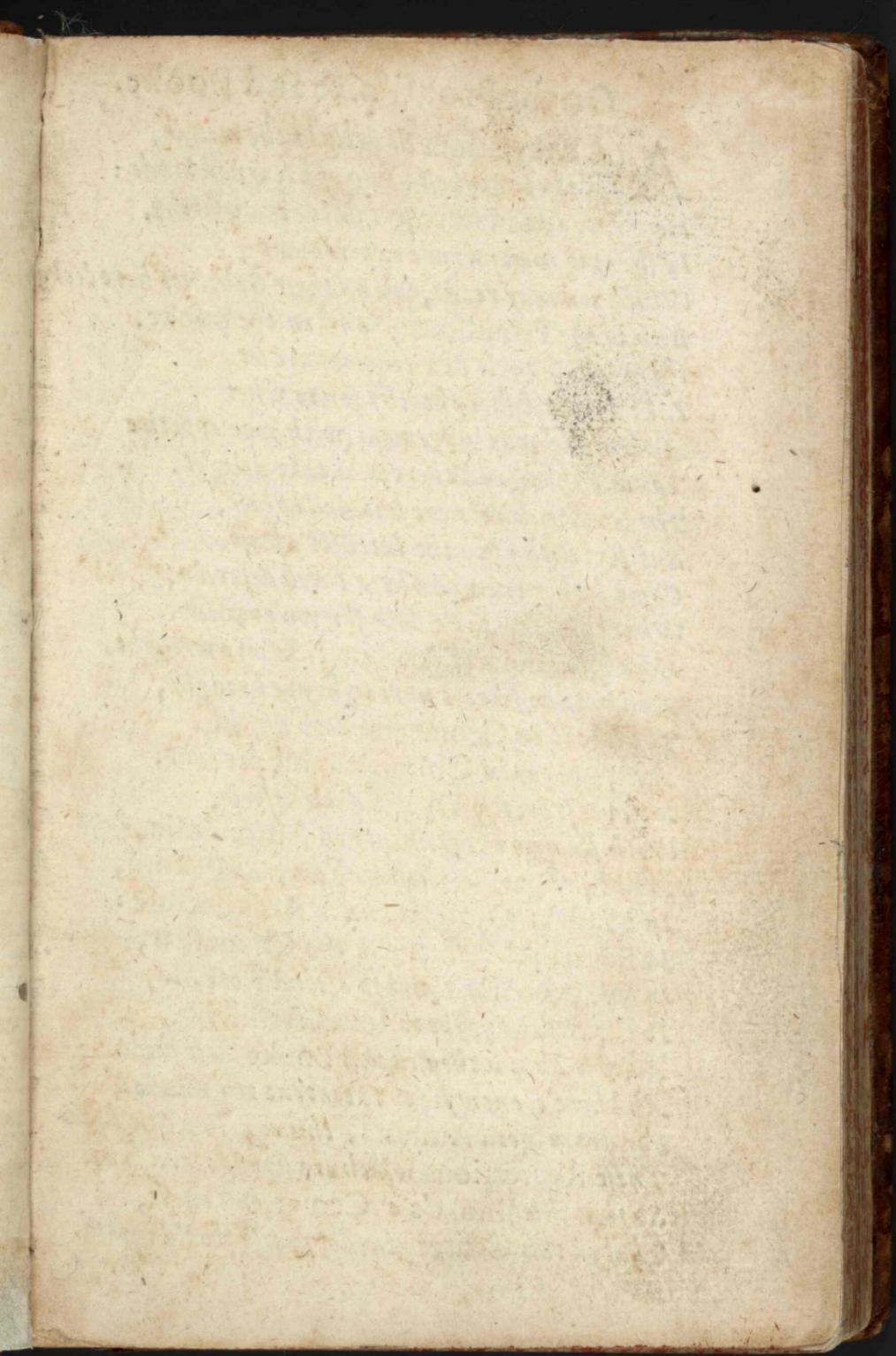
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*[Faint, illegible handwritten marks]*



## On the Frontispice and Booke.

**A**LL Recreations do delight the minde,  
But these are best being of a learned kinde :  
Here Art and Nature strive to give content,  
In shewing many a rare experiment ;  
Which you may reade, and on their Schemes here looke  
Both in the Frontispice, and in the Booke.  
Upon whose table new conceits are set,  
Like dainty dishes, thereby for to whet  
And winne your judgement, with your appetite  
To taste them, and therein to take delight.  
The Senses objects are but dull at best,  
But Art doth give the Intellect a feast.  
Come hither then, and here I will describe,  
What this same table doth for you provide.  
Here Questions of Arithmeticke are wrought,  
And hidden secrets unto light are brought,  
The like it in Geometrie doth unfold,  
And some too in Cosmographie are told :  
It diverse pretty Dyalls doth descric,  
With strange experiments in Astronomie,  
And Navigation with each severall Picture,  
In Musicke, Opticks, and in Architecture :  
In Staticke, Machanicks, and Chimestrie,  
In Waterworkes, and to ascend more hie,  
In Fireworkes, like to Ioves Artillerie.  
All this I know thou in this Booke shalt finde,  
And here's enough for to content thy minde.  
For from good Authors, this our Author drew  
These Recreations, which are strange, and true.  
So that this Booke's a Center, and tis fit,  
That in this Center, lines of praise should meete.

# Mathematicall Recreations.

Or a Collection of sundrie Problemes,  
extracted out of the Ancient and Moderne Philo-  
sophers, as secrets in nature, and experiments in  
*Arithmeticke, Geometrie, Cosmographie, Horologogra-  
phie, Astronomie, Navigation, Musicke, Opticks,  
Architectore, Staticke, Machanicks, Chimestrie,  
Waterworkes, Fireworks, &c.* Not vulgarly made  
manifest untill this time: Fit for *Schollers,*  
*students,* and *Gentlemen,* that desire to know the  
*Philosophicall* cause of many admirable  
Conclusions.

Usefull for others, to acuate and stirre them up  
to the search of further knowledge; and service-  
able to all for many excellent things, both for  
pleasure and *Recreation.*

Most of which were written first in *Greeke* and *Latine,*  
lately compiled in *French,* by *Henry Van Etten*  
*Gent.* And now delivered in the *English* tongue,  
with the *Examinations, Corrections,* and  
*Augmentations.*

---

Printed at *London* by *T. Cotes,* for *Richard Hawkins,*  
dwelling in *Chancery Lane,* neere the *Rowles,* 1633.





TO  
The thrice Noble and  
most generous Lo. the Lo.

Lambert Verreyken, Lo. of  
*Hinden, wolwertem, &c.*

*My honorable Lo.*



Mongst the rare and  
curious Propositi-  
ons which I have  
learned out of the  
studies of the Ma-  
thematicks in the famous Vniver-  
sitie of Pont a Mousson, I have ta-

A 3

ken

## The Contents.

*How is it that a man in one and the same time may have his head upward, and his feet upward, being in one and the same place.* 41

### PROBLEM. XXV.

*Of a Ladder by which two men ascending at one time, the more they ascend the more they shall be asunder, notwithstanding the one be as high as the other.* 42

### PROBLEM. XXVI.

*How is it that a man having but a Rod or Pole of land, doth brag that he may in a right line passe from place to place 3000 miles.* 42

### PROBLEM. XXVII.

*How is it that a man standing upright, and looking which way he will, he looketh true North or South.* 43

### PROBLEM. XXVIII.

*To tell any one what number remains after certaine operations being ended, without asking any question.* 44

### PROBLEM. XXIX.

*Of the play with two severall things.* 45

### PROBLEM. XXXI.

*How to describe a circle that shall touch 3. points placed howsoever upon a plaine, if they be not in a right line.* 47

### PROBLEM. XXXII.

*How to change a circle into a square forme.* 48

### PROBLEM. XXXIII.

*With one and the same compasses, and at one and the same extent or opening, how to describe many circles concentricall, that is, greater or lesser one than another.* 49

PROB-

*The Epistle Dedicatory.*

whole indevours, I shall alwayes  
dedicate unto your Honour, with  
an ardent desire to bee accounted  
ever,

*Your most humble and  
obedient Nephew,  
and Servant*

H. VAN ETTEN.

*The Epistle Dedicatory.*

ken singular pleasure in certaine  
*Problemes* no lesse ingenious than  
recreative, which drew me unto  
the search of demonstrations more  
difficult and serious, some of which  
I have amassed and caused to passe  
the *Presse*, and here dedicate them  
now unto your *Honour*; not that  
I account them worthy of your  
view, but in part to testifie my af-  
fectionate desire to serve you, and  
to satisfie the curious, who de-  
light themselves in these pleasant  
studies, knowing well that the  
*Nobillitie*, and *Gentrie* rather stu-  
die the *Mathematicall Arts*, to con-  
tent and satisfie their affections,  
in the speculation of such ad-  
mirable experiments as are ex-  
tracted from them, than in hope  
of gaine to fill their *Purses*. All  
which studies, and others, with my  
whole



## To the Reader.

**I**t hath beene observed by many, that sundry fine wits as well amongst the Ancient as Moderne, have sported and delighted themselves upon severall things of small consequence, as upon the foote of a fly, upon a straw, upon a point, nay upon nothing; striving as it were to shew the greatnesse of their glory in the smallnesse of the subject: And have amongst most solid and artificiall conclusions, composed and produced sundry Inventions both P hilosophicall and Mathematicall

The Contents.

below.

PROBLEM. XXXXV.

How that if all the powder in the world were inclosed in a bowle of paper or glasse, & being fired on all parts, it could not breake that bowle. 68

PROBLEM. XXXXVI.

To finde a number which being divided by 2. there will remaine 1. being divided by 3. there will remaine 1. and so likewise being divided by 4, 5, or 6. there would still remaine one; but being divided by 3. will remaine nothing. 69

PROBLEM. XXXXVII.

One had a certaine number of Crownes and counting them by 2, and 2. there rested 1. counting them by 3, and 3. there rested 2. counting them by 4, and 4, there rested 3. counting them by 5, and 5, there rested 4. counting them by 6, and 6, there rested 5. but counting them by 7, and 7, there rested nothing, how many crownes might he have. 71

PROBLEM. XXXXVIII

How many sorts of weights in the least manner must there be to weigh all sorts of things betweene one pound and 121. pound, and so unto 364. pound. 71

PROBLEM. XXXXIX.

Of a deceitfull ballance which being empty seemed to be just, because it hangs in Equilibrio, notwithstanding putting 12. pound in one ballance and 11. in the other, it will remaine in Equilibrio. 72

PROBLEM. L.

To heave or lift up a bottle with a straw. 72

PROB

The Epistle to the Reader.

Tyberill, and others) knowing that Art imitating nature, glories alwayes in the variety of things, which she produceth to satisfie the minde of curious inquisitors. And though perhaps these labours to some humorous persons may seeme vaine, and ridiculous, for such it was not undertaken. But for these which intently haue desired and sought after the knowledge of these things, it being an invitation and motive to the search of greater matters, and to imploy the minde in usefull knowledge, rather than to be busied in vaine Pamphlets, Play-bookes, fruitlesse Legends, and prodigious Histories that are invented out of fancie, which abuse many Noble spirits, dull their wits, & alienate their thoughts from laudable and honourable studies. In this Tractate thou maist therefore make choise of such Mathematicall Problemes and Conclusions as may  
de-

the English language  
whole in a volume I shall always  
be obliged unto your Honour with  
my ancient duty to be accounted

Your most humble and  
obedient Servant  
and Son

H. VAN BITHEN

A 2

The Epistle to the Reader.

*thy spirit may easily digest them,  
and put them finely in  
order, though now  
in disorder.*

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## The Contents.

*Of a fine lampe which goeth not out, though o  
carries it in ones pocket, or being rowled on t  
ground will still burne.* 83

### PROBLEM. LXI.

*Any one having thought a card amongst many  
cards, how artificially to discover it out.* 89

### PROBLEM. LXII.

*Three women A, B, C. carried Apples to a market  
to sell: A, had 20. B, had 30. C, 40. they sold as  
many for a penny one as the other, and brought  
home one as much mony as another, how could  
this be?* 90

### PROBLEM. LXIII.

*Of the properties of some numbers.* 91

### PROBLEM. LXIII.

*Of an excellent lampe which serves or furnissheth  
it selfe with oyle, and burnes a long time.* 95

### PROBLEM. LXV.

*Of the play at keyles or nine pins.* 97

### PROBLEM. LXVI.

*Of Spectacles of pleasure.*

*Of Spectacles which give severall colours to the  
visage.* 98

*Of Spectacles which make a Towne seeme to be  
a Citie, one armed man as a company, and a  
peece of gold as many peeces.* 99

*How out of a chamber to see the objects which  
passe by according to the lively perspective.* 100

*Of Gallileus admirable opticke Glasse, which  
helpes one to see the beginning and ending of  
Eclipses the spots in the Sunne, the Starres  
which moves about the Planets, and perspicu  
ously things farrere mote.* 101



# A Table of the Contents, and chiefe points contained in this Booke.

---

## PROBLEM. II.

**H**ow visible objects that are without, and things that passe by, are most lively represented to these that are within. Page 6

## PROBLEM. I.

Of finding of numbers conceived in the minde.

1, 2, 3

## PROBLEM. V.

Of a Geographicall Garden plot, fit for a Prince or some great personage.

14

## PROBLEM. XXXVII.

Any liquid substance as water or wine, placed in a Glasse, may be made to boyle by the motion of the finger, and yet not touching it.

54

## PROBLEM. III.

How to weigh the blow of ones fist, of a mallet, a hatchet or such like.

9

## PROBLEM. XXX.

Two severall numbers being taken by two sundry

dry

The Epistle to the Reader.

ticall, to solace the minde, and recreate the spirits, which the succeeding ages have imbraced; and from them gleaned and extracted many admirable, and rare conclusions, judging that borrowed matter oftentimes yeelds praise to the industrie of its author. Hence for thy use (Courteous Reader) I have with great search and labour collected also, and heaped up together in a body of these pleasant and fine experiments to stirre up and delight the affectionate, (out of the writings of Socrates, Plato, Aristotle, Demosthenes, Pythagoras, Democrates, Plinie, Hiparchus, Euclides, Vitruvius, Diaphantus, Pergæus, Archimedes, Papi Alexandrinus, Vitelius, Ptolomeus, Copernicus, Proclus, Muralicus, Cardanus, Valalpandus, Kepleirus, Gilbertus, Tychonius, Dureirus, Iosepheus, Clavius, Gallileus, Maginus, Euphanus  
Tiberill,

## The Contents.

things, to finde which each of them hath taken. 19

### PROBLEM. VI.

How to dispose three staves which may support each other in the ayre. 15

### PROBLEM. XIII.

Many things being disposed Circular (or otherwise) to finde which of them any one thinks upon. 28

### PROBLEM. XIX.

To finde a number thought upon without asking questions. 33

### PROBLEM. XI.

How a Milstone or other ponderosity may hang upon the point of a Needle without bowing, or any wise breaking of it. 26

### PROBLEM. XX. and XXI.

How a body that is uniforme and inflexible may passe through a hole which is round, square, and Triangular; or round, square and oval-wise, and exactly fill these severall holes. 35, 37

### PROBLEM. X.

How a sticke may stand upon ones finger or a Picke in the middle of a court without falling. 24

### PROBLEM. XXII.

To finde a number thought upon after another manner than these which are formerly delivered. 39

### PROBLEM. XXIII.

To finde out many numbers that sundry persons or any one hath thought upon. 40

### PROBLEM. XXIII.

\*

How

## The Contents.

Of Nero his great Colossus which had a face of  
12. foot large. 119

Of monstrous Gyants,

Of the Gyant Ogge and Goliath. 119, 120

Of the Carkasse of a man found which was in  
length 49. foote; and of that monster found in  
Crete, which had 46. Cubits of height. 120

Of Campefius his relation of a monster of 300  
foot found in Sicile, whose face according to  
the former proportion should be 30. foot in  
length. 121

### PROBLEM. LXXI.

Of the game at the Palme, at Trap, at Bowles,  
Paile-maile, and others. 122

### PROBLEM. LXXII.

Of the game of square formes. 124

### PROBLEM. LXXIII.

How to make the string of a viol sensibly shake  
without any one touching it. 126

### PROBLEM. LXXIII.

Of a vessell which containes 3. severall kinds of  
liquor, all put in at one bung-hole, and drawne  
out at one Tap severally without mixture. 128

### PROBLEM. LXXV.

Of burning Glasses.

Archimedes his way of burning the ships of Sy-  
racuses. 129

Of Proclus his way, and of concave and sphericall  
Glasses which burne; the cause and demonstra-  
tion of burning with Glasses. 131

Of Maginus his way of setting fire to Powder  
in a Mine by Glasses. 131

Of

The Contents.

PROBLEM. XXXIIII.

ny numbers under 10. being thought upon, to  
finde what numbers they were.

51

PROBLEM. XXXV.

Of the play with the ring.

52

PROBLEM. XXXVI.

The play of 3, 4. or more Dice.

53

PROBLEM. XXXVIII.

Of a fine vessell which holds wine or water being  
cast into it at a certaine height, but being filled  
higher it will runne all out of its owne accord.

56

PROBLEM. XXXIX.

Of a glasse very pleasant.

58

PROBLEM. XXXX.

If any one should hold in each hand as many pec-  
ces of money as in the other, how to finde how  
much there is.

59

PROBLEM. XXXXI.

Many Dice being cast, how artificially to disco-  
ver the number of the points that may arise.

60

PROBLEM. XXXXII.

Two mettals as gould and silver or of other kind,  
weighing alike, being privately placed into  
two like boxes, to finde in which of them the  
gold or silver is in.

62

PROBLEM. XXXXIII.

Two globes of divers mettels (as one gold, the  
other copper) yet of equall weight, being put in  
a box as B.G. to finde in which end the gold or  
copper is.

65

PROBLEM. XXXXIIII.

How to represent divers sorts of Rainebowes here

67

The Epistle to the Reader.

delight thee; which kind of learning doth excellently adorne a man, seeing the usefulness thereof, and the manly accomplishments it doth produce: profitable and delightfull for all sorts of people, who may furnish and adorne themselves with abundance of matter in that kind, to helpe them by way of use, and discourse. And to this we have also added our Pyrotechnic, knowing that Beasts have for their object onely the surface of the earth; but hoping that thy spirit which followeth the motion of fire, will abandon the lower Elements, and cause thee to lift up thine eyes to soare in a higher Contemplation, having so glittering a Canopie to behould; and these pleasant and recreative fires ascending may cause thy affections also to ascend. The Whole whereof we send forth to thee, that desirest the scrutability of things; Nature having furnished us with matter,  
thy

The Contents.

PROBLEM. LI.

*How in the middle of a wood or desert, without  
the sight of the Sunne, Starres, shadow or com-  
pass, to finde out the North or South or the 4.  
Cardinall points of the world, East, West, &c.* 75

PROBLEM. LII.

*Three persons having taken Counters, Cards, or  
other things, to finde how much each one hath  
taken.* 77

PROBLEM. LIII.

*How to make a consort of musicke of many parts  
with one voyce or one instrument onely.* 78

PROBLEM. LIIII.

*To make or describe an ovall forme, or that which  
is neare resemble unto it at one turning, with  
a paire of common compasses.* 79

PROBLEM. LV.

*Of a purse difficult to be opened.* 80

PROB. LVI. *Whether is it more hard and ad-  
mirable without compasses to make a perfect cir-  
cle, or being made to finde out the center of it.* 82

PROB. LVI. *Any one having taken 3 Cards,  
to finde how many points they containe.* 83

PROB. LVII. *Many Cards placed in divers  
rankes, to finde which of these Cards any one  
hath thought.* 85

PROB. LVIII. *Many Cards being offered  
to sundry persons, to finde which of those Cards  
any one thinketh upon.* 86

PROBLEM. LIX.

*How to make an instrument that helpes to heare,  
as Gallileus made to helpe to see.* 87

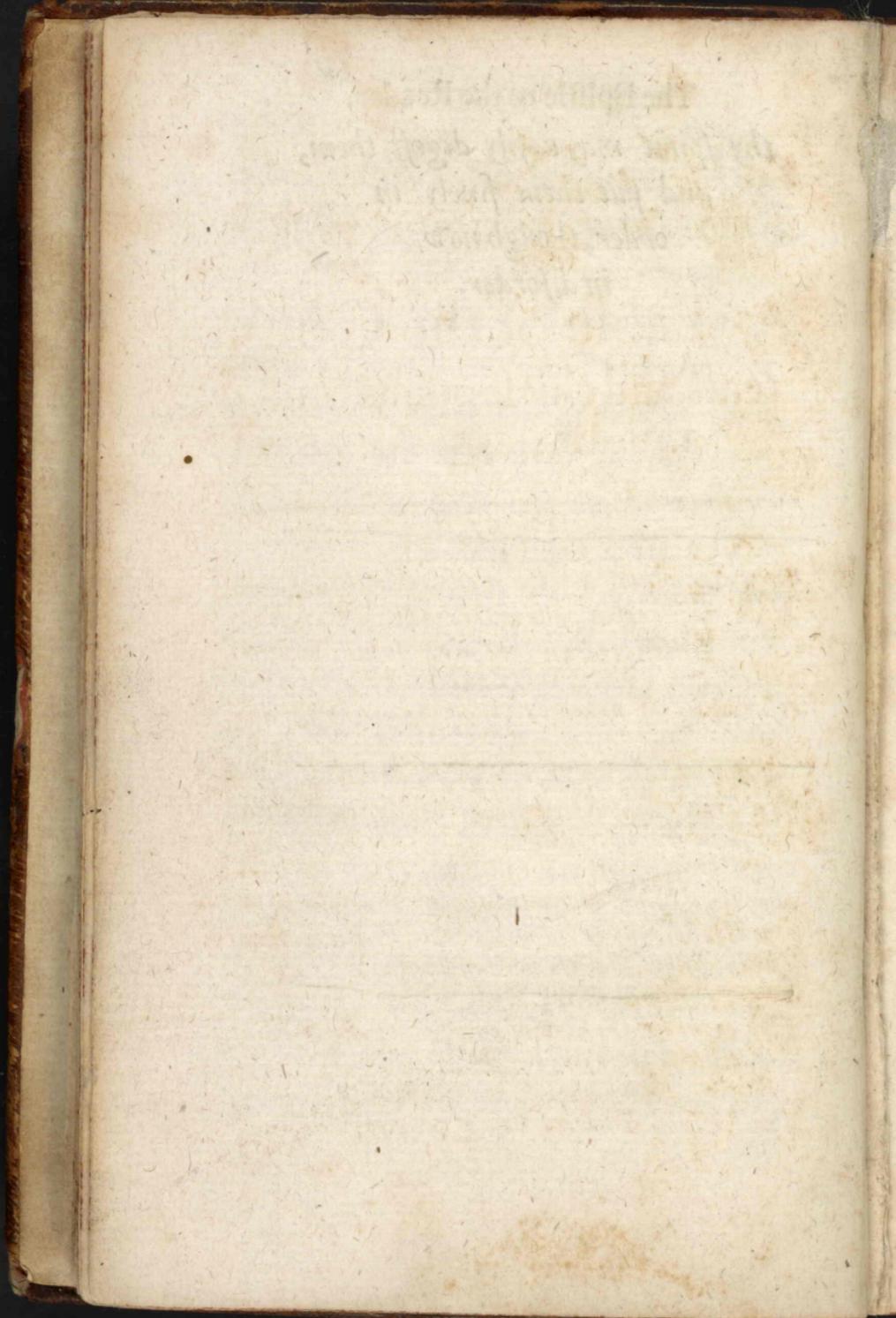
PROBLEM. LX.

## The Contents:

- How an Image may be seene to hang in the ayre  
by helpe of a glasse : and writing read or easi-  
ly understood.* 146
- Experiments upon Gibbous, or convex Spheri-  
call glasses.*
- How lively to represent a whole Citie, fortifica-  
tion, or Army, by a Gibbous glasse.* 147
- How the Images are seene in Concave Glasses.*  
149
- How the Images are transformed by'approching  
to the center of the Glasse, or point of concourse;  
and of an exceeding light that a concave  
Glasse gives by helpe of a candle.* 151
- How the Images : as a man, a sword, or hand, doth  
come forth out of the Glasse.* 152, 153
- Of strange apparitions of Images in the ayre, by  
helpe of sundry Glasses.* 153, 154
- Of the wonderfull augmentation of the parts of  
mans body comming neare the point of inflam-  
mation, or center of the Glasse.* 155
- How writing may be reverberated from a glasse  
upon a wall, and read.* 156
- How by helpe of a concave glasse to cast light in-  
to a Campe, or to give a perspective light to  
Pyoners in a mine, by one candle onely.* 156
- How excellently by helpe of a concave glasse and  
a candle placed in the center, to give light to  
reade by.* 157
- Of other glasses of pleasure.* 158
- Of strange deformed representations by glasses ;  
causing a man to have foure eyes, two mouthes,  
two noses, two heads.*
- Of glasses which give a colour to the visage, and  
make*

The Contents.

of the parts of Gallileus his Glasse.	102
PROBLEM. LXVII.	
Of the Magnes and Needles touched therewith.	
How Rings of Iron may hang one by another in the ayre.	103
Of Mahomets Tombe which hangs in the ayre by the touch of the Magnes.	104
How by the Magnes onely to finde out North and South.	105
Of a secrecie in the Magnes, for discovering things farre remote.	106
Of finding the Poles by the Magnes.	107
PROBLEM. LXVIII.	
Of the properties of <i>Aolipiles</i> or bowles to blow the fire.	108
PROBLEM. LXIX.	
Of the Thermometer, or that which measures the degrees of heat and cold by the ayre.	110
Of the proportion of humane bodies, of statues, of Coloffus, or huge Images and monstrous Gyants.	113
Of the commensuration of the parts of the bodie the one to the other in particular, by which the Lyon was measured by his claw, the Gyant by his thumbe, and Hercules by his foot.	115, 116
Of statues, or Colosses, or huge Images; that mount Athos, metorphis'd by Dynocrates into a statue, in whose hand was a Towne able to receive ten thousand men.	117
Of the famous Coloffus at Rhodes which had 70. cubits in height, and loaded 900. Cammels, which weighed 1080000. pound.	118



## The Contents.

*Of the examination of burning by Glasses.* 133

### PROBLEM. LXXVI.

*Of pleasant questions by way of Arithmetike.*

*Of the Ass and the mule.* 134

*Of the number of souldiers that fought before  
old Troy.* 135

*Of the number of Crownes that two men had.*  
136

*About the houre of the day.* 137

*Of Pythagoras Schollers.* 137

*Of the number of Apples given amongst the Gra-  
ces and the Muses.* 138

*Of the testament or last will of a dying father.* 138

*Of the cups of Crassus.* 139

*Of Cupids Apples.* 139

*Of a Mans Age.* 140

*Of the Lyon of Bronze placed upon a fountaine  
with his Epigramme.* *ibid*

### PROBLEM. LXXVII

*In Opticks, excellent experiments.*

*Principles touching reflections.* 141

*Experiments upon flat and plaine Glasses.* 142

*How the Images seemes to sinke into a  
plaine glasse, and alwayes are seene perpendicu-  
lar to the glasse, and also inversed.* 143

*The things which passe by in a street may by helpe  
of a plaine glasse be seene in a Chamber, and the  
height of a tower or tree observed.* 143

*How severall Candles from one Candle are re-  
presented in a plaine glasse, and glasses alternatly  
may be seene one within another, as also the  
backe parts of the body, as well as the foreparts  
are evidently represented.* 144

How

## The Contents:

<i>Of a Dyall which was about an Obeliske at Rome.</i>	168
<i>Of Dyals with Glasses.</i>	168
<i>Of a Dyall which hath a glasse in the place of the stile</i>	169
<i>Of Dyals with water, which the Ancients used.</i>	171

### PROBLEM. LXXXIII.

<i>Of shooting out of Cannons or great Artillery</i>	
<i>How to charge a Cannon without powder.</i>	173
<i>To finde how much time the Bullet of a Cannon spends in the Ayre before it falls to the ground.</i>	174
<i>How it is that a Cannon shooting upward, the Bullet flies with more violence, than being shot point blanke, or shooting downward.</i>	174
<i>Whether is the discharge of a Cannon so much the more violent, by how much it hath the more length.</i>	176

### PROBLEM. LXXXIII.

<i>Of prodigious progressions, and multiplications of creatures, plants, fruits, numbers, gold, silver, &amp;c.</i>	
<i>Of graines of Mustardseede, and that one graine being sowne, with the increase thereof for 20. yeares will produce a heape greater than all the earth a hundred thousand times.</i>	178
<i>Of Pigges, and that the great Turke with all his revenue, is not able to maintaine for one yeare, a Sow with all her increase for 12. yeares</i>	179
<i>Of graines of Corne, and that 1. graine with all its increase for 12. yeares, will amount</i>	180

## The Contents.

- make the face seeme faire and soule.* 160
- PROBLEM. LXXVIII.
- How to shew one that is suspicious, what is in another Chamber or Roome, notwithstanding the interposition of that wall.* 160
- Corollary, 1. to see the Assiegers of a place, upon the Rampart of a fortification.* 161
- Corollary, 2. and 3. notwithstanding the interposition of walls, and chambers, by helpe of a Glasse things may be seene, which passe by.* 162
- PROBLEM. LXXIX.
- How with a Musket to strike a marke not looking towards it, as exactly as one aymed at it.* 162
- How exactly to shoot out of a Musket to a place which is not seene, being hindred by some obstacle or other interposition.* 163
- PROBLEM. LXXX.
- How to make an Image to be seene hanging in the ayre, having his head downeward.* 164
- PROBLEM. LXXXI.
- How to make a company of representative Soldiers seeme to be as a regiment, or how few in number may be multiplied to seeme to be many in number.* 165
- COROLARIE.
- Of an excellent delightfull Cabinet made of plaine glasses.* 165
- PROBLEM. LXXXII.
- Of fine and pleafant Dyalls in Horologographic.*
- Of a Dyall of herbes for a Garden.* 166
- Of the dyall upon the finger and hand, to finde what of the Clocke it is.* 167
- Of

## The Contents.

*dry persons, how subtiltie to discover which of those numbers each of them tooke.* 46

### PROBLEME. III.

*That a staffe may be broken, placed upon two Glasses, without hurting of the Glasses.* 12

### PROBLEME. VII.

*How to dispose lots that the 5. 6. 9. &c. of any number of persons may escape.* 16

### PROBLEME. XIII.

*How the waight of smoke of a combustible bodie, which is exhaled, may be weighed.* 27

### PROBLEME. XII.

*Of three knives which may be so disposed to hang in the ayre, and moove upon the Point of a needle.* 27

### PROBLEME. XVII.

*Of a deceitfull bowle, to bowle withall.* 32

### PROBLEME. XVI.

*A ponderous, or heavy body may be supported in the ayre without any one touching it.* 30

### PROBLEME. XVIII.

*How a Peare, or Apple, may be parted into any parts, without breaking the rind thereof.* 33

### PROBLEME. XV.

*Of a fine kind of dore which opens and shuts on both sides.* 30

### PROBLEME. IX.

*How the halfe of a vessell which contains 8. measures may be taken, being but onely two other measures, the one being 3, and the other 8, measures.* 22

### PROBLEME. VIII.

*Three persons having taken each of them severall things,*



## The Contents.

- necks, and other experiments upon water, or other liquor.
- First, how water at the foot of a mountaine may be made to ascend to the top of it, and so to descend on the other side of it. 190
- Secondly, to finde how much liquor is in a vessell, onely by using the tap hole. 191
- Thiraly, how is it, that a vessell is sayd to hold more water at the foote of a mountaine, than at the top of it. 191
- 4 How to conduct water from the top of one mountaine to the top of another. 192
- 5 Of a fine fontaine which spouts water very high and with great violence, by turning of a Cocke. 193
- 6 Of Archimedes screw which makes water ascend by descending. 194
- 7 Of a fine fontaine of pleasure. 196
- 8 Of a fine watering pot for gardens. 197
- 9 How easily to take wine out of a vessell at the bung hole without piercing a hole in the vessell. 198
- 10 How to measure irregular bodyes by helpe of water. 198
- 11 To finde the weight of water. 199
- 12 To finde the charge that a vessell may carry, as shippes, boates or such like. 200
- 13 How comes it that a ship having safely sailed in the vast Ocean, and being come into the port or harbour, will sinke downe right. 200
- 14 How a grosse body of mettall may swim upon the water. 201
- 15 How to weigh the lightnesse of the ayre. 203
- 16 Ba-

## The Contents.

- 16 Being given a body, to marke it about, and shew how much of it will sinke in the water, or swim above the water. 204
- 17 To finde how much severall mettles or other bodies doe weigh lesse in the water than in the ayre. 204
- 18 How is it that a ballance having like weights in each scale, and hanging in *Equilibrio* in the ayre, being removed from that place (without deminishing the weights in each ballance, or adding to it) it shall cease to hang in *Equilibrio* sencibly, yea by a great difference of weight. 205
- 19 To shew what waters are heavier one than another, and how much. 206
- 20 How to make a pound of water weigh as much as 10. 20. 30. or a hundred pound of Lead; nay as much as a thousand or ten thousand pound weight. 207

### PROBLEM. LXXXVI.

Of sundry questions of Arithmeticke, and first of the number of sands calculated by Archimedes and Clarius. 208

- 2 Divers mettles being melted together in one body, to finde the mixture of them. 210
- 3 A subtil question of three partners about equality of wine and vessels. 213
- 4 Of a Ladder which standing upright against a wall of 10. foot high, the foot of it is pulled out 6. foot from the wall upon the pavement, how much hath the top of the Ladder descended. 214

### PROBLEM. LXXXVII.

*Witty*

## The Contents.

Witty suits or debates betweene Caius and Ser-  
pronius, upon the forme of fingers: which Geo-  
metricians call Isoperimeter, or equall in cir-  
cuit, or Compasse. 214

Incident: of changing a field of 6. measures square,  
for a long rectangled field of 9 measures in  
length and 3. in breadth: both equall in circuit  
but not in quantitie. 215

2 Incident: about two sacks each of them houl-  
ding but a bushell, and yet were able to hould  
4. bushels. 217

3 Incident: sheweth the deceit of pipes which  
conveies water, that a pipe of two inches dia-  
meter, doth cast out foure times as much water  
as a pipe of one such diameter. 218

7. heaps of Corne of 10. foote every way, is not as  
much as one heape of Corne of 20. foot every  
way. 218

### PROBLE M. LXXXVIII.

Of sundry questions in matter of Cosmogra-  
phic, and Astronomy.

In what place the middle of the earth is supposed  
to be. 219

Of the depth of the earth, and height of the hea-  
vens, and the compasse of the world, how much.  
219

How much the starry Firmament, the Sunne, and  
the Moone are distant from the center of the  
earth. 220

How long a Milstone would be falling to the cen-  
ter of the earth from the superficies, if it might  
ter have passage. 220

How long time a man or a bird may be in com-  
passing

## The Contents.

r=	passing the whole earth.	220
o-	If a man should ascend by supposition 20. miles	
-	every day: how long it would be before he ap-	
4	proach to the Moone.	221
e,	The Sunne moves more in one day than the	
in	Moone in 20. dayes.	221
it	If a milstone from the orbe of the Sunne should	
5	descend a thousand miles in an houre, how long	
l.	it would be before it come to the earth.	221
ld	Of the Sunnes quicke motion, of more than 7500.	
7	miles in one minute.	221
cb	Of the rapt and violent motion of the starry Fir-	
a-	rament, which if a horseman should ride eve-	
er	ry day 40. miles, he could not in a thousand	
8	yeares make such a distance as it moves every	
as	houre.	221
ry	To finde the Circle of the Sun by the fingers.	213
8	<b>PROBLEM. LXXXIII.</b>	
a-	Of finding the new and full Moone in each	
a-	moneth.	224
ed	<b>PROBLEM. LXXXIII.</b>	
9	To finde the Latitude of Countries.	225
a-	<b>PROBLEM. LXXXV.</b>	
b,	Of the Climats of Countries, and how to finde	
9	them.	225
nd	<b>PROBLEM. LXXXVI.</b>	
be	Of Longitude and Latitude of the places of the	
o	earth and of the Starrs of the Heavens.	227
n-	To finde the Longitude of a Countrey.	228
ht	Of the Latitude of a Countrey.	229
oo	To finde the Latitude of a Countrey.	230
s-	To finde the distance of places.	230
ig	Of the Longitude, Latitude, Declination, and di-	
	* *	stance

## The Contents.

- Distance of the starres.* 231  
*How is it that two Horses or other creatures coming into the world at one time, and dying at one and the same instant, yet the one of them to be a day older than the other.* 232

### Certaine fine Observations.

- In what places of the world is it that the needle hangs in Equilibrio, and verticall.* 233  
*In what place of the world is it the sunne is East or west but twice in the yeare.* 233  
*In what place of the world is it that the Sunnes Longitude from the Equinoctiall points and Altitude, being equall, the Sunne is due East or West.*  
*That the Sunne comes twice to one point of the Compasse in the forenoone or afternoone.* 233  
*That in some place of the world there is but two kinds of winde all the yeare.* 233  
*Two ships may be two leagues asunder under the equinoctiall, and sayling North at a certaine parallell they will be but just halfe so much.* 133  
*To what inhabitants and at what time the Sunne will touch the north part of the Horizon at midnight.* 234  
*How a man may know in his Navigation when he is under the Equinoctiall.* 234  
*At what day in the yeare the extremitie of the stils shadow in a Dyall makes a right line.* 234  
*What height the Sunne is of and how farre from the Zenith, or Horizon, when a mans shadow is as long as his height.* 234

PROBLE M. LXXXVII.

To

## The Contents.

231	To make a Triangle that shall have three right Angles.	234
	PROBLEM. LXXXVIII.	
232	To divide a line in as many parts as one will, without compasses or without seeing of it.	235
	PROBLEM. LXXXIX.	
233	To draw a line which shall incline to another line, yet never meete, against the Axiome of Parallels.	236
	PROBLEM. C.	
233	To finde the variation of the Compasse by the Sunne shining.	237
	PROBLEM. CI.	
234	To know which way the winde is in ones Chamber without going abroad.	238
	PROBLEM. CII.	
235	How to draw a parallell sphericall line with great ease.	239
	PROBLEM. CIII.	
236	To measure an height onely by helpe of ones Hat.	240
	PROBLEM. CIIII.	
237	To take an height with two strawes.	240
238	In Architecture how statues or other thing in high buildings shall beare a proportion to the eye below eyther equall, double, &c.	242
	PROBLEM. CVI.	
239	Of deformed figures which have no exact proportion, where to place the eye to see then direct.	243
	PROBLEM. CVII.	
240	How a Cannon that hath shot may bee covered from the battery of the enemy.	244
	PROB-	

The Contents.

PROBLEM. CVIII.

*Of a fine Lever by which one man alone may  
place a Cannon upon his Carriage.* 245

PROBLEM. CIX.

*How to make a Clocke with one wheele.* 246

Of waterworkes.

PROBLEM. CX.

*How a child may draw up a hogshead of water  
with ease.* 247

PROBLEM. CXI.

*Of a Ladder of Cords to carry in ones pocket, by  
which he may mount a wall or Tower alone.* 248

PROBLEM. CXII.

*Of a marvelous Pumpe which drawes up great  
quantity of water.* 249

PROBLEM. CXIII.

*How naturally to cause water to ascend out of a  
Pit.* 250

PROBLEM. CXIIII.

*How to cast water out of a fontaine very high.* 252

PROBLEM. CXV.

*How to empty the water of a Pit by helpe of a  
Cisterne.* 253

PROBLEM. CXVI.

*How to spout out water very high.* 253

PROBLEM. CXVII.

*How to re-animate simples though brought a  
thousand miles.* 255

PROBLEM. CXVIII.

*How to make a perpetuall motion.* 155

PROB-

## The Contents.

### PROBLEM. CXIX.

*Of the admirable invention of making the Philosophers Tree, which one may see to grow by little and little.* 256

### PROBLEM. CXX.

*How to make the representation of the great world.* 257

### PROBLEM. CXXI.

*Of a Cone, or Pyramidall figure that moves upon a Table.* 258

### PROBLEM. CXXII.

*How an Anvill may be cleaved by the blow of a Pistoll.* 258

### PROBLEM. CXXIII.

*How a Capon may be rosted in a mans travells at his saddle bow.* 259

### PROBLEM. CXXIII.

*How a Candle may be made to burne three times longer than usually it doth.* 259

### PROBLEM. CXXV.

*How to draw wine out of water.* 260

### PROBLEM. CXXVI.

*Of two Marmouzets, the one of which lights a Candle and the other blowes it out.* 261

### PROBLEM. CXXVII.

*How to keepe wine fresh without Ice or Snow in the height of Summer.* 262

### PROBLEM. CXXVIII.

*To make a Cement which lasted as marble, resisting ayre and water.* 262

### PROBLEM. CXXIX.

*How to melt mettles upon a shell with little fire.* 263

PROB-

The Contents.

PROBLEM. CXXX.

*Of the hardning of Iron and Steele.*

263

PROBLEME. CXXXI.

*To preserve fire as long as you will, imitating  
the inextinguable fire of Vestales.*

264

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FINIS.

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## By vway of ad- vertisement.

Five or six things I have thought worthy  
to declare before I passe further.



*First, that I place not the specu-  
lative demonstrations with all  
these Problemes, but content  
my selfe to shew them as at the  
fingers end: which was my  
plot & intention, because these which under-  
stand the mathematicks, can conceive them  
easily; others for the most part will content  
themselves onely with the knowledge of them,  
without seeking the reason.*

*Secondly, to give a greater grace to the  
practise of these things, they ought to be con-  
cealed as much as they may, in the subtiltie of  
the way: for that which doth ravish the spirits  
is, an admirable effect, whose cause is un-  
knowne: which if it were discovered, halfe  
the pleasure is lost, therefore all the finenesse,*

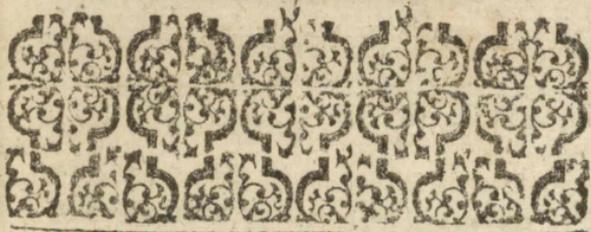
## By way of Advertisement.

*consists in the dexterity of the Act, concealing the meanes, and changing often the streame.*

Thirdly, great care ought to be had that one deceive not himselfe, that would declare by way of Art to deceive another: this will make the matter contemptible to ignorant Persons, which will rather cast the fault upon the Science, than upon he that shewes it: when the cause is not in the Mathematicall principles, but in him that sayles in the acting of it.

Fourthly, in certaine Arithmeticall propositions they have onely their answers as I found them in sundry Authors, which any one being studious of Mathematicall learning, may finde their originall, and also the way of their operation.

Fifthly, because the number of these Problemes, and their dependences are many, and intermixed, I thought it convenient to gather them into a Table: that so each one according to his fancie, might make best choise of that which might best please his palet: the matter being not of one nature, nor of like subtiltie: But whosoever will have patience to reade on, shall finde the end better than the beginning.



# MATHEMATICALL RECREATION.

## PROBLEME. I.

To finde a number thought upon.



*Id him that hee Quadruple the  
Number thought upon, that is,  
multiply it by 4 and unto it bid  
him to adde, 6. 8. 10. or any  
Number at pleasure : and let  
him take the halfe of the summe,*

*then aske how much it comes to : for then if  
you take away halfe the Number from it which  
you willed him at first to adde to it, there  
shall remiaie the double of the number  
thought upon.*

*Example.*

The Number thought upon.	5.
The Quadruple of it.	20.
Put 8. unto it, makes	28.
The halfe of it is	14.
	take

Take away halfe the number }  
 added frō it, viz. 4. the rest is } 10.  
 The double of the number thought upon,  
 viz, 10.

*Another way to finde what number  
 was thought upon.*

**B**id him which thinketh, double his *Num-  
 ber*, and unto that double adde 4. and bid him  
 multiplie that same product by 5, and unto that  
 product, bid him adde 12. and multiply that  
 last *number* by 10. (which is done easily by set-  
 ting a Ciphar at the end of the *number*;) then  
 aske him the last number or product, and  
 from it secretly subtract 320. the remainder  
 in the hundreth place, is the *number* thought  
 upon.

*Example.*

The <i>number</i> thought upon	7.	} For which 700. account onely but the <i>number</i> of the hundreds viz. 7. so have you the <i>number</i> thought upon.
His double	14.	
To it adde 4, makes	18.	
Which multiplied by 5, maks	90.	
To which ad 12 makes	102.	
This multiplied by 10 which is onely by ad- ding a Ciphar to it, makes	1020.	
From this subtract	320.	
Rest	700.	

To finde numbers conceived upon otherwise than the former.

**B**Id the partie which thinks the number, that he triple his thought, cause him to take the halfe of it : if it be odde take the least halfe and put one unto it. : then will him to Triple the halfe and take halfe of it as before ; lastly, aske him how many nines there is in the last halfe, and for every 9. account 4. in your memorie, for that shall shew the number thought upon, if both the Triples were even : but if it be odde at the first Triple, and even at the second, for the one added unto the least halfe keepe one in memorie : if the first Triple be even and the second odde, for the one added unto the least halfe keepe two in memorie : lastly if at both times in tripling, the numbers be odde, for the two added unto the least halfe, keepe three in memorie, these cautions observed and added unto as many fowes as the partie sayes there is nines contained in the last halfe, shall never faile you to declare, or discern truly what number was thought upon.

*Example.*

The number thought upon,	4. or 7.
The Triple	12. or 21.
The halfe there of 6. or 10. I put to it makes	17.
The Triple of the halfe	18. or 33.
The halfe 6. or 16. I put to it maks	17.
The number of nines in the last halfe	1. or 1.

The first 1. representeth the 4. number thought upon, and the last 1. with the caution makes 7. the other number thought upon.

*Note.*

Order your method, so that you bee not discovered: which to helpe you may with dexteritie, and industrie make additions, *Subtractions*, multiplications, divisions, &c. and in stead of asking how many nines there is: you may aske how many eights, tens, &c. there is, or subtract 8. 10. &c. from the number which remains, for to finde out the number thought upon.

Now touching the *Demonstrations* of the former directions, and others which follow, they depend upon the 2. 7. 8. and 9. *Booke* of the *Elements* of *Euclid*: upon which 2. *Booke* and 4. *proposition* this may bee extracted for these which are more learned for the finding of any number that any one thinketh on.

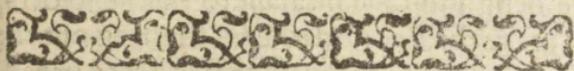
*Bid* the partie that thinkes, that hee breake the number thought upon into any two parts and unto the *squares* of the parts, let him add the double product of the parts: then aske what it amounteth unto, so the *Root Quadr* shall be the number thought upon.

The number thought upon 5. the parts suppose 3. and 2.

The square of 3. makes 9. }  
 The square of 2. makes 4 } The summe of these  
 The product of } three numbers 2 5. the  
 the parts viz. 3. by } square Root of which  
 2. makes 6. which } is 5. the number  
 5. doubled makes } thought upon.

Or more compendiously, it may be deliv-  
 ed thus,

Breake the *number* into two parts, and to  
 the product of the parts, adde the *square* of  
 halfe the difference of the parts, then the *Root*  
*Quadrante* of the aggregate is halfe the *number*  
 conceived.



EXAMINATION.

**T**He Problemes which concern Arithmetick,  
 we examine not, for these are easie to any one  
 which hath read the grounds and prin-  
 ciples of Arithmeticke: but we especially touch  
 upon that, which tends to the speculations of  
 Physicke, Geometrie and Optickes, and such o-  
 thers which are of more difficultie, and more  
 principally to be examined and considered.

## PROBLEM. II.

How to represent to these which are in a chamber that which is without, or all that which passeth by.

THIS is one of the finest experiments in the *Optiques*, and it is done thus, chuse a *Chamber* or place which is towards the street, frequented with people, or which is against some faire flourishing object, that so it may be more delightfull and pleasant to the beholders, then make the *Room* darke by shutting out the light, except a small *hole* of sixe pence broad, this done, all the *Images* and species of the object which are without, will be seene within: and you shall have pleasure to see it not onely upon the wall but especially upon a sheete of white *paper* or some white cloth hung nere the *hole*: and if unto the *hole* you place a round *Glasse*, that is, a *Glasse* which is thicker in the middle than at the edge: such as is the common burning *Glasses*, or such which old people use, for then the *Images* which before did seeme dead, and



of a darkish colour, will appeare and be seene upon the paper, or white *cloth*, according to their naturall colours, yea more lively than their naturall; and the appearances will be so much the more beautifull, and perfect, by how much the *hole* is lesser, the day cleare & the sun *shining*. It is pleasure to see the beautifull and goodly representation of the *Heavens*, intermixed with *clouds* in the *Horizon*, upon a wooddy situation, the motion of *Birds* in the *Aire*, of *Men*, and other *Creatures* upon the ground, with the trembling of *Plants*, tops of *Trees*, and such like, for every thing will be seene within even to the life, but inverfed: notwithstanding this beautifull paint will so naturally represent it selfe in such a lively *perspective*, that hardly the most accurate *Painter* can represent the like. Now the reason why the *Images* and objects without are inverfed, is because the *species* doe intersect one another in the *hole*: so that the *species* of the feet ascend, and these of the head descend.

But heere note, that they may be Represented right two manner of wayes; first with a *concave glasse*, secondly, by helpe of another *convex glasse*: disposed or placed betweene the paper and the other *Glasse*: as may



be seene here by the figure.

Now I will adde here onely by passing by, for such which affect painting, and portraiture, that this experiment may excellently helpe them, in the lively painting of things perspective wise, as *Topographicall cards*, &c. and for philosophers, it is a fine secret to explaine the organ of the sight, for the hollow of the eye is taken as the *close Chamber*, the balle of the Aple of the eye, for the *hole of the Chamber*, the *Crystalline humor* at the small of the *Glasse*, and the bottome of the eye, for the *wall*, or leafe of *Paper*.



### EXAMINATION.

**I**T is false that the species being pressed together or contracted doth performe it upon a wall, for the species of any thing doth represent it selfe not onely in one hole of a window, but in infinite holes; even unto the whole Spheare, or at least unto a Hemisphere (*intellectuall in a free medium*) if the beames or reflections be not interposed, & by how much the hole is made lesse to give passage to the species, by so much the more lively are the Images formed.

In *convexe*, or *concave* Glasses the Images will be disproportionable to the eye, by how much they are more *concave*, or *convexs*, and by how  
much

much the parts of the Image comes neare to the Axis, for these that are neare are better proportionated, than these which are farther off.

But to have them more lively, and true, according to the imaginariis conicall section, let the hole be no greater than a pins head made upon a peece of thinne Brasse, or such like, which hole represents the top of the Cone, and the Base thereof the terme of the species: this praëlice is best when the Sunne shines upon the hole, for then the objects which are opposite to that plaine, will make two like Cones, and will lively represent the things without, in a perfect inversed perspective, which drawne by the Pensell of some artificiall Painter, turne the paper upside downe, and it will be direct, and to the life.

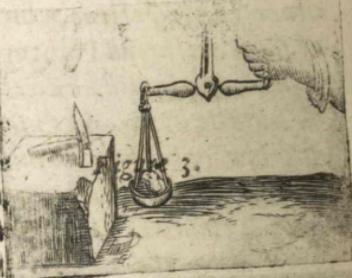
But the apparences may be direct, if you place another hole opposite unto the former so that the spectator be under it; or let the species reflect upon a Concave Glasse, and let that Glasse reflect upon a paper, or some white thing.

PROBLEM. III.

To tell how much waighs the blow of ones fist, of a Mallet, Hatchet or such like, or resting without giving the blow.

Scaliger in his 331. exercise against Cardan, relates that the Mathematicians of Maximilian the Emperour did propose upon a day

this *Question*, and promised to give the resolution; notwithstanding *Scaliger* delivered it not, and I conceive it to be thus. Take a *Balance*, and let the fist, the *Mallet* or *Hatchet* rest upon the *Scale* or upon the beame of the *Balance*; and put into the other *scale*, as much weight as may counterpoise it; then charging or laying more waight into the *Scale*, and striking upon the other end: you may see how much one *blow* is heavier than another, and so consequently how much it may waygh: for as *Aristotle* saith; the motion that is made in striking ads great waight unto it, and so much the more, by how much it is quicker: therefore in effect if there were placed a thousand *mallets*, or a thousand pound waight upon a stone, nay though it were exceedingly pressed downe by way of a vice, by levers or other mechanick *In-gine*, it would be nothing to the rigor and violence of a blow.



Is it not evident that the edge of a *knife* laid upon *butter*, and a *hatchet* upon a leafe of *Paper*, without striking makes no impression, or at least enters not; but striking upon the *wood* a little, you may presently see what effect it hath, which is from the quicknesse of the motion, which breakes and enters without resistance,

if

It be extreame quicke, as experience shewes us, in the blowes of *Arrows*, of *Cannons*, *Thunderboults*, and such like.



## EXAMINATION.

**T**His Probleme was extracted from Scaliger, who had it from Aristotle, but somewhat refractory compiled, and the strength of the effect he sayes depends onely in the violence of the motion; then would it follow that a little light hammer upon a peece of wood being quickly caused to smite, would give a greater blow and doe more hurt than a great sledge striking soft; this is absurd, and contrary to experience: therefore it consists not totally in the motion, for if two severall hammers, the one being 20. times heavier than the other, should move with like quicknesse, the effect would be much different: there is then something else to be considered besides the Motion which Scaliger understood not, for if one should have asked him, what is the reason that a stone falling from a window to a place neare at hand is not so forceable, as if it fell farther downe; and when a bullet flying out of a peece and striking the marke neare at hand, will not make such an effect as striking the marke further off: but wee suppose that Scaliger and Cardanus who handles this subject, would not  
bee

bee lesse troubled to resolve this, than they have  
bee in that.

PROBLEM. IIII.

How to breake a staffe which is laid upon two  
Glasses full of water, without breaking  
the Glasse, spilling the water, or  
upon two Reeds or Strawes  
without breaking  
of them.

**F**irst place the Glasses which are full of water  
upon two joynt stooles, or such like, the  
one as high as the other from the ground, and  
distant one from another by 2. or 3. foote, then  
place the ends of the staffe upon the edges of the  
two Glasses so that they bee sharpe; this done  
with all the force you can, with another staffe  
strike the staffe which is upon the two Glasses  
in the middle, and it  
will breake without  
breaking the Glasses  
or spilling the water.  
In like manner may  
you doe upon two  
Reeds, held in the  
aire without breaking  
them: thence Kitchen-  
boyes often breake  
bones of mutton upon  
their hand, or with a



napkin without any hurt, in onely striking upon the middle of the bone, with a *knife*.

Now in this act the two ends of the *staffe* in breaking slides away from the *Glasses*, upon which they were placed; hence it commeth that the *Glasses* are no wise indangered, no more than the knee upon which a *staffe* is broken, for as much as in breaking it presteth not: as *Aristotle* in his *Mechanicke questions* observeth.



EXAMINATION.

**I**T were necessary here to note, that this thing may be experimented, first, without *Glasses*, in placing a small slender *Staffe* upon two props, and then making tryall upon it, by which you may see how the *Staffe* will either breake, bow, or depart from his props: and that eyther directly, or obliquely: But why by this violence, that one *Staffe* striking another, (which is supported by two *Glasses*) will bee broken without offending the *Glasses*, is as great a difficultie to be resolved as the former.

PROB-

## PROBLEM. V.

*How to make a faire Geographicall Card in a Garden Plot, fit for a Prince, or great personage.*

**I**T is usuall amongst great men to have faire *Geographicall mappes*, large *Cards*, and great *Globes*, that by them they may as at once have a view of any place of the world, and so furnish themselves with a generall knowledge, not onely of their owne *kingdomes* forme, situation, *Longitude*, *Latitude*, &c. but of all other places in the whole *Vniverse*, with their *Magnitudes*, *Positions*, *Climats*, and distances.

Now I esteeme that it is not unworthy for the meditations of a *Prince*, seing it carries with it many profitable and pleasant contentments: if such a *Card* or *Mappe* by the advice and direction of an able *Mathematitian* were *Geographically* described in a *Garden plot* forme, or in some other convenient place; and in stead of which generall description might particularly, and Artificially be prefigured his whole *kingdomes* and dominions, the *Mountaines* and *Hills* being raised like small *hillocks* with turfes of earth, the *vallies* somewhat concave; which will be more agreeable & pleasing to the *Eye*, than the description in plaine *Mapps* and *Cards*, within which may be presented, the *townes*, *villages*, *Castles*, or other remarkable *edifices* in small greene *Mossie* bankes, or *springworks* proportionall to the *plat forme*,  
the

the *forrests* and *woods* represented according to their forme and capacitie, with *heerbs* and *stoubs*, the *great rivers*, *lakes* and *ponds*, to dilate themselves according to their course from some Artificiall *fountain* made in the *Garden* to passe through *Channels*; then may there bee composed *walkes* of pleasure, *Ascents*, places of repose adorned with all varietie of delightful *heerbs* & *flowers*, both to please the *eye*, or other senses. A *Garden* thus accommodated shall farre exceede that of my *Lo. of Verulam*s specified in his *Essayes*; that being onely for delight and plasure, this may have all the properties of that, and also for singular use, by which a *Prince* may in little time personally visite his whole *kingdome*, and in short time know them distinctly, and so in like manner may any particular man *Geographically* prefigure his owne possession, or heritage.

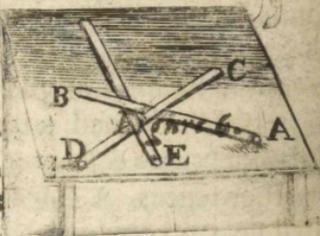
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PROBLEM. VI.

*How three staves, knives, or likebodies may be conceived to hang in the Aire, without being supported by any thing, but by themselves.*

**T**ake the first *staffe* *A. B.* raise up in the *Aire*, the end *B.* and upon him croswise place the *staffe* *C. B.* then lastly in *Triangle* wise place the third *staffe* *E. F.* in such manner that it may be under *A. B.* and yet upon *C. D.* I say that these staves so disposed cannot fall, and  
the

the space *C.B.E.* is made the stronger, by how much the more it is pressed downe, if the *staves* breake not, or sever themselves from the *triangular* forme: so that alwayes the Center of gravitie be in the Center of the *Triangle*: for *A.B.* is supported by *E.F.* and *E.F.* is helde up by *C.D.* and *C.D.* is kept up from falling by *A.B.* therefore one of these *staves* cannot fall, and so by consequence none.




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PROBLEM VII.

*How to dispose as many men, or other things, in such sort that rejecting, or casting away the 6.9.10. part, unto a certaine number, there shall remaine these which you would have.*

**O**Rdinarily the proposition is delivered in this wise: 15. *Christians* and 15. *Turkes* being at Sea in one *Shippe*, an extreme tempest being risen, the Pilot of the *Shippe* say it is necessary to cast over board halfe of the number of *Persons* to disburthen the *Shippe*, and

to save the rest : now it was agreed to bee done by *lot* and therefore they content to put themselves in ranke, counting by nine and nine the ninth *Person* should alwayes be cast into the *Sea*, untill there were halfe throwne over board; Now the *Pilote* being a *Christian* in-deavoured to save the *Christians*, how ought hee therefore to dispose the *Christians*, that the *lot* might fall alwayes upon the *Turkes*, and that none of the *Christians* be in the ninth place?

The resolution is ordinarily comprehended in this verse,

*Populeam virgam mater regina ferebat.*

For having respect unto the vowels, making *a* one, *e* two, *i* three, *o* foure and *u* five : *o* the first vowell in the first word sheweth that there must bee placed 4. *Christians*, the next vowell *u*, signifieth that next unto the 4. *Christians* must be placed 5. *Turkes*, and so to place both *Christians* and *Turkes* according to the quantitie and value of the vowels in the words of the verse, untill they be all placed: for then counting from the first *Christian* that was placed, unto the ninth, the *lot* will fall upon a *Turke*, and so proceede. And here may be further noted that this *Probleme* is not to bee limited, seeing it extends to any *number* and order whatsoever, and may many wayes be usefull for *Captaines*, *Magistrats*, or others which have divers *persons* to punish, and would chastise chiefly the unruliest of them, in taking the 10, 20, or 100, person, &c. as we reade was

commonly practised amongst the ancient *Romans*: heretofore to apply a generall rule in counting the third, 4. 9. 10. &c. amongst 30. 40. 50. persons, and more or lesse; this is to bee observed: take as many unites as there are *persons*, and dispose them in order privately: as for example, let 24. *men* bee proposed to have committed some outrage, 6. of them especially are found accessary: and let it be agreed that counting by 8. and 8. the eighth man should be alwayes punished: Take therefore first 24. unites, or upon a peece of paper write downe twenty foure Ciphars, and account from the beginning to the eighth, which eighth marke, and so continue counting alwayes marking the eighth, untill you have markt 6. by which you may easily perceive how to place those 6. men that are to bee punished, and so of others. It is supposed that *Iosephus* the Author of the *Iewish History*, escaped the danger of death by helpe of this *Probleme*; for a worthy Author of belife reports in his eighth Chapter of the third Booke of the destruction of *Ierusalem*, that the Towne of *Iotapata* being taken by maine force by *Vespasian*; *Iosephus* being governour of that Towne accompaied with a troope of 40. Souldiers, hid themselves in a *Cave* in which they relolved rather to famish than to fall into the hands of *Vespasian*: and with a bloody resolution in that great distresse would have butchered one another for sustenance: had not *Iosephus* perswaded them to die by

lot, and order, upon which it should fall : Now seeing that *Iosephus* did save himselfe by this Art : It is thought that his industrie was exercised by the helpe of this *Probleme*; so that of the 40. persons which hee had, the third was alwayes killed. Now by putting himselfe in the 16. or 31. place he was saved, and one with him which hee might kill, or easily perswade to yeeld unto the *Romans*.

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PROBLEM. VIII

*Three things, and three persons proposed,  
to finde which of them hath either  
of these three things.*

**L** Et the three things bee a *Ring*, a peece of *Gold*, and a peece of *Silver*, or any other such like, and let them bee knowne privatly to your selfe, by these three vowels, *a e i*: or let there bee three persons that have different names, as *Ambrose*, *Edmond* and *Iohn*; which privatly you may note or account to your selfe once knowne by the aforesaid vowels, which signifie for the first vowel 1. for the second vowel 2. for the third vowel 3.

Now if the sayd three persons should by the mutual consent of each other privatly change their names, it is most facill by the course and excellencie of numbers, distinctly to declare each ones name, so interchanged : or of three persons in private, the one should take a *Ring*, the

C 2

other

other a peece of *Gold*, and the third should take a peece of *Silver*; it is easie to finde which hath the *Gold*, the *Silver*, or the *King*, and it is thus done.

Take 30 or 40. *Counters* (of which there is but 24. necessary) that so you may conceale the way the better, and lay them downe before the parties, and as they sit or stand give to the first 1. *Counter*, which signifieth a the first vowel, li, to the second 2. *Counters* which represents the second vowel, and to the third 3. *Counters* which stands for i. the third vowel: then leaving the other *Counters* upon the *Table*, retire apart, and bid him which hath the *Ring*, take as many *Counters* as you gave him, and hee that hath the *Gold*, for every one that you gave him, let him take 2. and he that hath the *Silver* for every one that you gave him let him take 4. this being done, consider to whom you gave one *Counter*, to whom two, and to whom three; and marke what number of *Counters* you had at the first, for there are necessarily but 24. as was sayd before, the surpluse you may privately reject. And then there will be left either 1. 2. 3. 5. 6. or 7. & no other number can remaine, w<sup>ch</sup> if there be, then they have failed in taking according to the directions delivered: but if either of these numbers doe remaine, the resolution will bee discovered by one of these 6. words following, which ought to be had in memory, viz.

*Salve, certa, anima, semita, vita, quies.*

1.      2.      3.      5.      6.      7.

As

As suppose 5. did remaine, the word belonging unto it is *femita*, the vowels in the first two fillables are *e* and *i*, which sheweth according to the former directions that to whom you gave 2. *Counters* he hath the *Ring* (ieeing it is the second vowell represented by two as before) and to whom you gave the 3. *Counters* he hath the *Gould*, for that *i* represents the third vowell, or 3. in the former direction, and to whom you gave one *Counter*, he hath the *Silver*, and so of the rest: the varietie of changes in which exercise, is layd open in the Table following.

	rest	men	hid	rest	men	hid
1		1	a		1	
1		2	e	5	2	
		3	i		3	
2		1	e		1	
		2	a	6	2	
		3	i		3	
		1	a		1	
3		2	i	7	2	
		3	e		3	

This feat may be done also without the former words by helpe of the *Circle A.* for having divided the *Circle* into 6. parts, write 1. within and 1. without, 2. within and 5. without, &c. the first 1. 2. 3. which are within with the numbers over them, belongs to the upper semicircle; the other numbers both within and without, to the under semicircle;

C 3

now

now if in the Action there remaineth such a number which may bee found in the upper *semicircle* without, then that which is opposite within shewes the first, the next is the second, &c. as if 5. remaines, it shewes to whom hee gave 2. hee hath the *Ring*, to whom you gave 3. hee hath the *Gould* &c. but if the remainder bee in the under *semicircle*, that which is opposite to it, is the first; the next backwards towards the right hand is the second, as if 3. remaines, to whom you gave 1. he hath the *Ring*; he that had 3. he had the *Gould*, &c.

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PROBLEM IX.

*How to part a vessell which is full of wine containing 8. Pints, into two equall parts, by two other vessells which contained as much as the greater vessell; as the one being 5. Pints, and the other 3. Pints.*

**L** Et the 3. *vessells* be represented by *A. B. C.*, *A.* being full, the other two being emprie; first powre out *A.* into *B.* untill it bee full: so there will be in *B.* 5. *Pints* and in *A.* but 3. *Pints*; then powre out of *B.* into *C.* untill it bee full: so in *C.* shall be 3. *Pints*, in *B.* 2. *Pints*, and in *A.* 3. *Pints*; then powre the wine which is in *C.* into *A.* so in *A.* will be 6. *Pints*, in *B.* 2. *Pints*, and in *C.* nothing: then powre out the wine which is in *B.* into the pot *C.* so in *C.* there

there is now 2. Pints, in B. nothing, and in A, 6. Pints. Lastly, powre out of A, into B. untill it be full, so there will be now in A. onely 9.

1. Pint, in B. 5. Pints, and in C. 2. Pints :

But it is now evident that if from B. you powre in unto the pot C. untill it be full, there will remaine in B. 4. Pints, and if that which is in C.

viz. 3 Pints bee powred into the vessell A. which before had 1.

Pint, there shall be in the vessell A. but halfe of its liquor that was in it at the first, viz 4. Pints as was required. Otherwise powre out

of A. into C. untill it be full, which powre into B then powre out of A. into C. againe untill it be full, so there is now in A. onely 2. Pints,

in B. 3. and in C 3. then powre from C into B. untill it be full; so in C. there is now but 1.

Pint, 5. in B. and 2. in A. powre all that is in B. into A. then powre the wine which is in C. into B. so there is in C. nothing, in B. onely 1 Pint, and in A. 7. Pints :

Lastly out of A. fill the pot C. so there will remaine in A. 4. Pints, or be but halfe full: then if the liquor in C. bee powred into B. it will bee the other halfe. In like manner might bee taken the halfe of a vessell which containes 12. Pints, by having but the measures 5. and 7. or 5. and 8. Now



C 4

such

such others might be proposed, but wee omit many, in one and the same nature.

PROBLEM. X.

To make a sticke stand upon the tipp of ones finger, without falling.

**F**asten the edges of two knives or such like of equall poise, at the end of the *sticke*, leaning out somewhat from the *sticke*, so that they may counterpoise one another; the *sticke* being sharpe at the end and held upon the top of the *finger*, will there rest without supporting: if it fall it must fall together, and that perpendicular or plambe wise, or it must fall side-wise or before one another; in the first manner it cannot: for the Center of gravitie is supported by the top of the *finger*: and seeing that each part by the *knives* is counterpoysed it cannot fall side-wise, therefore it cannot fall no wise.



In like manner may great peeces of *Timber* as *lofts* &c. be supported, if unto one of the ends be applyed convenient proportionall counterpoises, yea a *Lance* or *Pike*, may stand prepen-

perpendicular in the Aire upon the top of ones finger : or placed in the midst of a Court by helpe of his Center of gravitie.



EXAMINATION.

**T**His Proposition seemes doubtfull for so imagine absolutely, that a Pike, or such like, armed with two knives, or other things shall stand upright in the Ayre, and so remaine without any other support, seeing that all the parts hath an infinite difference of propensitie to fall; and it is without question that a staffe so accomodated upon his Center of gravitie, but that it may incline to some one part without some remedie be applyed, and such as is here specified in the Probleme will not warrant the thing, nor keepe it from falling; and if more knives should be placed about it, it should cause it to fall more swiftly, for asmuch as the superiour parts (by reason of the Centricall motion) is made more ponderous and therefore lesse in rest.

To place therefore this prop really, let the two knives, or that which is for counterpoise, be longer alwaies than the staffe and so it will hang together as one body: and it will appeare admirable if you place the Center of gravitie, neare the side of the top of the finger or point; for it will then hang Horizontall, and seeme to hang onely by a touch, yet more strange if you turne the point or top of the finger upside downe.

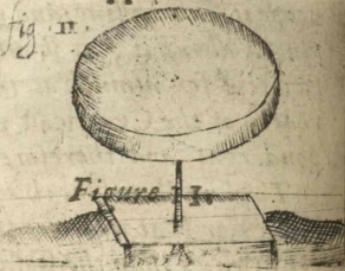
PRGB.

## PROBLEM. XI.

*How a milstone or other Ponderositie, may be supported by a small needle, without breaking or any wise bowing the same.*

**L**Et a needle be set perpendicular to the *Horizon*, and the center of gravitie of the *stone*, be placed on the top of the *Needle*: it is evident that the *stone* cannot fall, for asmuch as it hangs in *equilibra*, or is counterpoysed in all parts alike; and moreover it cannot bow the *Needle* more on the one side, than on the other, the *Needle* will not therefore be eyther broken or bowed; if otherwise, then the parts of the *Needle* must penetrate and sinke one with another: that which is absurd and impossible to nature: therefore it shall be supported. The experiments which are made upon trencher plates, or such like lesser thing doth make it most credible in greater bodies.

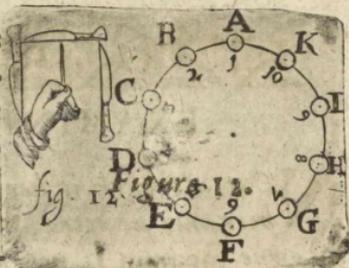
But here especially is to be noted that the *Needle* ought to be uniforme in matter and figure, and that it be erected perpendicular to the *Horizon*, and lastly that the *Center of gravitie* be exactly found.



PROBLEM. XII.

To make three knives hang and move upon the point of a Needle.

Fit the three knives in forme of a ballance, and houlding a Needle in your hand, and place the backe of that knife which lies crosswise to the other two, upon the point of the Needle: as the figure here sheweth you; for then in blowing softly upon them, they will easily turne & move upon the point of the needle without falling.



PROBLEM. XIII.

To finde the weight of smoake, which is exhaled of any combustibile body whatsoever.

Let it be supposed that a great heape of Fagots, or a load of straw waying 500. l should be fired, it is evident that this grosse substance will bee all inverted into smoake and Ashes: now it seemes that the smoake waighes nothing; seeing it is of a thinne substance now delated in the Aire, notwithstanding if it were gathered and reduced into the thickest

kelt that it was at first, it would bee sensibly waighty: waigh therefore the *ashes* which admit 50 pound, now seeing that the rest of the matter is not lost, but is exhaled into *smoke*, it must necessarily bee, that the rest of the waight (to wit) 450 pound, must bee the waight of the *smoke* required.



## EXAMINATION.

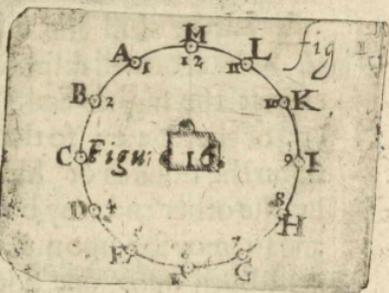
**N**ow although it bee thus delivered, yet here may be noted, that a ponderositie in his owne medium is not waightie: for things are sayd to be waighty, when they are out of their place, or medium: and the difference of such gravitie, is according to the motion: the *smoke* therefore certainly is light being in its true medium (the ayre) if it should change his medium, then would we change our discourse.

## PROBLEM. XIII.

Many things being disposed circular, (or otherwise) to find which of them, any one thinkes upon.

Suppose that having ranked 10 things, as *S.A.B.C.D.E.F.G.H.I.K.* Circular (as the figure sheweth) and that one had touched or thought upon *G.* which is the 7: aske the partie at what letter he would begin to account (for ac-

count he must, otherwise it cannot be done) which suppose, at *E* which is the 5 place, then ad secretly to this 5. 10. (which is the number of the *Circle*) and it makes 15, bid him account 15. backward from *E*, beginning his account with that number hee thought upon, so at *E* hee shall account to himselfe, 7, at *D* account 8, at *C* account 9 &c. So the account of 15 will exactly fall upon *G*, the thing or number thought upon: and so of others: but to conceale it the more, you may will the party from *E* to account 25. 35 &c. and it will be the same.



There are some that use this play at cards, turned up side downe, as the ten simple *Cards*, with the *King* and *Queene*, the *King* standing for 12, and the *Queene* for 11, and so knowing the scituation of the *Cards*: & thinking a certaine houre of the day: cause the partie to account from what *Card* hee pleaseth: with this Proviso, that when you see where hee intends to account set 12. to that *number*, so in counting as before, the end of the account shall fall upon the *Card*: which shall denote or shew the *houre* thought upon, which being turned up will give grace to the action, and wonder to those that are ignorant in the cause.

PRO-

## PROBLEM. XV.

*How to make a dore, or a Gate, which shall open on both sides.*

**A**LL the skill and subtiltie of this, rests in the artificiall disposer of 4 plates of *Iron*; two at the higher end, and two at the lower end of the Gate: so that one side may move upon the hookes or hindges of the *Posts*, and by the other end may be made fast to the Gate, and so moving upon these hindges, the Gate will open upon one side with the aforelaid plates, or hookes of *Iron*: and by helpe of the other two plates, will open upon the other side.

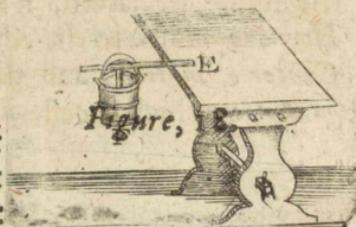
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## PROBLEM. XVI.

*To shew how a Ponderositie, or heaوية thing, may be supported upon the end of a staffe (or such like) upon a Table, and nothing holding or touching it.*

**T**AKE a paile which hath a handle, and fill it full of *water* (or at pleasure:) then take a staffe or sticke which may not rowle upon the Table as *E C*, and place the handle of the Paile upon the staffe; then place another staffe, or sticke

sicke, under the *staffe*  $CE$ , which may reach  
 from the bottome of  
 the *Paile* unto the  
 former *staffe*  $CE$ ,  
 perpendicular wise:  
 which suppose  $F.G$ ,  
 then shall the *Paile* of  
 water hang without  
 falling, for if it fall it  
 must fall perpendicu-  
 larly, or plumbe wise:  
 and that cannot bee  
 seeing the *staffe*  $CE$ ,  
 supports it, it being parallel to the *Horizon* and  
 sustained by the *Table*, and it is a thing admi-  
 rable that if the *staffe*  $CE$ , were alone from  
 the table, and that end of the *staffe* which is up-  
 on the *Table* were greater and heavier than the  
 other: it would be constrained to hang in that  
 nature.



### EXAMINATION.

**N**OW without some experience of this *Pro-  
 bleme*, a man would acknowledge either  
 a possibility or impossibilitie; therefore it is  
 that very touchstone of knowledge in any  
 thing, to discourse first if a thing bee possible  
 in nature, and then if it can bee brought to ex-  
 perience and under sense without seeing it  
 done. At the first, this proposition seemes to be  
 absurd

absurd, and impossible at the first. Notwithstanding, being supported with two sticke as the figure declareth, it is made facill: for the *Horizontall* line to the edge of the *Table*, is the *Center of motion*; and passeth by the *Center of gravitie*, which necessarily supporteth it.

PROBLEM. XVII.

*Of a deceitfull Bowle to play withall.*

**M**ake a hole in one side of the *Bowle*, and cast moulten *Lead* therein, and then make up the hole close, that the *knavery* or deceit be not perceived: you will have pleasure to see, that notwithstanding the *Bowle* is cast directly to the play, how it will turne away side-wise: for that on that part of the *Bowle* which is heavier upon the one side than on the other, it never will goe truly right, if artificially it bee not corrected; which will hazard the *game* to those which know it not: but if it bee knowne that the *leady* side in rowling, be alwayes under or above, it may goe indifferently right; if otherwise, the weight will carry it alwayes side-wise.

PROB-

## PROBLEM: XVIII.

To part an Apple into 2. 4. or 8 like parts,  
without breaking the Rind.

**P**asse an *needle* and threed under the *Rind* of the *Apple*; and then round it with diverse turnings, untill you come to the place where you began: then draw out the *thread* gently, and part the *Apple* into as many parts as you thinke convenient: and so the parts may bee taken out betwene the parting of the *Rind*, and the rind remaining alwayes whole.

## PROBLEM. XIX.

To finde a number thought upon without asking of any questions, certain operations being done.

**B**id him adde to the number thought (as admit 15) halfe of it, if it may bee, if not the greatest halfe that exceede the other but by an unite, which is 8; and it makes 23: Secondly, unto this 23. adde the halfe of it if it may bee, if not the greatest halfe *viz.* 12. makes 35. in the meane time; note that if the number thought upon cannot be halfed at the first time as here it cannot: then for it keepe 3. in the memory, if at the second time it will not be

D

equally

equally halved, reserve 2. in memory, but if at both times it could not be equally halved, then may you together reserve five in memory: this done, cause him from the last summe, viz. 35. subtract the double of the *number* thought, viz. 30. rest 5. will him to take the halfe of that if he can, if not, reject 1. and then take the halfe of the rest: which keepe in your memory: then will him to take the halfe againe if he can, if not take one from it, which reserve in your memory, and so perpetually halveing untill 1. remaine: for then marke how many halves there were taken, for the first halfe account 2, for the second 4, for the third 8, &c. and adde unto those *numbers* the ones which you reserved in memory, so there being 5 remaining in this proposition, there were 2 halveings: for which last I account 4, but because it could not exactly be halved without rejecting of 1: I adde the 1 therefore to this 4, makes 5, which halfe or summe alwayes multiplied by 4, makes 20: from which subtract the first 3 and 2, because the halfe could not bee formerly added, leaves 15, the *number* thought upon.

Other examples.

			The number thought	79
			The greatest halfe	40 3
			The summe	119
			The greatest halfe of which	
			is	60 2
The number thought	12	} the number thought upon	The summe of it is	179
The halfe of it	6		The double of 79 is	158
The summe	18		Which taken from it, rests 21	
The halfe of it	9		The lesser half 10. wch halve:	
The summe of it	27		The halfe of this is 5 which	
The double of the number	24		makes	
Which taken away, rests	3		The half of this is 2 wch is 10	
The halfe of it	1		The half of this is 1, with 10	
For which account	2		and 11 is 21	
and 1 put to it because the	3		this 21 which is the double	
could not bee halfed, makes	3	of the last halfe with the re-		
this multiplied by 4 makes	12	mainder being multiplied by 4		
		makes 84, from which take		
		the aforefaid 3 and 2, rest 79;		
		the number thought upon.		

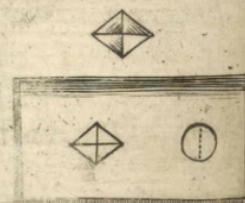
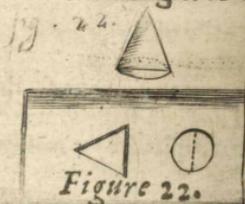
PROBLEM. XX.

*How to make an uniforme, & an inflexible body,  
to passe through two small holes of divers  
formes, as one being circular, & the other  
square, Quadrangular, and Tri-  
angularwise, yet so that the  
holes shall be exactly  
filled.*

**T**His Probleme is extracted from Geometri-  
call observations, and seemes at the first

Dia some

somewhat obscure, yet that which may be extracted in this nature, will appeare more difficult and admirable. Now in all *Geometricall practices*, the lesser or easier Problemes doe alwayes make way to facilitate the greater: and the aforesaid *Probleme* is thus resolved. Take a *Cone* or round *Pyramidie*, and make a *Circular hole* in some board, or other hard materiall, which may bee equall to the bates of the *Cone*, and also a *Triangular hole*, one of whose sides may be equall to the *Diamiter* of the *circle*, and the other two sides equall to the length of the *Cone*: Now it is most evident that this *Conicall* or *Pyramidall* body, will fill up the *Circular hole*, and being placed side-wise will fill up the *Triangular hole*: moreover if you cause a body to be turned, which may be like to two *Pyramids* conjoyned, then if a *Circular hole* bee made, whose *Diamiter* is equall to the *diamiter* of the *Cones* conjoyned, and a *Quadrangular hole*, whose sloping sides bee equall to the length of each side of the *Pyramidie*, and the bredth of the hole equall to the *diamiter* of the *Circle*, this conjoyned *Pyramidie* shall exactly fill both the *Circular hole*, and also *Quadrangle hole*.



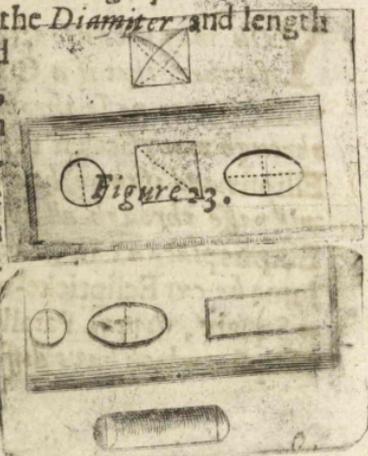
PROBLEME. XXI.

How with one uniforme body or such like to fill three severall holes; of which the one is round, the other a just square; and the third an oval forme.

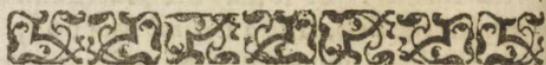
THIS proposition seemes more subtile than the former, yet it may bee practised two wayes: for the first, take a *Cilindricall* body as great or little as you please: Now it is evident that it will fill a *Circular hole*, which is made equal to the basis of it: if it bee placed downe right, and will also fill a long square; whose sides are equal unto the *Diameter* and length of the *Cylinder*, and according to *Pergemus*, *Archimedes*, &c. in their *Cilindricall* demonstrations, a true *Ovall* is made when a *Cylinder* is cut slope-wise, therefore if the *Ovall* have bredth equal unto the *Diameter* of the *Basis* of the *Cylinder*, & any length whatsoever: the *Cylinder* being put into his owne *Ovall hole* shall also exactly fill it.

The second way is thus, make a *Circular hole* in some board, and also a square hole, the side of which *Square* may bee equal to the *Diameter*

D 3 of



of the *Circle*: and lastly make a hole *Ovall* wide whose breadth may be equall unto the diagonal of the *Square*; then let a *Cylindricall* body be made, whose *Basis* may be equall unto the *Circle*, and the length equall also to the same. Now being placed downe right shall fall in the *Circle*, and flat-wise will fit the *Square* hole, and being placed sloping-wise will fill the *Ovall*.



### EXAMINATION.

**Y**ou may note upon the last two Problems farther, that if a Cone be cut Eclipticke-wise, it may passe through an Iffocele Triangle through many Scalen Triangles, and through an Ellipsis; and if there be a Cone cut scalen wise, it will passe through all the former, onely for the Ellipsis place a Circle: and further if a solid Colu-  
 me be cut Eclipticke-wise it may fill a Circle, a Square, divers Parallelogrames, and divers Ellipsis, which have different Diameters.

PROBLEM.

## PROBLEM XXII.

To finde a number thought upon after another manner, than that which is formerly delivered.

**B**id him that he multiply the number thought upon, by what number he pleaseth, then bid him divide that product by any other number, and then multiply that Quotient by some other number; and that product againe divide by some other, and so as often as he will: and here note that he declare or tell you by what number he did multiply and divide. Now in the same time take a number at pleasure, and secretly multiply and divide as often as he did: then bid him divide the last number by that which hee thought upon. In like manner doe yours privately, then will the Quotient of your divisor be the same with his, a thing which seemes admirable to those which are ignorant of the cause. Now to have the number thought upon without seeming to know the last Quotient, bid him adde the number thought upon to it, and aske him how much it makes: then subtract your Quotient from it, there will remaine the number thought upon. For example, suppose the number thought upon were 5, multiply it by 4 makes 20: this divided by 2, the Quotient makes 10, which multiplied by 6 makes 60, and divided by 4 makes 15: in the same time admit you thinke upon 4, which multiplied by 4 makes 16, this divided by 2 makes 8, which

D 4

multiplied

multiplied by 6 makes 48, and divided by  
makes 12; then divide 15 by the number  
thought which was 5, the Quotient is 3; di-  
vide also 12 by the number you tooke, viz. 4  
the Quotient is also 3 as was declared; therefore  
if the Quotient 3 bee added unto the number  
thought viz 5, it makes 8, which being knowne  
the number thought upon is also knowne.

PROBLEM. XXIII.

To finde out many numbers that sundry per-  
sons, or one man hath thought upon.

**I**F the multitude of numbers thought upon be  
odde, as three numbers, five numbers, seaven  
&c. as for example let 5 numbers thought upon  
be these, 2, 3, 4, 5, 6. Bid him declare the sum  
of the first and second, which will be 5; the se-  
cond and third which makes 7, the third and  
fourth which makes 9, the fourth and fifth  
which makes 11, and so alwayes adding the  
two next together; aske him how much the  
first and last makes together, which is 8; then  
take these summes and place them in order, and  
adde all these together which were in the odde  
places: that is the first, third, and fifth, viz. 5.  
9, 8, makes 22. In like manner adde all these  
numbers together which are in the even places,  
that is in the second and fourth places, viz. 7  
and 11 makes 18, subtract this from the former  
22, then there will remaine the double of the  
first

first number thought upon, viz. 4, which knowne the rest is easily knowne: seeing you know the summe of the first and second; but if the multitude of numbers bee even as these fixe numbers, viz. 2, 3, 4, 5, 6, 7, cause the partic to declare the summe of each two, by antecedent and consequent, and also the summe of the second and last which will bee 5, 7, 9, 11, 13, 10, then adde the odde places together, except the first that is 9, and 13, makes 22; adde also the even places together, that is 7, 11, 10, which makes 28; subtract the one from the other, there shall remaine the double of the second number thought upon, which knowne all the rest are knowne.

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PROBLEM. XXIII.

*How is it that a man in one and the same time, may have his head upward, and his feet upward, being in one and the same place.*

**T**He answer is very facill, for to bee so he must be supposed to be in the center of the earth: for as the heavens is above on every side, *Cælum undique sursum*, all that which lookes to the heavens being distant from the center is upward; and it is in this sense that *Maurolyens* in his *Cosmographie*, and first dialogue, reported of one that thought hee was led by one of the *Muses* to hell, where hee saw *Lucifer* sitting  
in

in the middle of the *world*, and in the *center* of the *earth* as in a *Throne*; having his *head* and *feete* upward.

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PROBLEM. XXV.

*Of a Ladder by which two men ascending at one time; the more they ascend the more they shall be asunder, notwithstanding one being as high as another.*

**T**His is most evident, that if there were a *Ladder* halfe on this side of the *Center* of the *earth*, and the other halfe on the other side: and that two at the *Center* of the *world* at one instant, being to ascend the one towards us, and the other towards our *Antipodes*, they should in ascending goe farther and farther, one from another; notwithstanding both of them being of like height.

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PROBLEM. XXVI.

*How it is that a man having but a Rode or Pole of land, doth bragge that he may in a right line passe from place to place above 3000 miles.*

**T**He opening of this is easie, forasmuch as he that possesseth a *Rode* of ground possesseth

seth not only the exterior surface of the *earth*, but is master also of that which extends even to the *center* of the *earth*, and in this wise all *heritages* and *possessions* are as so many *Pyramides*, whose *summers* or *points* meete in the *center* of the *earth*, and the *basis* of them are nothing else but each mans *possession*, *field*, or visible *quantity*; and therefore if there were made or imagined so to be made, a descent to goe to the botto-  
 me of the *heritage*, which would reach to the *center* of the *earth*; it would bee above 3000 miles in a right line as before.

---

 PROBLEM. XXVII.

How it is that a man standing upright, and looking which way he will, he looketh true North or South.

THIS happeneth that if the partie be under either of the *Poles*, for if he be under the *North pole*, then looking any way hee looketh *South*, because all the *Meridians* concurre in the *Poles* of the world, and if he be under the *South pole*, hee lookes directly *North* by the same reason.

PROB-

## PROBLEM. XXVIII.

To tell any one what number remains after certaine operations being ended, without asking any question.

**B**id him to thinke upon a number, and will him to multiply it by what number you thinke convenient: and to the product bid him adde what number you please, provided that secretly you consider, that it may be divided by that which multiplied, and then let him divide the sum by the number which he first multiplied by, and subtract from this Quotient the number thought upon: In the same time divide apart the number which was added by that which multiplied, so then your Quotient shall be equall to his remainder, wherefore without asking him any thing, you shall tell him what did remaine, which will seeme strange to him that knoweth not the cause: for example, suppose he thought 7, which multiplied by 5 makes 35, to which adde 10, makes 45, which divided by 5 yeeldes 9; from which if you take away one the number thought, (because the Multiplier divided by the divisor gives the Quotient 1,) the rest will be 2, which will be also proved, if 10 the number which was added, were divided by 5, viz, 2.

## PROBLEM. XXIX.

*Of the play with two severall things.*

**I**T is a pleasure to see and consider how the science of *numbers* doth furnish us, not only with sports, to recreate the spirits, but also bring us to the knowledge of admirable things, as shall in some measure bee shewen in this ensuing progression. In the meane time to produce alwaies some of them: suppose that a man hold divers things in his hand, as *Gould* and *Silver*, and in one hand he held the *Gould*, and in the other hand hee held the *Silver*: to know subtilly, and by way of divination, or artificially in which hand the *Gold* or *Silver* sit; attribute to the *gould*, or suppose it have a certaine prise, & so likewise attribute to the *Silver* another price, conditionally that the one be od and the other even: as for example, bid him that the *Gould* be valued at 4. *Crownes*, or *shillings*, and the *Silver* at 2. *Crownes* or 3. *Shillings* or any other *number* so that one be odde, and the other even as before: then bid him triple that which is in the right hand, and double that which is in the left hand, and bid him adde these two products together, and aske him if it be even or odde, if it be even then the *Gould* is in the right hand, if odde the *Gould* is in the left hand.

PROB-

## PROBLEM. XXX.

*Two numbers being proposed unto two severall parties, to tell which of these numbers is taken by each of them.*

**A**S for example : admit you had proposed unto two men whose names were *Peter*, and *John*, two numbers, or peeces of money, the one even, and the other odde, as 10. and 9. and let the one of them take one of the numbers, and the other partie take the other number, which they place privately to themselves: how artificially, according to the congruitie, and excellency of numbers, to finde which of them did take 10. and which 9. without asking any question: and this seemes most subtile, yet delivered howsoever differing little from the former, and is thus performed: Take privately to your selfe also two numbers, the one even and the other odde, as 4. and 3. then bid *Peter* that he double the number which he tooke, and doe you privately double also your greatest number; then bid *John* to triple the number which he hath, and doe you the like upon your last number: adde your two products together, and marke if it be even or odde, then bid the two parties put their numbers together, and bid them take the halfe of it, which if they cannot doe, then immediately tell *Peter* hee tooke 10. and *John* 9. because the aggregate of the double of 4. and the triple of 3. makes odde, and

and such would be the aggregate or summe of the double of *Peters number* and *Johns number*, if *Peter* had taken 10. if otherwise, then they might have taken halfe, and so *John* should have taken 10, and *Peter* 9. as suppose *Peter* had taken 10. the double is 20, and the triple of 9. the other number is 27. which put together makes 47. odde : in like manner the double of your number conceived in minde, viz. 4. makes 8. and the triple of the 3. the other number, makes 9. which set together makes 17. odde : Now you cannot take the halfe of 17. nor 47. which argueth that *Peter* had the greater number, for otherwise the double of 9. is 18. and the triple of 10. is 30. which set together makes 48. the halfe of it may be taken : therefore in such case *Peter* tooke the lesse number : and *John* the greater, and this being done cleanly carries much grace with it.

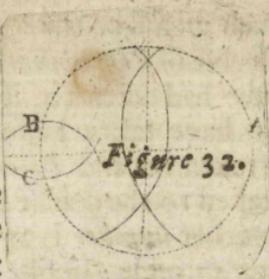
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PROBLEM. XXXI.

*How to describe a Circle that shall touch 3.  
Points placed howsoever upon a plaine,  
if they be not in a right line.*

**L**Et the three points bee *A. B. C.* put one foot of the *Compassse* upon *A.* and describe an *Arch* of a *Circle* at pleasure : and placed at *B.* crosse that *Arke* in the two points *E.* and *F.* and placed in *C.* crosse the *Arke* in *G.* and *H.* then lay a ruler upon *G, H.* and draw a line, and place

place a *Ruler* upon *E.* and *F.* cut the other line in *K.* so *K.* is the Center of the *Circumference* of a *Circle*, which will passe by the said three points *A. B. C.* or it may bee inverted having a *Circle* drawne, to finde the *Center* of that *Circle.* Make 3-points in the *circumference*, and then use the same way : so shall you have the *Center* a thing most facill, to every practitioner in the pinciples of *Geometrie.*



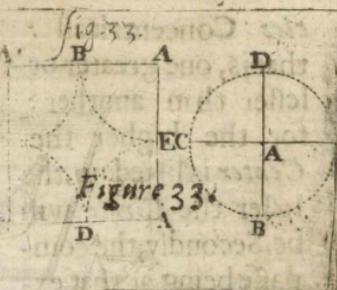

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PROBLEM. XXXII.

*How to change a Circle into a Square forme.*

**M**ake a *Circle* upon pastboard or other materiall, as the *Circle A. C. D. E.* of which *A.* is the *Center*; then cut it into 4-quarters and dispose them so, that *A.* at the center of the *Circle* may alwaies be at the *Angle* of the *square*, and so the foure quarters of the *Circle*

Circle being placed  
 so, it will make a per-  
 fect square, whose  
 side *A. A.* is equall to  
 the diameter *B. D.*  
 Now here is to bee  
 noted that the square  
 is greater than the  
 Circle by the vacuity  
 in the middle, viz, *M.*

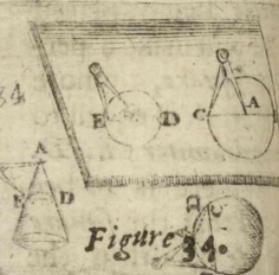


PROBLEM. XXXIII.

With one and the same compasses, and at one and  
 the same extent, or opening, how to describe  
 many Circles concentricall, that is,  
 greater or lesser one than  
 another.

IT is not without cause that many admire how  
 this proposition is to bee resolved; yea in  
 the judgement of some it is thought impossi-  
 ble: who consider not the industrie of an inge-  
 nious Geometritian, who makes it possible, and  
 that most facill, sundry wayes; for in the first  
 place if you make a Circle upon a fine plaine,  
 and upon the Center of that Circle, a small  
 pegge of wood be placed, to bee raised up and  
 put downe at pleasure by helpe of a small hole  
 made in the Center, then with the same ope-  
 ning of the Compasses, you may describe Cir-  
 cles

cles Concentricall :  
that is, one greater or  
lesser than another :  
for the higher the  
Center is lifted up, the  
lesser the Circle will  
be. Secondly, the com-  
passe being at that ex-  
tent upon a *Gibus* bo-  
dy, a Circle may bee  
described, which will  
be lesse than the for-



mer, upon a plaine, and more artificially upon  
a *Globe*, or round *bowle*: and this againe is most  
obvious upon a round *Pyramide*, placing the  
*Compasses* upon the top of it which will be farre  
lesse than any of the former; and this is demon-  
strated by the 20. *Pro.* of the first of *Euclid*.  
for the *Diameter*  $E.D.$  is lesse than the line  
 $D.AE.$  taken together, and the lines  $A.D.$   
 $AE.$  being equall to the *Diameter*  $B.C.$  because  
of the same distance or extent of opening the  
*Compasses*, it followes that the *Diameter*  $E.D.$   
and all his *Circles* together is much lesse than  
the *Diameter*, and the *Circle*  $B.C.$  which waste  
be performed.

## PROBLEM. XXXIIII.

Any numbers under 10. being thought upon,  
to finde what numbers they were.

**L**Et the first number be doubled, and unto it adde 5. and multiplied that summe by 5. and unto it adde 10. and the next number thought upon; multiplye this same againe by 10. and adde unto it the next number, and so proceede: now if he declare the last summe; marke if he thought but upon one figure, for then subtract onely 35. from it, and the first figure in the place of tens is the number thought upon: if he thought upon two figures, then subtract 35 also, and the 2. also the said 35. from his last summe, and the two figures which remaines are the number thought upon: if he thought upon three figures, then subtract 350. and then the first 3. figures are the numbers thought upon, &c. so if one thought upon these numbers 5. 7. 9. 6. double the first, makes 10. to which adde 5. makes 15. this multiplied by 5. makes 75. to which adde 10. makes 85. to this adde the next number, viz. 7. makes 92. this multiplied by 10. makes 920. to which adde the next number, viz. 9. makes 929. which multiplied by 10. makes 9290. to which adde 6. makes 9296. from which subtract 3500. resteth 5796. the foure numbers thought upon. Now because the two last figures are like the two numbers thought

upon: to conceale this bid him take the halfe of it, or put first 12. or any other *number* to it, and then it will not be so open.

PROBLEM. XXXV.

Of the Play with the Ring.

**A**Mongst a company of 9. or 10. persons, one of them having a *Ring*, or such like: to finde out in which hand: upon which *finger*, joynt it is; this will cause great astonishment to ignorant spirits, which will make them beleeve that he that doth it workes by *magicke*, or *witchcraft*: But in effect it is nothing else but an nimble act of *Arithmeticke*, founded upon the precedent *Probleme*: for first it is supposed that the persons stand or sit in order that one is first, the next second, &c. likewise there must be imagined that of these two hands the one is first and the other second: and also of the five *fingers* the one is first, the next is second, and lastly of the *joynts*, the one is as 1. the other as 1. the other is as 2. the other as 3. &c. from whence it appeares that in performing this *Play* there is nothing else to be done than to thinke 4. *numbers*: for example if the fourth person had the *Ring* in his left hand: and upon the fifth *finger* and third *joynt*, and I would divine and finde it out thus: I would proceede as in the 35. *Probleme*: in causing him to double the first *number*: that is, the number of persons



one having throwne three *Dice* & you would declare the *numbers* of each one, or how much they make together, bid him double the points of one of the *Dice*, to which bid him adde 5. then multiply that by 5. and to it adde 10. and to the summe bid him adde the number of the second *Dice*: and multiplie that by 10. lastly, to this bid him adde the *number* of the last *Dice*, and then let him declare the whole *number*: then if from it you subtract 350. there will remaine the number of the three *Dice* throwne.

## PROBLEM. XXXVII.

*How to make water in a Glasse seeme to boyle and sparkle.*

**T**AKE a *Glasse* neare full of *water* or other *liquor*; and setting one hand upon the foote of it, to hold it fast: turne slightly one of the *fingers* of your other hand upon the brimme, or edge of the *Glasse*; having before privatly wet your *finger*: and so passing softly on with your *finger* in pressing a little: for then first the *Glasse* will begin to make a noyse: secondly the parts of the *Glasse* will sensibly appeare to tremble, with notable *varification* and *condensation*: thirdly the *water* will shake, seeme to boyle: fourthly it will cast it selfe out of the *Glasse*, and leape out by small drops, with great astonishment to the standers by; if they be ignorant of the cause of it, which

is onely in the *Rarification* of the parts of the *Glasse*: occasioned by the motion and pressure of the *finger*.



## EXAMINATION.

**T**He cause of this, is not in the rarification of the parts of the *Glasse*, but it is rather in the quicke locall motion of the *finger*, for reason sheweth us that by how much a *Body* draweth nearer to a qualitie, the lesse is it subject or capable of another which is contrary unto it: now condensation, and rarification are contrary qualities and in this Probleme there is three bodies considered, the *glasse*, the *water*, and the *ayre*; now it is evident that the *Glasse* being the most solid, and impenetrable *Body*, is lesse subject, and capable of rarification than the *water*, the *water* is lesse subject than the *ayre*, and if there be any rarification, it is rather considerable in the *ayre* than in the *water*, which is inscribed by the *Glasse*, and above the *water*, and rather in the *water* than in the *Glasse*: the agitation, or the trembling of the parts of the *Glasse* to the sence appears not: for it is a continued body; if in part why then not in the whole; and that the *water* turnes in the *Glasse* this appears not, but onely the upper contiguous parts of the *water*: that at the bottome being lesse subject to this agitation, and it is most certaine that by how much

quicker the circular motion of the finger upon the edge of the Glasse is, by so much the more shall the Ayre be agitated, and so the water shall receive some apparant affection more or less from it, according to that motion: as wee see from the quicknesse of winde upon the Sea, or calme thereof, that there is a great or lesser agitation in the water; and for further examination, we leave it to the search of these which are curious.

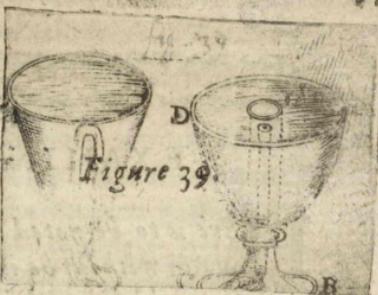
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PROBLEME XXXVIII.

Of a fine vessell which holds wine or water, being cast into it at a certaine height, but being filled higher, it will runne out of its owne accord.

**L**et there be a vessell *A. B. C. D.* in the middle of which place a Pipe; whose ends both above at *E*, and below at the bottome of the vessell as at *F*. are open; let the end *E*. be somewhat lower than the brimme of the Glasse: about this Pipe place another Pipe as *H. L*, which mounts a little above *E*, and let it most diligently be closed at *H*. that no Aire enter in thereby, and this Pipe at the bottome may have a small hole to give passage unto the water: then powre in water or wine, and as long as it mounts not above *E*, it is safe; but if you powre in the water so that it mount above it, farewell all: for it will not cease untill it be all gone out

out: the same may be done in disposing any crooked Pipe in a vessel in the manner of a fancet or sunnell, as in the figure H: for fill it under H. at pleasure, and all will goe well; but if you fill it unto H. you will see fine sport, for then all the vessel will be empty incontinent, and the



subtiltie of this will seeme more admirable, if you conceale the Pipe by a Bird, Serpent, or such like, in the middle of the Glasse. Now the reason of this is not difficult to these which know the nature of a Cocke or Fancet; for it is a bowed Pipe one end of which is put into the water or liquor, and sucking at the other end untill the Pipe be full, then will it runne of it selfe; and it is a fine secret in nature to see, that if the end of the Pipe which is out of the water be lower than the water, it will runne out without ceasing: but if the mouth of the Pipe be higher than the water or leuell with it, it will not runne, although the Pipe which is without be many times bigger than that which is in the water: for it is the property of water to keepe alwayes exactly leuell.

EXAMINA-



## EXAMINATION.

**H**ere is to be noted that if the face of the water without be in one and the same plain, with that which is within, though the outtermost Pipe bee ten times greater than that which is within: the water naturally will not runne, but if the plaine of the water without be any part lower than that which is within, it will freely runne: and here may be noted further that if the mouth of the Pipe which is full of water, doth but onely touch the superficies of the water within, although the other end of the Pipe without be much lower than that within, the water it will not run at all: which contradicts the first ground; hence we gather that the pressure or ponderositie of the water within, is the cause of running in some respect.

## PROBLEM. XXXIX.

*Of a Glasse very pleasant.*

**S**ometimes there are Glasses which are made of a double fashion, as if one Glasse were within another, so that they seeme but one, but there is a little space betweene them. Now powre wine or other liquor betweene the two edges

edges by helpe of a *Tunnell*, into a little hole left to this end: so will there appeare two fine delusions or fallacies; for though there be not a droppe of *wine* within the hollow of the *Glasse*, it will seeme to these which behold it that it is an ordinary *Glasse* full of *wine*, and that especially to these which are sidewise of it; and if any one moove it, it will much confirme it, because of the motion of the *wine*: but that which will give most delight, is that if any one shall take the *Glasse*, and putting it to his mouth shall thinke to drinke the *wine*; instead of which hee shall suppe the *aire*: and so will cause laughter to these that stand by: who being deceived, will hold the *Glasse* to the light; and thereby considering that the rayes or beames of the light are not reflected to the eye, as they would bee if there were a liquid substance in the *Glasse*: hence they have an assured prooffe to conclude, that the hollow of the *Glasse* is totally empty.

PROBLEM. XL.

If any one should hold in each hand, as many peeces of money as in the other, how to finde how much there is.

**B**Id him that holdes the *money* that hee put out of one hand into the other what *number* you thinke convenient: (provided that it may be done,) this done, bid him that out of the *hand* that he put the other *number* into, that he take

take out of it as many as remaine in the other hand, and put it into that hand: for then be assured that in the hand which was put the first taking away: there will be found just the double of the number taken away at the first. Example, admit there were in each hand 12 Shillings or Counters, and that out of the right hand you bid him take 7 and put it into the left: and then put into the right hand from the left as many as doth remaine in the right, which is 5: so there will bee in the left hand 14, which is the double of the number taken out of the right hand, to wit 7: then by some of the rules before delivered, it is easie to finde how much is in the right hand, viz. 10.

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PROBLEM. XLI.

*Many Dice being cast, how artificially to discover the number of the points that may arise.*

**S**uppose any one had cast three Dice secretly, bid him that he adde the points that were upmost together: then putting one of the Dice apart, unto the former summe adde the points which are under the other two, then bid him throw these two Dice, and marke how many points a paire are upwards, which adde unto the former summe: then put one of these Dice away not changing the side, marke the points which

which are under the other *Dice*, and adde it to  
 the former summe: lastly throw that one *Dice*,  
 and whatsoever appeares upward adde it unto  
 the former summe; and let the *Dice* remaine  
 thus: this done, comming to the *Table*, note  
 what points doth appeare upward upon the  
 three *Dice* which adde privately together, and  
 unto it adde 21 or 3 times 7: so this *Addition*  
 or summe shall be equall to the summe which  
 the party privately made of all the operations  
 which hee formerly made. As if hee should  
 throw three *Dice*, & there should appeare up-  
 ward 5, 3, 2. the sum of them is 10: & setting one  
 of them aparte as 5. unto 10, adde the points  
 which are under 3 and 2, which is 4 and 5; and  
 it makes 19: then casting these two *Dice* sup-  
 pose there should appeare 4 and 1, this added  
 unto 9 makes 24: and setting one of these two  
*Dice* aparte as the 4. unto the former 24, I adde  
 the number of points which is under the other  
*Dice*, viz. under 1, that is 6, which makes 30.  
 Last of all I throw that one *Dice*, and suppose  
 there did appeare 2, which I adde to the former  
 30, and it makes 32: then leaving the 3 *Dice*  
 thus, the points which are upward will be these,  
 5, 4, 2, unto which adde secretly 21, (as before  
 was said) so have you 32 the same number which  
 he had: and in the same manner you may pra-  
 ctice with 4, 5, 6, or many *Dice* or other *bodies*,  
 observing onely that you must adde the points  
 opposite of the *Dice*: for upon which depends  
 the whole demonstration or secret of the play;  
 for alwayes that which is above and under-  
 neath

neath makes 7: but if it make another *number*, then must you adde as often that *number*.

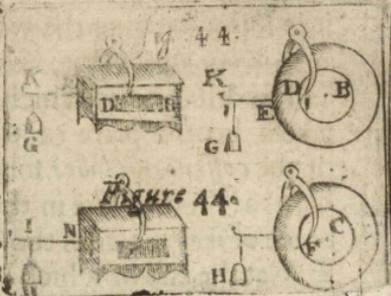
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PROBLEM. XLII.

*Two mettals as Gold and Silver, or of other kind weighing alike, being privately placed into two like Boxes, to finde which of them the Gold or Silver is in.*

**I**T is said that an *Emperor* was requested by one of his *servants* after he had long time remained with him, to assigne him some reward: to which after few dayes the *Emperour* condescended, and caused him to come into his *Treasury*, where he had prepared two *Boxes*, one full of *Gold*, and the other full of *Lead*, both weighing, and of forme and *magnitude* alike: and bid him chuse which he would have. Now many thinke that in this *Probleme* one must be guided onely by fortune in this choise, and it is that which most makes a man happy in such a choise: but the want of knowledge causeth them so to judge which knoweth not otherwise. A *Mathematician* accounts it an easie proposition and will infallibly chuse the chest of *gold*, and leave the chest of *lead*, without either breaking, or opening any of the chests, and not goe by chance and fortune: for if he may bee permitted to weigh those chests first in the *aire*, then in the *water*: it is a thing cleare by

by the proportion of  
mettalls, and accord-  
ing to the princi-  
ples of *Archimedes*,  
that the *Gold* shall  
be lesse weighty by  
his eighteenth part,  
and the *lead* by his  
eleventh part; where-  
fore there may bee  
gathered in which  
is the *Gold*, and in  
which is the *lead*.



But because that this experiment in water  
hath diverse accedents, and therefore subject  
to a caution; and namely because the matter of  
the chest, mettles, or other things may hinder:

Behold here a more subtill and certaine in-  
vention to finde and discover it out without  
weighing it in the water: Now experience and  
reason sheweth us that two like bodies or *mag-  
nitudes* of equall weight, and of divers mettalls,  
are not of equall quantity: & seeing that *gold* is  
the heaviest of all mettalls, it will occupie lesse  
roome or place; from which will follow that  
the like weight of *lead* in the same forme, will  
occupie or take up more roome or place. Now  
let there be therefore presented 2 *globes* or *chests*  
of *wood* or other matter alike, and equall one to  
the other, in one of which in the middle there  
is another *Globe* or body of *lead* weighing 12  
pound (as *C*), and in the other a *Globe* or like  
body of *gold* weighing 12 pound (as *B*.) Now

it

it is supposed that the wooden *globes* or *chests* are of equall weight, forme, and magnitude: and to discover in which the *gold* or *lead* is in, take a broade paire of *Compasses* and clip one of the *coffers* or *globes* somewhat from the middle as at *D*; then fixe in the *chest* or *globe* a small peece of *iron* between the feet of the *compasses*, as *E K*, at the end of which hang a weight *G* so that the other end may be counterpoysed, and hang in *equilibrio*: & doe the like to the other *chest* or *globe*. Now if that the other *chest* or *globe* being clipped in like distant from the end, and hanging at the other end the same weight *G*. there be found no difference: then clipse them nearer towards the middle, that so the points of the *Compassse* may bee against some of the mettell which is inclosed: or just against the extremitie of the *gold* as in *D*, and suppose it hang thus in *equilibrio*; it is certaine that in the other *coffer* is the *lead*; for the points of the *Compasses* being advanced as much as before, as at *F*. which takes up a part of the *lead*, (because it occupieth a greater place than the *gold*) therefore that shall helpe the weight *G* to weigh, and so will not hang in *equilibrio* except *G* be placed neare to *F*: hence we may conclude that there is the *lead*; and in the other *chest* or *globe* there is the *gold*.

(EXAMINA-



## EXAMINATION.

**I**F the two Boxes being of equall magnitude weighed in the aire be found to bee of equall weight, they shall necessarily take up like place in the water, & therefore weigh also one as much as another: hence there is no possibilitie to finde the inequallitie of the mettells which are inclosed in these Boxes in the water: the intention of Archimedes was not upon contrary mettells inclosed in equall Boxes, but consisted of comparing mettells, simple in the water one with another: therefore the inference is false and absurd.

## PROBLEM: XLIII.

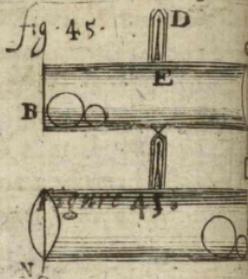
Two Globes of diverse mettles, (as one gold and the other copper) yet of equall weight being put into a boxe as *B. G.* to finde in which end the gold or copper is.

**T**His is discovered by the changing of the places of the two Bowles or Globes having the same counterpoise *H.* to bee houg at the other side as in *N.* and if the Gould which is the lesser Globe were before the nearest to the handle *D. E.* having now changed his place will bee farthest from the handle *D. E.* as in *K.*

F

there

therefore the Center of gravitie of the two Globes taken together, shall bee farther separate from the middle of the handle (under which is the Center of gravitie of the *Box*): than it was before, and seeing that the handle is alwayes in the middle of the *box*, the waight *N*, must bee augmented, to keepe it in æquilibria: and by this way one may know, that if at the second time, the counterpoise bee too light, it is signe that the *Gould* is farthest off the handle, as at the first triall it was nearest,




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PROBLEM. XLIII.

*How to represent diverse sorts of Rainebowes here below.*

**T**He *Rainebow* is a thing admirable in the world, which ravisheth often the eyes and spirits of men in consideration of his rich intermingled colours which are seene under the cloudes, seeming as the glistering of the *stars*, pretious stones, & ornaments of the most beauntious flowers: some part of it as the resplendant *stars*, or as a *rose*, or burning *cole* of fire: in it one may

may see dies of sundry sorts, the *violet*, the *blew*, the *orion*, the *saphir*, the *jacint*, and the *emerald* colours, as a lively plant placed in a greene soyle: and as a most rich treasure of nature, it is a high worke of the *Sunne* who casteth his rayes or beames as a curious Painter drawes strokes with his pensell, and placeth his colours in an exquisite situation; and *Salomon* saith, *Eccles.* 43. it is a chiefe and principall worke of *God*. Notwithstanding there is left to industrie how to represent it from above, here below, though not in perfection yet in part, with the same intermixture of colours that is above.

Have you not seene how by *Oares* of a *Boate* it doth exceeding quickly glide upon the *water* with a pleasant grace? *Aristotle* sayes that it coloureth the *water* and makes a thousand *atomes*, upon which the beames of the *Sunne* reflecting makes a kinde of coloured *Rainebow*: or may we not see in *houses* or *gardens* of pleasure artificiall *fountaines*, which powre forth their droppie streames of *water*, that being betweene the *Sunne* and the *fountain*, there will be presented as a continuall *Rainebow*? But not to goe farther, I will shew you how you may doe it at your doore, by a fine and facill experiment.

Take *water* in your mouth, and turne your backe to the *Sunne*, and your face against some obscure place, then blow out the *water* which is in your mouth, that it may bee sprinkled in small drops and vapours: you shall see these

atomes vapours in the beames of the *Sunne* to turne into a faire *Rabinebow*, but all the grieft is that it lasteth not but soone is vanished.

But to have one more stable and permanent in his colours, take a *Glasse* full of *water* and expose it to the *Sunne*, so that the rayes that passe through strike upon a shadowed place, you will have pleasure to see the fine forme of a *Rabinebow* by this reflexion. Or take *Trigonall Glasse* or *Cristall Glasse* of diverse Angles, and looke through it; or let the beames of the *Sunne* passe through it, or with a candle let the appearances be received upon a shadowed place: you will have the same contentment.

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PROBLEM. XLV.

*How that if all the Powder in the world were inclosed within a bowle of paper or glasse, and being fired on all parts, it could not breake that bowle.*

**I**F the *bowle* and the *powder* be uniforme in all his parts, the by that means the *powder* would presse and move equally on each side, in which there is no possibilitie whereby it ought to begin by one side more than another. Now it is impossible that the *bowle* should bee broken in all his parts: for they are infinite.

Of like finenes or subtiltie may it be that a *bowle* of *iron* falling from a high place upon a plaine pavement of thin *Glasse*, it were impossible

sible any wise to breake it; if the *bowle* were perfectly round, and the *Glasse* flat and uniforme in all his parts: for the *bowle* would touch the *Glasse* but in one point, which is in the middle of infinite of parts which is about it: neither is there any cause why it ought more on one side than on another, seeing that it may not be done with all his sides together; it may be concluded as speaking naturally, that such a *bowle* falling upon such a *glasse* will not break it. But this matter is meere *Metaphysicall*, and all the workemen in the world cannot ever with all their industrie make a *bowle* perfectly round, or a *Glasse* uniforme.

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 PROBLEM. XLVI.

To finde a number which being divided by 2 there will remaine 1, being divided by 3, there will remaine 1; and so likewise being divided by 4, 5, or 6. there would still remaine 1: but being divided by 7, there will remaine nothing.

**I**N many Authors of Arithmetick this *Probleme* is thus proposed: A woman carrying *egges* to market in a *basket*, mett an unruly fellow who broake them; who was by order made to pay for them: and she being demanded what number she had, shee could not tell: but she re-

measured that counting them by 2, & 2; there remained 1: likewise by 3 and 3, by 4 and 4, by 5 and 5, by 6 and 6; there still remained 1: but when she counted them by 7 and 7, there remained nothing: Now how may the number of *egges* be discovered?

Finde a number which may exactly be measured by 7, and being measured by 2, 3, 4, 5, and 6; there will still remaine a unity: multiply these *numbers* together, makes 702, to which adde 1; so have you the *number*, viz. 703: in like manner 301 will be measured by 2, 3, 4, 5, 6; so that 1 remains: but being measured by 7, nothing will remaine; to which continually adde 220, and you have other *numbers* which will doe the same: hence it is doubtfull what *number* shee had, therefore not to faile it must be knowne whether they did exceed 400, 800, &c. in which it may bee conjectured that it could not exceed 4 or 5 hundred, seeing a *man* or *woman* could not carry 7 or 8 hundred *egges*; therefore the *number* was the former 301. which shee had in her *basket*: which being counted by 2 and 2, there will remaine 1, by 3 and 3, &c. but counted by 7 and 7, there will

PROBLEME XLVII.

*One had a certaine number of crownes, and counting them by 2 and 2, there rested 1: counting them by 3 and 3, there rested 2: counting them by 4 and 4, there rested 3: counting them by 5 and 5, there rested 4: counting them by 6 and 6, there rested 5: but counting them by 7 and 7, there remained nothing: how many crownes might hee have.*

**T**His *Question* hath some affinity to the precedent, and the resolution is almost in the same manner: for here there must be found a number, which multiplied by 7, and then divided by 2, 3, 4, 5, 6; there may alwayes remaine a number lesse by 1 than the divisor: Now the first number which arives in this nature is 119, unto which if 420 be added, makes 539, which also will doe the same: and so by adding 420, you may have other numbers to resolve this proposition.

PROBLEME XLVIII.

*How many sorts of weights in the least manner must there be to weigh all sorts of things betweene 1 pound and 10 pound, and so unto 121, and 364 pound.*

**T**O weigh things betweene 1 and 40: take numbers in triple proportion, so that their

F 4

summe

summe be equall, or somewhat greater than 40, as are the numbers 1. 3. 9. 27. I say that with 4 such weights, the first being of 1 pound, the second being 3 pound, the third being 9 pound, and the fourth being 27: any weight betweene 1 and 40 pound may bee weighed. As admit to weigh 21 pound, put unto the thing that is to be weighed the 9 pound weight, then in the other *ballance* put 27 pound and 3 pound which doth counterpoise 21 pound and 9 pound: and if 20 pound were to be weighed, put to it in the *ballance* 9 and 1, and in the other *ballance* put 27 and 3, and so of others.

In the same manner take those 5 weights, 1, 3, 9, 27, 81, you may weigh with them betweene 1 pound, and 121 pound: and taking those 6 weights, as 1, 3, 9, 27, 81, 243, you may weigh even from 1 pound unto 364 pound: this depends upon the property of continued proportionalls, the latter of which containing twice all the former.

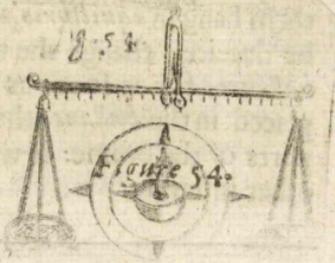
PROBLEM. XLIX.

*Of a deceitfull ballance which being empty seems to be just, because it hangs in equilibrio: notwithstanding putting 12 pound in one ballance, and 11 in the other, it will remaine in equilibrio.*

**A**ristotle maketh mention of this *ballance* in his mechanicke *Questions*, and saith that the

the Merchants of purpose in his time used them to deceive the world: the subtilie or craft of which is thus, that one arme of the *ballance* is longer than another, by the same proportion, that one weight is heavier than another: As if the beame were 23 inches long,

and the handle placed so that 12 inches should be on one side of it, and 11 inches on the other side: conditionally that the shorter end should be as heavy as the longer, a thing easie to be done: then afterwards put into the *ballance* two unequal weights in such proportion as the parts of the *beame* have



one unto another, which is 12 to 11; but so that the greater be placed in the *ballance* which hangs upon the shorter part of the *beame*, and the lesser weight in the other *ballance*: it is most certaine that the *ballances* will hang in *aquilibrium*, which will seeme most sincere and just; though it be most deceitfull, abominable, and false.

The reason of this is drawne from the experiments of *Archimedes*, who shewes that two unequal weights will counterpoise one another, when there is like proportion betweene the parts of the *beame* (that the handle separates)

rates) and the weights themselves: for in one and the same counterpoise, by how much it is farther from the Center of the handle, by so much it seemes heavier; therefore if there be a diversitie of distance that the *ballances* hang from the handle, there must necessarily be an inequality of weight in these *ballances* to make them hang in *equilibrio*, and to discover if there be deceite, change the weight into the other *ballance*, for as soone as the greater weight is placed in the *ballance* that hangs on the longer parts of the beame: it will weigh downe the other instantly.

## PROBLEM. L.

To heave or lift up a bottle with a straw.

TAke a *straw* that is not bruised, bow it that it make an Angle, and put it into the *bottle*: so that the greatest end bee in the necke; then the Reede being put in the bowed part will cast sidewise, and make an Angle as in the figure may be seene; then may you take the end which is out of the *bottle* in your hand, and heave up the *bottle*: and it is



so much surer, by how much the Angle is acuter or sharper; and the end which is bowed approacheth to the other perpendicular parts which comes out of the *bottle*.

## PROBLEM. LI.

*How in the middle of a wood or desert, without the sight of the Sunne, Starres, Shaddow or Compasse, to finde out the North or South, or the foure Cardinall points of the world, East, West, &c.*

IT is the opinion of some, that the *windes* are to be observed in this: if it be hot, the South is found by the windes that blow that way, but this observation is uncertaine and subject to much error: nature will helpe you in some measure to make it more manifest than any of the former from a *tree*, thus: cut a small *tree* off even to the ground, and marke the many *circles* that is about the sap or pith of the *tree*, which seeme nearer together in some part than in other, which is by reason of the sunnes motion about the *tree*: for that the humiditie of the parts of the *tree* towards the South by the heat of the *Sunne* is rarified and caused to extend: and the *Sunne* not giving such heat towards the North part of the *tree*, the sap is lesser rarified but condensed; by which the *circles* are nearer together on the North part, than on the South part: therefore if a line bee drawne from the widest

widest to the narrowest part of the *circles*, it shall shew the North and South of the world: Another experiment may be thus, take a small *needle* such as women worke with: place it gently downe flatwise upon still water and it will not sinke, (which is against the generall tenet that iron will not swimme) which *needle* will by little and little turne to the North and South points. But if the *needle* bee great and will not swimme, thrust it through a small peece of *corke* or some such like thing, and then it will doe the same: for such is the propertie of *iron* when it is placed in *equilibrio*, it strives to finde out the *Poles* of the world, or points of North and South: in a manner as the *magues* doth.



## EXAMINATION.

### EXAMINATION.

**H**ere is observable that the *moysture* which aydeth to the growth of the tree, is dilated and rarified by the Meridionall heat, and contracted by the Septentrionall cold: this rarification workes upon the part of the *humour* or *moysture* that

that is more thinne, which doth easily dissipate and evaporate: which evaporation carries a part of the salt with it; and because that solidation or condensation, so that there is left but a part of the nourishment which the heat bakes up and consumes: so contrarily on the other side the condensation and restrictive quality of the moysture causeth lesse evaporation and perdition: and so consequently there remaines more nourishment, which makes a greater increase on that side than on the other side: for as trees have their growth in winter, because their powers, and these of the earth are shut up: so in the spring when their powers are open, and when the sappe and moysture is drawne by it, there is not such cold on the North side that it may bee condensed at once: But contrarily to the side which is South, the heate may be such, that in little time by continuance, this moysture is dissipated greatly: and cold is nothing but that which hardneth and contracteth the moysture of the tree, and so converteth it into wood.

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 PROBLEM. LII.

Three persons having taken Counters,  
Cards, or other things, to finde how  
much each one hath taken.

CAUSE the third party to take a *number*  
which may be divided by 4, & as often as he  
takes 4, let the second party take 7, and the  
first

first take 13, then cause them to put them all together and declare the summe of it: which secretly divide by 3, and the *Quotient* is the double of the *number* which the third person did take. Or cause the third to give unto the second and first, as many as each of them hath; then let the second give unto the first and third, as many as each of them hath: lastly let the third give unto the second and first, as many as each of them hath; and then aske how much one of them hath: (for they will have then all alike,) so halfe of that *number* is the *number* that the third person had at the first: which knowne all is knowne.

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PROBLEME LIII.

*How to make a consort of musicke of many parts with one voyce, or one instrument onely.*

THIS Probleme is resolved, so that a singer or player upon an instrument, be neare an *Echo* which answereth his voice or *instrument*; and if the *Echo* answereth but once at a time, he may make a *double*; if twice, then a *triple*; if three times, then an *harmonie* of foure parts; for it must be such a one that is able to exercise both tune and note as occasion requires. As when he begins *ut*, before the *Echo* answereth, he may begin *sol*, and pronounce it in the same tune that the *Echo* answereth, by which meanes you have a fit, agreeable consort of *musicke*: then  
in

in the same time that the *Echo* followeth, to sound the second note *sol*, hee may sound forth another *sol* higher or lower to make an eight; the most perfect consort of *musicke*, and so of others; if he will continue his voyce with the *Echo*: and sing alone with two parts. Now experience sheweth this to be true, which often comes to passe in many *Churches*; making one to beleeve that there is many more parts in the musicke of a *Quier*, than in effect truly there is, because of the resounding and multiplying of the voyce, and redoubling of the *Quire*.

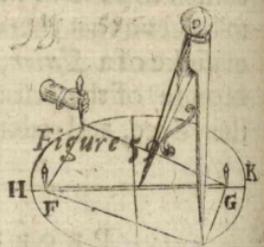
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PROBLEM. LIIII.

To make or describe an *Ovall* forme, or that which neare resembles unto it, at one turning with a paire of common *Compasses*.

There is many fine wayes in *Geometricall* practices, to make an *Ovall* figure or one neare unto it, by severall centers: any of which I will not touch upon; but shew how it may be done promptly upon one center only. In which I will say nothing of the *Ovall* forme which appeares, when one describeth circles with the points of a common *compasses*, somewhat deepe upon a skinne stretched forth hard: which contracting it selfe in some parts of the skinne maketh an *Ovall* forme. But it will more evidently appeare upon a *columnne* or *cylinder*: if paper  
be

be placed upon it, then with a paire of *Compasses* describe as it were a *circle* upon it, which paper afterwards being extended, will not be *circular* but *ovall-wise*: and a paire of *Compasses* may be so accommodated that it may be done also upon a plain thus. As let the length of the *Ovall* be *H. K*, fasten 2 pinnes or nayles neare the end of that line as *F. G*, and take a threed which is double to the length of *G. H*, or *F. K*: then if you take a *Compassse* which may have one foot lower than another, with a spring betweene his legges: & placing one foot of this *Compassse* in the *Center* of the *Ovall*, and guiding the threed by the other foot of the *Compassse*, and so carrying it about: the spring will helpe to describe and draw the *Ovall* forme. But in stead of the *Compassse* it may be done with ones hand onely, as in the figure may appear.



PROBLEM. LV.

*Of a purse difficult to be opened.*

**I**T is made to shut and open with *rings*: first at each side there is a strap or string, as *A B* and

and *CD*, at the end of which are 2 rings, *B* & *D*, and the string *CD* passeth through the ring *B*, so that it may not come out againe; or be parted one from another: and so that the ring *B*, may slide up and downe upon the string *CD*, then over the purse there is a peece of leather *E. F. G. H.* which covers the opening of the purse,

and there is another peece of leather *A.*

*E.* which passeth through many rings:

which hath a flitte towards the end *I.* so

great that the string *B. C.* may slide into

it: Now all the cunning or craft is how

to make fast or to open the purse, which

consists in making the string *B. C.* slide through

the side at *I*; therefore bring downe *B.* to *I*,

then make the end *I.* passe through the ring *B:*

and also *D.* with his string to passe through the

slit *I*, so shall the purse be fast; and then may the

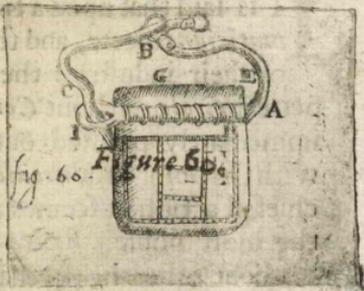
strings be put as before: and it will seeme difficult

to discover how it was done. Now to open the

purse, put through the end *I.* through the

ring *B*, and then through the slit *I*; by which you

put through the string *D G*: by this way the



PROPO

## PROBLEM. LVI.

Whether it is more hard and admirable without  
Compasses to make a perfect circle, or being  
made to finde out the Center of it.

**I**T is said that upon a time past, two *Mathe-*  
*maticians* meete, and they would make tryall  
of their industry: the one made instantly a  
perfect circle without *Compasses*, and the other  
immediately pointed out the center thereof  
with the point of a needle: now which is the  
chieftest action: it seemes the first: for to draw  
the most noblest figure upon a plaine *Table*  
without other helpe than the hand, and the  
minde, is full of admiration: to finde the center  
is but to finde out only one point, but to draw a  
round, there must be almost infinite points, e-  
quidistant from the center or middle: that in  
conclusion it is both the circle and the center  
together. But contrariily it may seeme that to  
finde the center is more difficult, for what atten-  
tion, vivacitie, and subtiltie must there be in the  
spirit, in the eye, in the hand, which will chuse  
the true point amongst a thousand other points?  
He that makes a circle keeps alwayes the same  
distance, and is guided by a halfe distance to  
finish the rest; but he that must finde the center,  
must in the same time take heed to the parts a-  
bout it, and choose one onely point which is  
equall distant from an infinite of other points  
which are in the circumference: which is very  
difficult.

difficult. *Aristotle* confirms this amongst his moralls, and seemes to explaine the difficultie which is to be found in the middle of vertue; for it may want a thousand wayes and be farre separated from the true *center* of the end of a right mediocritie of a vertuous action: for to doe well it must touch the middle point which is but one, and there must be a true point which respects the end, and thats but one onely. Now to judge which is the most difficults as before is said, either to draw the round or to finde the *center*: the round seemes to be harder than to finde the *center*, because that in finding of it, it is done at once, and hath an equall distant from the whole: But as before to draw a round there is a visible point imagined, about which the circle is to bee drawne. I esteeme that it is as difficult therefore if not more, to make the circle without a *center*, as to finde the middle or *center* of that circle.

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PROBLEM. LVI.

*Any one having taken 3 Cards, to finde how many points they containe.*

**T**His is to bee exercised upon a full packe of Cards of 52, then let one choose any three at pleasure secretly from your sight; and bid him secretly account the points in each Card: and will him to take as many Cards as will make up 15 to each of the points of his Cards;

G 2

then

then will him to give you the rest of the *Cards*, for 4 of them being rejected, the rest shewes the number of points that his three *Cards* which he tooke at the first did containe. As if the 3 *Cards* were 7, 10, and 4; now 7 wants of 15, 8; take 8 *Cards* therefore for your first *Cards*; the 10 wants of 15, 5, take 5 *Cards* for your second *Card*: lastly 4 wants of 15, 11, take 11 *Cards* for your third *Card*, and giving him the rest of the *Cards*, there will be 25; from which take 4, there remaines 21: the number of the three *Cards* taken, viz. 7, 10, and 4.

Whosoever would practise this play with 4, 5, 6, or more *Cards*, and that the whole number of *Cards* be more or lesse than 52; and that the terme be 15, 14, 12, &c. this generall rule ensuing may serve: multiply the terme by the number of *Cards* taken at first: to the product adde the number of *Cards* taken, then subtract this summe from the whole number of *Cards*; the remainder is the number which must be subtracted from the *Cards*, which remaines to make up the game: if there remaine nothing after the *subtraction*, then the number of *cards* remaining doth justly shew the number of points which were in the *Cards* chosen. If the *subtraction* cannot be made, then subtract the number of *Cards* from that number, and the remainder added unto the *Cards* that did remaine, the summe will be the number of points in the *Cards* taken, as if the *Cards* were 7, 10, 5, 8, and the terme given were 12; so the first wants 5, the second wants 2, the third wants 7, and the

the fourth wants 4 *Cards*, which taken, the party gives you the rest of the *Cards*: then secretly multiply 12 by 4, makes 48; to which adde 4 the number of *Cards* taken, makes 52, from which 52 should bee taken, rest nothing: therefore according to the direction of the remainder of the *Cards* which are 30, is equall to the points of the foure *Cards* taken, viz. 7, 10, 5, 8. Againe let these five *Cards* bee supposed to be taken, 8, 6, 10, 3, 7; their differences to 15, the termes are 7, 9, 5, 12, 8, which number of *Cards* taken, there will remaine but 6 *Cards*: then privatly multiply 15 by 5, makes 75, to which adde 5 makes 80, from this take 52 the number of *Cards*, rest 28, to which adde the remainder of *Cards*, make 34: the summe with 8, 6, 10, 3, 7.

PROBLEM. LVII.

*Many Cards placed in diverse rankes, to finde which of these Cards any one hath thought.*

**T**AKE 15 *Cards* and place them in 3 heapes in ranke-wise, 5 in a heape: now suppose any one had thought one of these *Cards* in any one of the heapes, it is easie to finde which of the *Cards* it is, and it is done thus: aske him in which of the heapes it is, which place in the middle of the other two: then throw downe the *Cards* by 1 and 1 into three severall heapes in ranke-wise, untill all be cast downe; then aske

G 3

him

him in which of the rankes his *Card* is: which heape place in the middle of the other two heapes alwayes; and this doe foure times at least, so in putting the *Cards* altogether, looke upon the *Cards*, or let their backe bee towards you, and throw out the eight *Card*: for that was the *Card* thought upon without faile.

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PROBLEM. LVIII.

*Many Cards being offered to sundry persons,  
to finde which of those Cards any  
one thinketh upon.*

**A**Dmit there were 4 persons, then take 4 *Cards* and shew them to the first: bid him think one of them, & put these 4 away; then take 4 other *Cards* and shew them in like manner to the second person, and bid him think any one of these *Cards*: and so doe to the third person, and so the fourth, &c. Then take the 4 *Cards* of the first person, and dispose them in 4 rankes: and upon them the 4 *Cards* of the second person, upon them also these of the third person, & lastly upon them these of the fourth person: then shew unto each of these parties each of these rankes, and aske him if his *Card* be in it which he thought: for infallibly that which the first partie thought upon will bee in the first ranke, and at the bottome; the *Card* of the second person will bee in the second ranke: the *Card* of the third thought upon will be in the third

third ranke, and the fourth mans Card will be in the fourth ranke; and so of others: if there bee more persons use the same methode. This may be practised by other things, ranking them by certaine numbers: allotted to peeces of money, or such like things.

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PROBLEM. LIX.

*How to make an instrument to helpe hearing, as Gallileus made to helpe the sight.*

**T**Hinke, not that the *Mathematickes* (which hath furnished us with such admirable helps for seeing) is wanting for that of hearing: its well knowne that long *trunkes* or *pipes* makes one heare well farre off, and experience shewes us that in certaine places of the *Arcades* in a hollow vault, that a man speaking but softly at one corner thereof, may be audibly understood at the other end: notwithstanding these which are betweene the parties cannot heare him speake at all: And it is a generall principle, that *pipes* doe greatly helpe to strengthen the activitie of naturall causes: we see that fire contracted in a *pipe*, burnes 4. or 5. foot high, which would scarce heat, being in the open aire: the rupture or violence of water issuing out of a *fountain*, shewes us that water being contracted into a *pipe*, causeth a violence in its passage. The *Glasses* of *Gallileus* makes us

see how usefull pipes or trunkes are to make the light and species more visible, and proportionable to our eye. It is said that a Prince of Italy hath a faire hall, in which he can with facility heare distinctly the discourses of these which walke in the adjacent gardens, which is by certaine vessels and pipes that answere from the garden to the hall. *Vitruvius* makes mention also of such vessels and pipes, to strengthen the voyce and action of *Comedians*: and in these times amongst many noble personages, the new kinde of trunkes are used to helpe the hearing, being made of silver, copper, or other resounding material; in funnell-wise putting the widest end to him which speaketh, to the end to contract the voyce, that so by the pipe applyed to the eare it may be more uniforme and lesse in danger to dissipate the voyce, and so consequently more fortified.

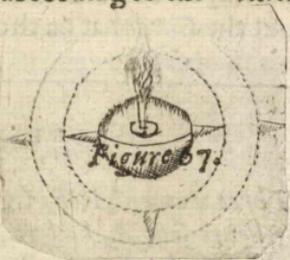
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PROBLEM. LX.

Of a fine lampe which goes not out, though one carry it in ones pocket: or being rouled upon the ground will still burne.

**I**T must be observed that the vessell in which the oyle is put into, have two pinnes on the sides of it one against another, being included within a circle: this circle ought to have two other pinnes, to enter into another circle of brasse,

brasse, or other sollid matter: lastly this second circle hath two pinnes which may hang within some box to containe the whole lampe, in such manner, that there be 6 pinnes in different position: Now by the aide of these pegges or pinnes, the lampe that is in the middle will bee alwayes well scituated according to his Center of gravity, though it bee turned any way: though if you endeavour to turne it upside downe, it will lie levell: which is pleasant and admirable to behold to these which know not the cause: And it is facill from this to make a place to rest quiet in, though there bee great agitation in the outward parts.



PROBLEM. LXI.

*Any one having thought a Card amongst many Cards, how artificially to discover it out.*

**T**AKE any number of Cards as 10, 12, &c. and open some 4 or 5 to the parties fight, and bid him thinke one of them, but let him note whether it be the first, second, third, &c. then with promptnesse learne what number of Cards you

you had in your hands, and take the other part of the *Cards*, & place thē on the top of these you hold in your hand; and having done so, aske him whether his *Card* were the first, second, &c. then before knowing the number of *Cards* that were at the bottome, account backwards untill you come to it: so shall you easily take out the *Card* that he thought upon.

## PROBLEM. LXII.

Three women *A. B. C.* carried apples to a market to sell, *A.* had 20, *B.* 30, and *C.* 40; they sold as many for a penny, the one as the other: and brought home one as much money as another, how could this be.

The answer to the *Probleme* is easie, as suppose at the beginning of the market: *A.* sold her apples at a penny an apple: and sold but 2. which was 2 pence, and so shee had 18 left: but *B.* sold 17. which was 17 pence, and so had 13. left: *C.* sold 32 which was 32 pence, and so had 8 apples left: then *A.* said she would not sell her apples so

	18	and	54	is	66
<i>B.</i>	17	and	51	is	68
<i>C.</i>	32	and	96	is	128
	8	and	24	is	32

Figure 61.

cheape,

cheape, but would sell them for 3 pence the peeces, which shee did: and so her apples came to 54 pence, and *B.* having left but 13 apples sold them at the same rate which came to 39 pence: and lastly *C.* had but 8 apples, which at the same rate came to 24 pence: these summes of money which each others before received come to 56 pence, and so much each one received; and so consequently brought home one as much as another.

PROBLEM. LXIII.

*Of the properties of some numbers.*

First, any two numbers is just the summe of an number that have equall distance from the halfe of that number: the one augmenting, and the other diminishing, as 7 and 7, of 8, and 6, of 9 and 5, of 10 and 4, of 11 and 3, of 12 and 2, of 13 and 1: as the one is more than the halfe the other is lesse.

Secondly, it is difficult to finde two numbers whose summe and product is alike, (that is) if the numbers be multiplied one by another, and added together, will be equall: which two numbers are 2 and 2, for to multiply 2 by 2 makes 4, and adding 2 unto 2 makes the same: this property is in no other two whole numbers, but in broken numbers there are infinite, whose summe and product will be equall one to another. As *Clavius* shewes upon the 36 *Pro.* of the 9<sup>th</sup> booke of *Euclide*.

Thirdly.

Thirdly, the numbers 5 and 6 are called circular numbers, because the circle turnes to the point from whence it begins: so these numbers multiplied by themselves, doe end alwayes in 5 and 6, as 5 times 5 makes 25, that againe by 5 makes 125; so 6 times 6 makes 36, and that by 6 makes 216, &c.

Fourthly, the number 6, is the first which Arithmeticians call a perfect number, that is, whose parts are equall unto it, so the 6 part of it is 1, the third part is 2, the halfe is 3, which are all his parts: now 1, 2, and 3, is equall to 6. It is wonderfull to conceive that there is so few of them, and how rare these numbers are, so of perfect men: for betwixt 1 & 1000000000000 numbers there is but ten, that is; 6, 28, 486. 8128. 120816. 2096128. 33550336. 536854528. 8589869056, & 137438691328: with this admirable property, that alternately they end all in 6 and 8, & the twentieth perfect number is 151115727451553768931328.

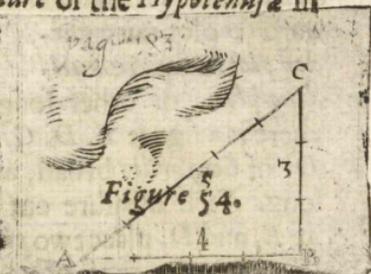
Fifthly, the number 9 amongst other privileges carries with it an excellent property, for take what number you will, either in grosse or in part: the nines of the whole or in its parts rejected, and taken simply will be the same, as 27 it makes 3 times 9, so whether the nines be rejected of 27, or of the summe of 2 and 7, it is all one: so if the nines were taken away of 240. it is all one, if the nines were taken away of 2, 4, and 0; for there would remaine 6 in either: and so of others.

Sixthly, 11 being multiplied by 2, 4, 5, 6, 7, 8,

8, or 9, will end and begin with like numbers; so 11 multiplied by 5 makes 55: if multiplied by 8, it makes 88, &c.

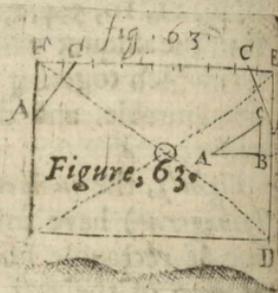
Seventhly, the numbers 220 and 284 being unequal, notwithstanding the parts of the one number doth alwayes equallise the other number: so the aliquot parts of 220 are 110, 54, 44, 22, 20, 11, 10, 5, 4, 2, 1, which together makes 284: the aliquot parts of 284 are 142, 71, 4, 2, 1, which together makes 220, a thing rare and admirable, and difficult to finde in other numbers.

Eightly, the numbers 3, 4, 5, (found out by Pythagoras) have an excellent property in making of rectangle Triangles: upon which the 47 Pro: of the first booke of *Euclide*, was grounded, that the square of the Hypotenuse in any such Triangle, is equall to the square of the other two sides: that is 5, the Hypotenuse multiplied in 5 makes 25, and 4 multiplied in 4 makes 16, and 3 multiplied in 3, makes 9: but 9 and 16 is equall to 25: or if these numbers 3, 4, 5, be doubled, viz. 6, 8, 10: the square of 10 is equall to the square of 8 and 6, viz. 10 times 10 makes 100, and 8 times 8 makes 64, and 6 times 6 is 36; which



36 and 64, put together makes 100 as before and so may they be *Tripled, Quadrupled, &c.*

The use of these numbers 3, 4, 5, are manifold, but it may be applied thus, for the helpe of such which plot out *gardens, houses, encampe horse or foote, &c.* Example, take 3 cords: one of 5 yards, another of 4 yards, and another of 3 yards; or the *double, triple, decuple, &c.* or all in one line: and make knots at the rearmes of these measures; so these three parts will make a right angled Triangle, as *A. B. C.* and it is easie with this Triangular cord to plot out a *garden plot: a square building plot,* or other long square. As suppose there is a figure *E. D. G. F.* to be plotted: *E. D.* of 60 yards broad, and *D. G.* 100 yards long. First measure out *E. D.* 60 yards, and at *E.* and *D.* place two pinnes or pegges; then at *E.* place the angle of your Triangular cord *B.* and let the line of the Triangle *A. B.* be in the line *E. D.*: which suppose at *A.* make the cord *A. B.* fast in *E.* and *A.*, then put the other two cords of the Triangle untill they meete, which will be in *C.* and place a pegge at *C.*: take afterwards a long cord, and by the points *E.* and *C.* augment it unto *F.* 100 yards from *E.*, and at *F.* place a pegge: then at *F.* apply your Triangular



cord

cord as you did at *E*, and so may you draw the line *F. G.* as long as *E. D.*, viz. 60 yards. Lastly it is easie to draw the line *G. D.*, and so the re-ctanguled figure or long square shall be plotted, whose bredth is 60 yards, and length 100 yards as was required: and to examine this, measure *E. G.*, then if *F. D.* be as long, the figure is true: otherwise it is defective and may easily bee amended.

If one bee taken from any square number which is odde, the square of halfe of it being added to the first square, will make a square number.

The square of halfe any even number  $\div$  1 being added to that even number makes a square number, and the even number taken from it leaves a square number.

If odde numbers bee continually added from the unitie successively, there will bee made all square numbers, and if cubicke numbers bee added successively from the unitie, there will bee likewise made square numbers.

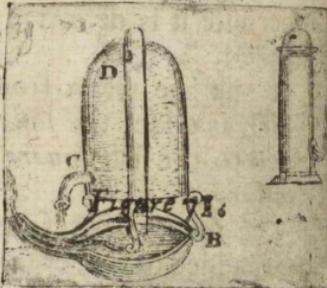
PROBLEM. LXV.

Of an excellent lampe which serves or furnishest it selfe with oyle, and burnes a long time.

I Speake not here of a common lampe which *Cardanus* writes upon in his book *de subtilitate*, for thats a little vessell in collumne-wise, which

which is full of *oyle*, and because there is but one little hole at the bottome neare the weeke or match; the *oyle* runnes not, for feare that there be emptinesse above: when the match is kindled it begins to heat the lampe, and rarifying the *oyle* it issueth by this occasion: and so sends his more airie parts above to avoide vacuitie.

But that which I here deliver is more ingenious, the principall peece of which is a *vessell* as *C.D.* which hath neare the bottome a hole, and a funnell or pipe *C*: & then a bigger funnell which passeth through the middle of the *vessell*, having an opening at *D*. neare the *E* top, and another at the bottome as at *E*, neare the *vessell* under it, so that the pipe touch it not: the *vessell* being thus made, fill it with *oyle*, and opening the hole *C*. the *oyle* running out will stop the hole at *E*: or throwing in *oyle* into the *vessell* underneath, untill *E*. bee stopped; then the *oyle* at *C*. will not runne: because no aire can come into the pipe *D. E*. Now as the *oyle* burneth and consumeth in the *vessell* *A. B.* the hole at *E*, will begin to be open, then immediatly will *C*. begin to runne to fill up *A. B.*: and *E* being stopped with the *oyle*, the *oyle* at *C*. ceaseth to run.



It is certaine that such a *lampe* the *Athenians* used, which lasted a whole yeare without being touched: which was placed before the statue of *Minerva*, for they might put a certaine quantitie of oyle in the *lampe C.D*, and a match to burne without being consumed: such as the naturallists write of, by which the *lampe* will furnish it selfe and so continue in burning: and here may be noted that the oyle may be powred in at the top of the *vessell* at a little hole, & then made fast againe that the aire get not in.

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PROBLEM. LXV.

*Of the play at Keyles or nine Pinnes.*

**Y**OU will scarce beleve that with one bowle and at one blow playing freely, one may strike downe all the Keyles at once: yet from *Mathematicall* principles it is easie to bee demonstrated, that if the hand of him that playes was so well assured by experience, as reason induceth one thereto: one might at one blow strike downe all the Keyles, or at least 7 or 8, or such a number as one pleaseth.

For they are but 9 in all disposed or placed in a perfect *square*, having three every way. Let us suppose then that a good player beginning to play at 1 somewhat low, should so

H

strike

strike it, that it should strike down the Keyles 2 and 5, and these might in their violence strike down the Keyles 3, 6, and 9: and the bowle being in motion may strike downe the Keyle 4, and 7; which 4 Keyle may strike the Keyle 8: and so all the 9 Keyles may bee striken downe at once.




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PROBLEM. LXVI.

*Of Spectacles of pleasure.*

**S**imple Spectacles of *blew, yeallow, red or Greene* colour, are proper to recreate the sight, and will present the objects died in like colour that the *Glasses* are, onely those of the *greene* doe somewhat degenerate; instead of shewing a lively colour it will represent a pale dead colour, and it is because they are not dyed greene enough, or receive not light enough for greene: and colour these images that passe through these *Glasses* unto the bottome of the eye.

EXAMINA-

# PROPOSITION

## EXAMINATION.

**I**T is certaine that not onely Glasses dyed green, but all other Glasses coloured, yeeldes the appearances of objects strong or weake in colour according to the quantity of the dye, more or lesse, as one being very yellow, another a pale yellow; now all colours are not proper to Glasses to give colour, hence the defect is not that they want facultie to receive light, or resist the penetration of the beames, for in the same Glasses those which are most dyed, gives alwayes the objects more high coloured and obscure, and those which are lesse dyed gives them more pale and cleare: and this is daily made manifest by the painting of Glasse, which hinders more the penetration of the light than dying doth, where all the matter by fire is forced into the Glasse, leaving it in all parts transparent.

Spectacles of Crystall cut with diverse Angles dimond-wise doth make a marvelous multiplication of the appearances, for looking towards a house it becomes as a Towne, a Towne becomes like a Citie, an armed man seems as a whole company caused soly by the diversity of refractions; for as many plaines as there are on the outside of the Spectacle, so many times will the object be multiplied in the appearance, because of diverse Images cast into the eye.

These are pleasurable Spectacles for avaritious persons that love gold and silver, for one peece will seeme many, or one heape of money will seeme as a treasury: but all the mischief is, he will not have his end in the injoying of it, for indeavoring to taks it, it will appeare but a deceitfull image, or delusion of nothing. Here may you note that if the finger be directed by one and the same ray or beam, which pointeth to one & the same object, then at the first you may touch that visible object without being deceived: otherwise you may faile often in touching that which you see.

Againe there are Spectacles made which doe diminish the thing scene very much, and and brings them to a faire perspective forme, especially if one looks upon a faire garden plot, a greater walke, a stately building, or great court, the industry of an exquisite Painter cannot come neare to expresse the lively forme of it as this Glasse will represent it; you will have pleasure to see it really experimented, and the cause of this is, that the glasses of these Spectacles are hollow & thinner in the middle, than at the edges by which the visuall Angle is made lesser: you may observe a further secret in these Spectacles, for in placing them upon a window one may see those that passe to and fro in the streets, without being scene of any; for their property is to raise up the objects that it lookes upon.

Now I would not passe this Probleme without saying something of Gallileus admirable Glasse, for the common simple perspective Glasses give to aged men, but the eyes or sight of young men,  
but

but this of Gallileus gives a man an Eagles eye, or an eye that pearcheth the heavens: first it discovereth the spottie and shadowed opacous bodies that are found about the Sunne, which darkeneth and diminisheth the splendor of that beautifull and shining Luminary: secondly, it shewes the new planets that accompany Saturne and Iupiter: thirdly, in Venus is seene the new, full, and quartiall increase; as in the Moone by her separation from the Sunne: fourthly, the artificiall structure of this instrument helpeth us to see an innumerable number of stars; which otherwise are obscured by reason of the naturall weakenesse of our sight, yea the starres in via lactea are seene most apperantly; where there seemes no starres to be, this instrument makes apperantly to be seene, and further delivers them to the eye in their true and lively colour, as they are in the heavens: in which the splendor of some is as the Sunne in his most glorious beauty. This Glasse hath also a most excellent use in observing the body of the Moone in time of Eclipses, for it augments it manifold, and most manifestly shewes the true forme of the cloudy substance in the Sunne; and by it is seene when the shadow of the earth begins to eclipse the Moone, and when totally shee is overshadowed: besides the celestiall uses which are made of this Glasse, it hath another noble property; it farre exceedeth the ordinary perspective Glasses, which are used to see things remote upon the earth, for as this Glasse reacheth up to the heavens and excelleth them there in his performance, so on the earth it claimeth pre-

heminency: for the objects which are farthest remote, and most obscure, are seene plainer than those which are neere at hand, scorning as it were all small and triviall services, as leaving them to an inferiour helpe: great use may be made of this Glasse in discovering of Shippes, Armies, &c. Now the apparell or parts of this instrument or Glasse, is very meane or simple, which makes it the more admirable (seeing it performes such great service) having but a convex Glasse thickest in the middle, to unite and amasse the rayes, and make the object the greater: to augmenting the visuall Angle, as also a pipe or truncke to amasse the Species, and hinder the greatnes of the light which is about it: (to see well, the object must be well inlightened, and the eye in obscurity;) then there is adjoyned unto it a Glasse of a short sight to distinguish the rayes, which the other would make more confused if alone. As for the proportion of those Glasses to the Truncke though there be certaine rules to make them, yet it is often by hazard that there is made an excellent one, there being so many difficulties in the adion, therefore many ought to be tryed, seeing that exact proportion, in Geometricall calculation cannot serve for diversity of sights in the observation.

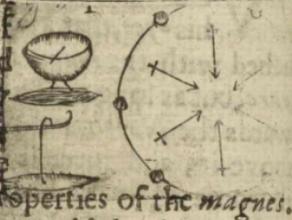
## PROBLEM LXVII.

Of the *Adamant* or *Magnes*, and the  
needles touched therewith.

**W**Ho would beleeve if he saw not with his eyes, that a *needle* of *steel* being once touched with the *magnes*, turnes not once, not a *yeare*, but as long as the world lasteth; his end towards the *North* and *South*, yea though one remove it, and turne it from his position, it will come againe to his points of *North* and *South*. Who would have ever thought that a brute *stone* blacke and ill formed, touching a ring of *iron*, should hang it in the *aire*: and that ring support a second, that to support a third, and so unto 10, 12, or more, according to the strength of the *magnes*; making as it were a chaine without a line, without souldering together, or without any other thing to support them onely; but a most occult and hidden vertue, yet most evident in this effect: which penetrateth insensibly from the first to the second, from the second to the third, &c.

Is it not a wonder to see that a *needle* touched once will draw other *needles*; and so a *nayle*, the point of a *knife*, or other peeces of *iron*. Is it not a pleasure to see how the *magnes* will turne file dust, or move *needles*, or *nayles* being upon a *Table*, or upon a peece of paper; for as soone as the *magnes* turnes, or it moves over, it moves also: who is it that would not bee ra-

wished as it were, to see a hand of iron, write upon a planke, without seeing the *Magnes* which causeth that motion behind the planke, or to make an image of iron to runne up and downe a *Turret*: now infinite of such inventions is proper to be extracted from the properties of the *magnes*.



What is there in the world that is more capable to cast a deeper astonishment in our mindes, than a great massie substance of iron to hang in the aire in the midst of a building without any thing in the world touching it, only but the aire? And histories assure us, that by the aide of a *magnes* or *adamant*, placed at the rooffe of one of the *Turkish* Synagogues in *Meca*: the sepulcher of that infamous *Mahomet* rests suspended in the aire; and *Plinie* in his naturall historie writes that the Architecter *Dinocrates* did begin to vault the Temple of *Arsinoe* in *Alexandria*, with store of *magnes* to produce the like deceit, to hang the sepulcher of that Goddess likewise in the aire.

I should passe the bounds of my counterpoise, if I should divulge all the secrets of this stone, and should expose my selfe to the laughter of the world: if I should brag to shew other the cause how this appeareth, than in its owne naturall

Naturall sympathy, for why is it that a *magnes* with one end will cast the *iron* away, and attract it with the other; from whence cometh it that all the *magnes* is not proper to give a true touch to the *needle*, but onely in the two *Poles* of the *stone*: which is knowne by hanging the stone by a threed in the aire untill it be quiet, or placed upon a peece of *Corke* in a dish of *water*, or upon some thinne board, for the *Pole* of the stone will then turne towards the *Poles* of the world, and point out the *North* and *South*; and so shew by which of these ends the *needle* is to be touched.

From whence comes it that there is a variation in the *needle*, and pointeth not out truly the *North* and *South* of the world, but onely in some place of the earth.

How is it that the *needle* made with pegges and inclosed within two *Glasses*, sheweth the height of the *Pole*, being elevated as many degrees as the *Pole* is above the *Horizon*.

Whats the cause that *fire* and *Garlicke* takes away the propertie of the *magnes*: There are many great hidden misteries in this stone, which have troubled the heads of the most learned in all ages; and to this time the world remains ignorant of declaring the true cause thereof.

Some sayes that by helpe of the *Magnes* persons which are absent may know each others minde, as if one being here at *London*, and another at *Prage* in *Germany*: if each of them had a *needle* touched with one *magnes*, then the vertue is such that in the same time that the  
*needle*

needle which is at *Prage* shall moove, this that is at *London* shall also; provided that the parties have like secret notes or alphabets, and the observation be at a set houre of the day or night; and when the one party will declare unto the other, then let that party move the needle to these letters which will declare the matter to the other, and the mooving of the other parties needle shall open his intention.

The invention is subtile, but I doubt whether in the world there can be found so great a stone, or such a *Magnes* which carries with it such vertue: neither is it expedient, for treasons would be then too frequent and open.



### EXAMINATION.

**T**He experimentall difference of reijection, and attraction procedes not from the different nature of stones, but from the quality of the iron, and the vertue of the stone consisteth onely and especially in his Poles; which being banged in the aire, turnes one of his ends alwayes naturally towards the South, and the other towards the North: but if a rod of iron be touched with one of the ends thereof, it hath the like property in turning North and South, as the *magnes* hath: notwithstanding the end of the iron rod touched, hath a contrary position to that end of the stone that touched it; yet the same end will attract it, and the other end reject it: and so  
contrarily

contrarily this may easily be experimented upon two needles touched with one or different stones, though they have one and the same position; for as you come unto the apply one end of the magnes neare unto the, the North of the one will abhorre the North of the other, but the North of the one will alwayes approach to the South of the other: and the same affection is in the stones themselves. For the finding of the Poles of the magnes, it may be done by holding a small needle betweene your fingers softly, and so moving it from part to part over the stone untill it be held perpendicular, for that shall be one of the Poles of the stone which you may marke out; in like manner finde out the other Pole: Now to finde out which of those Poles is North or South, place a needle being touched with one of the Poles upon a smooth convex body, (as the nayle of ones finger or such like,) and marke which way the end of the needle that was touched turneth: if to the South, then the point that touch'd it was the South Pole, &c. and it is most certaine and according to reason and experience: that if it be suspended in aquilibrio in the aire, or supported upon the water, it will turne contrary to the needle that toucheth it; for then the Pole that was marked for the South shall turne to the North, &c.

## PROBLEM. LXVIII.

Of the properties of *Aeolipiles* or *bowles*  
to blow the fire.

THESE are concave vessels of *brasse* or *copper*, or other materiall which may indure the fire: having a small hole very narrow by which it is filled with *water*, then placing it to the fire, before it bee hot there is no effect seene; but as soone as the heate doth penetrate it, the water begins to rarifie and issueth forth with a hideous and marvellous force; it is pleasure to see how it blowes the fire with great noyse.

*Vitruvius* in his first booke of *Architecture*, Cap. 8. approves from these *In-gines*, that the winde is no other thing than a quantitie of vapours and exhalations agitated with the aire by rarification and condensation, and wee may draw a conse-

quence from it, to shew that a little *water* may ingender a very great quantitie of vapours and aire: for a *Glasse* of *water* throwne into an *Aeolipile* will keep blowing neare a hole houre, sending forth his vapours a thousand times greater than it is extended.



Now

Now touching the forme of these vessels, they are not made of one like fashion: some makes them like a *bowle*, some like a head painted representing the *winde*, some makes them like a *peare*: as though one would put it to rost at the fire, when one would have it to blow, for the tale of it is hollow, in forme of a *funnell*, having at the toppe a very little *hole* no greater than the head of a *pinne*.

Some doe accustom to put within the *Aeolipile* a crooked *funnell* of many foldings, to the end that the *winde* that impetuously rowles to and fro within, may imitate the noyse of thunder.

Others content themselves with a simple *funnell* placed right upward, somewhat wider at the toppe than else where like a *Cone*, whose basis is the mouth of the *funnell*: and there may be placed a *bowle* of *iron* or *brasse*, which by the vapours that are cast out will cause it to leape up, and dance over the mouth of the *Aeolipile*.

Lastly, some apply neare to hole small *wind-mills*, or such like, which easily turne by reason of the vapours; or by help of two or more bowed *funnells*, a *bowle* may be made to turne: these *Aeolipiles* are of excellent use for the melting of mettalls and such like.

Now it is cunning and subiltie to fill one of these *Aeolipiles* with water at so little a hole, and therefore requires the knowledge of a *Philosopher* to finde it out: and the way is thus.

Heate the *Aeolipiles* being empty, and the  
aire

aire which is within it will become extremely rarified; then being thus hot throw it into water, and the aire will begin to bee condensed: by which meanes it will occupie lesse roome, therefore the water will immediately enter in at the hole to avoide vacuitie: thus you have some practicall speculation upon the *Aolipile*.

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PROBLEM. LXIX.

Of the Thermometer: or an instrument to measure the degrees of heat and cold in the aire.

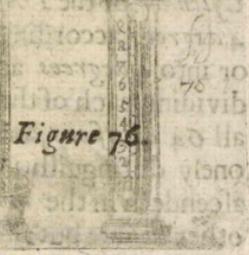
**T**His Instrument is like a *Cylindricall* pipe of *Glasse*, which hath a little ball or bowle at the toppe: the small end of which is placed into a vessell of water below, as by the figure may be seene.

Then put some coloured liquor into the *Cylindricall glasse*, as *blew*, *red*, *yealow*, *greene*, or such like: such as is not thicke. This being done the use may be thus.

*First*, I say that as the *aire* inclosed in the *Thermometer* is rarified or condensed, the *water* will evidently ascend or descend in the *Cylinder*: which you may try easily by carrying the *Thermometer* from a place that is hot unto a place that is cold, or without removing of it; if you softly apply the palme of the hand upon the balle of the *Thermometer*: the *Glasse* being so thinne, and the *aire* so capable of rarification, that

that at the very instant you may see the *water* descend: and your hand being taken away, it will softly ascend to his former place againe. This is yet more sensible when one heates the ball at the toppe with his breath, as if one would say a word in his eare to make the *water* to descend by command: and the reason of this motion is, that the *aire* heated in the *Thermometer*, doth rarifie and dilate, requiring a greater place; hence presseth the *water* and causeth it to descend: contrariwise when the *aire* cooleth and condenseth, it occupieth lesse roome; now nature abhorring vacuity, the *water* naturally ascendeth. In the second place I say, that by this meanes one may know the degrees of heate and cold, which are in the *aire* each houre of the day; for asmuch as the exterior *aire* is either hot or cold, the *aire* which is inclosed in the *Thermometer* doth likewise either rarifie or condense, and therefore the *water* ascends or descends; so you shall see that the *water* in the morning is mounted high, afterward by little and little it will descend towards noone or midday; and towards evening it will againe ascend: so in *winter* it will mount so high, that all the *Cylinder* of the *Thermometer* will bee full, but  
in

Figure 76.



in *Summer*, it will descend so low that scarce there will be perceaved in it any water at all.

These that will determine this change by *numbers* and degrees, may draw a line upon the *Cylinder* of the *Thermometer*; and divide it into 4 degrees, according to the ancient *Philosophers*, or into 4 degrees according to the *Physitians*, dividing each of these 8 into 8 others: to have in all 64 divisions, and by this way they may not onely distinguish upon what degree the water ascendeth in the *morning*, at *midday*, and at any other *houre*: but also one may know how much one day is *hotter* or *colder* than another: by marking how many degrees the water ascendeth or descendeth, one may compare the *hottest* and *coldest* dayes in a whole yeare together with these of another yeare: againe one may know how much *hotter* one roome is than another, by which also one might keepe a *chamber*, a *furnis*, a *stove*, &c. alwayes in an equalitie of heate, by making the *water* of the *Thermometer* rest alwayes upon one and the same degree: in brieve, one may judge in some measure the burning of *fevers*, and neare unto what extension the aire can bee rarified by the greatest heate.

Many make use of these glasses to judge of the weather, for it is observed that if the water fall in 3 or 4 houres a degree or thereabout, that raine insueth; and the water will stand at that stay, untill the weather change: marke the water at your going to bed, for if in the morning it hath descended raine followeth, but if it bee mounted

mounted higher, it argueth faire weather : so  
in very cold weather, if it fall suddainly, it is  
snow or some sleekey weather that will insue.

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PROBLEM. LXX.

*Of the proportion of humaine bodies of statues, of Colossus or huge images, and of monstrous Giants.*

**P**ythagoras had reason to say that man is the  
measure of all things.

First, because he is the most perfect amongst  
all bodily creatures, and according to the *Maxi-*  
*me of Philosophers, that which is most perfect,*  
*and the first in ranke, measureth all the rest.*

Secondly, because in effect the ordinary mea-  
sure of a foote, the intch, the cubit, the pace, have  
taken their names and greatnesse from *humaine*  
*bodies.*

Thirdly, because the *simmetrie* and concor-  
dancie of the parts is so admirable, that all  
workes which are well proportionable, as  
namely the building of *Temples*, of *Shippes*, of  
*Pillars*, and such like peeces of *Architecture*,  
are in some measure fashioned and composed  
after his proportion. And we know that the  
*Arke of Noah* built by the commandement of  
*God*, was in length 300 cubits, in bredth 50  
cubits, in height or depth 30 cubits, so that the  
length contains the bredth 6 times, and 10  
times the depth: now a man being measured

I

you

you will finde him to have the same proportion in length, breadth, and depth.

*Vilalpandus* treating of the *Temple of Salomon*, that chiefetaine of workes was modulated all of good *Architecture*, and curiously to be observed in many peeces to keepe the same proportion as the body to his parts: so that by the greatnesse of the worke and proportionable *symmetrie*, some dare assure themselves that by knowledge of one onely part of that *building*, one might know all the measures of that goodly structure.

Some *Architects* say that the foundation of *houses*, and basis of *columnes*, are as the foote; the *top*, and *rooffe* as the *head*; the rest as the *body*: those which have beene somewhat more curious, have noted that as in *humaine bodies*, the parts are uniforme as the *nose*, the *mouth*, &c. these which are double are put on one side or other, with a perfect equallitie in the same *Architecture*.

In like manner, some have beene yet more curious than solid; comparing all the ornaments of a *Corinth* to the parts of the *face*, as the *brow*, the *eyes*, the *nose*, the *mouth*; the rounding of *pillars*, to the writhing of haire, the chanells of *columnes*, to the fouldings of *womens robes*, &c.

Now *building* being a worke of the best *Artist*, there is much reason why man ought to make his imitation from the chiefe worke of nature; which is man.

Hence it is that *Virruvius* in his third book, and

and all the best *Architectures*, treateth of the proportion of man; and amongst others *Albert Dureus* hath made a whole booke of the measures of mans body, from the foot to the head; let them reade it who will, they may have a perfect knowledge therof: but I will content my selfe, and it may satisfie some with that which followeth.

*First*, the length of a *man* well made, which commonly is called height, is equall to the distance from one end of his *finger* to the other: when the *armes* are extended as wide as they may be.

*Secondly*, if a *man* have his feet and hands extended or stretched in forme of *S. Andrewes Crosse*, placing one foote of a paire of *Compasses* upon his *navill*, one may describe a *circle* which will passe by the ends of his hands and feet, and drawing lines by the termes of the hands and feet, you have a square within a *circle*.

*Thirdly*, the breadth of *man*, or the space which is from one side to another; the *breast*, the *head*, and the *necke*, makes the 6 part of all the *body* taken in length or height.

*Fourthly*, the length of the *face* is equall to the length of the *hand*, taken from the small of the *arme*, unto the extremitie of the longest *finger*.

*Fifthly*, the thickenesse of the *body* taken from the *belly* to the *backe*; the one or the other is the tenth part of the whole *body*, or as some will have, it the ninth part, little lesse.

*Sixthly*, the height of the *brow*, the length of the

the *nose*, the space betweene the *nose* and the *chinne*, the length of the *eares*, the greatnesse of the *thumb*, are perfectly equall one to the other.

What would you say to make an admirable report of the other parts, if I should reckon them in their least; but in that I desire to be excused, and will rather extract some conclusion upon that which is delivered.

In the first place knowing the proportion of a *man*, it is easie to *Painters*, *image-makers*, &c. perfectly to proportionate their worke; and by the same is made most evident, that which is related of the *images* and statues of *Greece*, that upon a day diverse workemen having enterprised to make the face of a *man*, being severed one from another in sundry places, all the parts being made and put together, the face was found in a most lively and true proportion.

Secondly, it is a thing most cleare that by the helpe of proportion, the body of *Hercules* was measured by the knowledge of his *foote* onely; a *Lyon* by his *claw*, the *Gyant* by his *thumb*, and a *Man* by any parte of his body. For so it was that *Pythagoras* having measured the length of *Hercules* foote, by the steps which was left upon the *ground*, found out all his height: and so it was that *Phydias* having onely the *claw* of a *Lyon*, did figure and draw out all the beast according to his true type or forme; so the exquisite Painter *Timantus*, having painted a *Pigmy* or *Dwarfe*, which he measured with a *fadome* made with the *itch* of a *Gyant*; it was suffici-

ent to know the greatnesse of that *Gyant*.

To be short, we may by like methode come easily to the knowledge of many fine antiquities touching *Statues*, *Colosses*, and monstrous *Gyants*, onely supposing one had found but one onely part of them, as the *head*, the *band*, the *foote*, or some bone mentioned in ancient *Histories*.

*Of Statues, of Colossus, or huge images.*

*Vitruvius* relates in his second booke that the *Architect* *Dinocrates* was desirous to put out to the world some notable thing, went to *Alexander* the great, and proposed unto him a high and speciall peece of worke which he had projected: as to figure out the mount *Athos* in forme of a great *Statue*, which should hold in his right hand a *Towne* capable to receive ten thousand men: and in his left hand a *vessell* to receive all the water that floweth from the *mountaine*, which with an *ingine* should cast into the *Sea*. This is a pretty project, said *Alexander*, but because there was not field roome thereabout to nourish and retaine the *Citizens* of that place, *Alexander* was wise not to entertaine the designe.

Now let it bee required of what greatnesse this *Statue* might have beene, the *Towne* in his right hand, and the receiver of water in his left hand if it had beene made.

For the *Statue*, it could not bee higher than the *mountaine* it selfe, and the *mountaine* was about a mile in height plume or perpendicular;

therefore the hand of this *Statue* ought to be the 10<sup>th</sup> part of his height, which would be 500 foote, and so the bredth of his hand would be 250 foote; the length now multiplied by the bredth, makes an hundred twenty five thousand square fecte; for the quantitie of his hand to make the towne in, to lodge the said 10 thousand men, allowing to each man neere about 10 foote of square ground: now judge the capacitie of the other parts of this *Colossus* by that which is already delivered.

Secondly, *Plinie* in his 34 booke of his natural History, speakes of the famous *Colossus* that was at *Rhodes*, betweene whose legges a Shippe might passe with his sailes open or displayed, the *Statue* being of 70 cubits high: and other Histories reports that the *Sarazins* having broken it, did load 900 Camells with the mettles of it, now what might be the greatnes and weight of this *Statue*.

For answere it is usually allowed for a Camells burthen 1200 pound weight, therefore all the *Colossus* did weigh 1080000 pound weight, which is ten hundred and forescore thousand pound weight.

Now according to the former rules, the head being the tenth part of the body, this *Statues* head should be of 7 cubits, that is to say, 10 foote and a halfe; and seeing that the nose, the brow, and the thumbe, are the third part of the face; his nose was 3 foote and a halfe long, and so much also was his thumbe in length: now the thicknesse being alwayes the third part of the

the length, it should seeme that his *thumbe* was a foote thicke at the least.

Thirdly, the said *Plinie* in the same place reports that *Nero* did cause to come out of *France* into *Italy*, a brave and bold *Statue-maker* called *Zenodocus*, to erect him a *Colossus* of *brasse*, which was made of 120 foot in height, which *Nero* caused to bee painted in the same height. Now would you know the greatnesse of the members of this *Colossus*, the breadth would be 20 foote, his *face* 12 foote, his *thumbe* and his *nose* 4 foote, according to the proportion before delivered.

Thus I have a faire *field* or subject to extend my selfe upon, but it is upon another occasion that it was undertaken; let us speake therefore a word touching the *Gyants*, and then passe away to the matter.

#### Of monstrous Gyants.

YOU will hardly beleeve all that which I say touching this, neither will I beleeve all that which *Authors* say upon this subject: notwithstanding you nor I cannot deny but that long agoe there hath beene men of a most prodigious greatnesse; for the *holy writings* witness this themselves in *Deut. Chap. 3.* that there was a certaine *Gyant* called *Ogge*, of the Towne of *Rabath*, who had a bed of iron, the length thereof was 9 cubits, and in bredth 4 cubits.

So in the first of *Kings Chap. 17.* there is mention

mention made of *Goliath*, whose height was a palme and 6 cubits, that is more then 9 foote, he was armed from the head to the foote, and his *Curiat* onely with the iron of his lance, weighed five thousand and sixe hundred sicles, which in our common weight, is more than 233 pound, of 12 ouncesto the pound. Now it is certaine that the rest of his armes taking his *Target*, *Helmet*, *Braselets*, and other *Armour* together, did weigh at the least 5 hundred pound, a thing prodigious; seeing that the strongest man that now is, can hardly beare 200 pound, yet this *Gyant* carries this as a *vesture* without paine.

*Solinus* reporteth in his 5 *Chap.* of his *Historie*, that during the *Grecians* warre after a great overflowing of the rivers, there was found upon the sands the carkasse of a man, whose length was 33 cubits, (that is 49 foote and a halfe) therefore according to the proportion delivered, his face should bee 5 foote in length, a thing prodigious and monstrous.

*Plinie* in his 7. booke and 16. *Chap.* saith, that in the Ile of *Crete* or *Candie*, a mountaine being cleaven by an *earthquake*, there was a body standing upright, which had 46 cubits of height: some beleeves that it was the body of *Orion* or *Othius*, (but I thinke rather it was some *Ghost* or some delusion,) whose hand should have beene 7 foote, and his nose two foot and a half long. But that which *Plutarch* in the life of *Sertorius* reports of is more strange, who saith that in *Timgy* a *Morative Towne*; where

where it is thought that the *Gyant Antheus* was buried, *Sertorius* could not beleieve that which was reported of his prodigious greatnesse, caused his sepulcher to bee opened, and found that his body did containe 60 cubits in length, then by proportion hee should bee 10 cubits or 15 foote in bredth; 9 foote for the length of his face, 3 foote for his thumb, which is neare the capacitie of the *Colossus* at *Rhodes*.

But behold here a fine fable of *Symphoris Canapesius*, in his booke intituled *Hortus Gallicus*, who sayes that in the Kingdome of *Sicile*, at the foote of a mountaine neare *Trepane*, in opening the foundation of a house, they found a Cave in which was laid a *Gyant*, which held in stead of a staffe a great post like the mast of a Shippe: and going to handle it, it mouldered all into ashes except the bones which remained of an exceeding great measure, that in his head there might be easily placed 5 quarters of corne, and by proportion it should seeme that his length was 200 cubits, or 300 foote: if he had said that hee had beene 300 cubits in length, then he might have made us beleieve that *Noahs Arke* was but great enough for his sepulcher.

Who can beleieve that any man ever had 20 cubits, or 30 foote in length for his face, and a nose of 10 foote long? but it is very certaine that there hath been men of very great stature, as the holy Scriptures before witnesseth, and many *Authours* worthy of beleife relateth: *Iosephus Acofta* in his first booke of the *Indian History*, Chap. 19. a late writer, reporteth that  
at

at *Pern* was found the bones of a *Gyant*, which was 3 times greater than these of ours are, that is, 18 foote: for it is usually attributed to the tallest ordinary man in these our times but 6 foote of length; and *Histories* are full of the description of other *Gyants* of 9, 10, and 12 foote of height, and it hath beene seene in our times some which have had such heights as these.

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PROBLEM. LXXI.

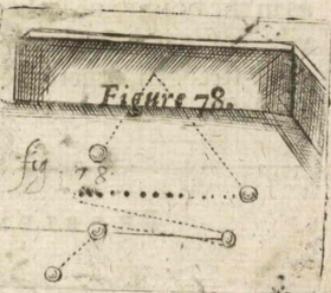
*Of the game at the Palme, at Trappe, at Bowles, Paile-maile and others.*

**T**HE *Mathematickes* often findeth place in sundry *Games* to aide and assist the *Gamessters*, though not unknowne unto them: hence by *Mathematicall* principles, the games at *Tennis* may be assisted; ifor all the moving in it is by right lines and reflections. From whence comes it, that from the appearances of flat or convex *Glasses*, the production and reflection of the species are explained, is it not by right lines? in the same proportion one might sufficiently deliver the motion of a *balle* or *bowle* by *Geometrical lines* and *Angles*.

But the exercise, experience, and dexteritie of the player seemes more in this action than any any other precepts: notwithstanding I will deliver here some *maximes*, which being reduced to practice, and joyned to experience, will give

give a great advantage to those which would make use of them in such gamings.

And the first *maxime* is thus: When a *Bowle* toucheth another *Bowle*, or when a *trapsticke* striketh the *Balle*, the moving of the *Balle* is made in a right line, which is drawne from the Center of the *Bowle* by the point of contingencie.



*Secondly*, in all kinde of such motion; when a *Balle* or *Bowle* rebounds, be it either against wood, a wall, upon a *Drumme*, a pavement, or upon a *Racket*; the incident Angle is alwayes equall to the Angle of reflection.

Now following these *maximes* it is easie to conclude, first in what part of the wood or wall, one may make the *Bowle* or *Balle* goe to reflect or rebound, to such a place as one would: *Secondly*, how one may cast a *Bowle* upon another, in such sort that the first or the second shall goe and meete with the third, keeping the reflection or Angle of incidence equall. *Thirdly*, how one may touch a *Bowle* to send it to what part one pleaseth: such and many other practices may bee done. At the exercises at *Keyles* there must be taken heed that the motion, slacke or diminisheth by little and little, and may

may be noted that the *Maximes* of reflections cannot be exactly observed by locall motion, as in the beames of light and of other qualities, whereof it is necessary to supply it by industry or by strength, other wise one may be frustrated in that respect.

PROBLEM. LXXII.

*Of the Game of square formes.*

**N***Umbers* have an admirable secrecie, diversly applyed, as before in part is shewed, and here I will say some thing by way of transmutation of *numbers*.

It is reported that at a certaine passage of a square forme, there were 4 gates opposite one to another, that is, one in the middle of each side, and that there was appointed 9 men to defend each front thereof, some at the gates, and the other at each corner or Angle, so that each Angle served to assist two faces of the *square* if neede required: Now this *square passage* being thus manned to have each side 9, it hapned that 4 *Souldiers* comming by, desired of the *Governour* of the *passage*, that they might be entertained into service, who told them hee could not admit of more then 9, upon each side of the *square*: then one of the *Souldiers* being versed in the *Art* of *numbers*, said that if he would take them into pay, they would easily place themselves amongst the rest, and yet  
keepe



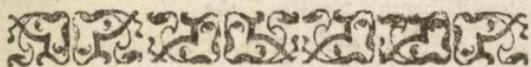
## PROBLEM. LXXIII.

How to make the string of a *Viole* sensibly shake, without any one touching it.

**T**His is a miracle in *musicke*, yet easie to be experimented; take a *Viole* or other *Instru-ment*, and choose two *strings*, so that there be one betweene them; make these two *strings* agree in one and the same *tune*: then move the *Viole bow* upon the greater *string*, and you shall see a wonder: for in the same time that that shakes which you play upon, the other will likewise sensibly shake without any one touching it; and it is more admirable that the *string* which is betweene them will not shake at all: and if you put the first *string* to another *tune* or note, and loosing the pin of the *string*, or stopping it with your *finger* in any fret, the other *string* will not shake: and the same will happen if you take two *Violes*, and strike upon a *string* of the one, the *string* of the other will sensibly shake.

Now it may be demanded how comes this shaking, is it in the occult sympathie, or is it in the *strings* being wound up to like notes or tunes, that so easily the other may receive the impression of the *aire*, which is agitated or moved by the shaking or the trembling of the other: and whence is it that the *Viole bow* moved upon the first *string*, doth instantly in the same time move the third *string* and not the second; if

if the cause be not either in the first or second:  
I leave to others to discant on.



## EXAMINATION.

**I**N this Examination we have something else  
to imagine, than the bare sympathie of the  
Cords one to another: for first there ought to be  
considered the different effect that it produceth  
by extension upon one and the same Cord in ca-  
pacitie: then what might be produced upon diffe-  
rent Cords of length and bignesse to make them  
accord in a unison or octavo, or some consort in-  
termediate: this being naturally examined, it  
will be facill to lay open a way to the knowledge  
of the true and immediate cause of this noble and  
admirable Phenomeny. Now this will sencibly  
appeare when the Cords are of equall length and  
greatnesse, and set to an unison; but when the  
Cords differ from their equalitie, it will be lesse  
sencible: hence in one and the same Instrument,  
Cords at a unison shall excite or shake more than  
that which is at an octavo, and more than those  
which are of an intermediate proportionall con-  
sort: as for the other consorts they are not ex-  
empted, though the effect be not so sencible, yet  
more in one than in another: and the experiment  
will seeme more admirable in taking two Lutes,  
Vioies &c. and in seting them to one tune:  
for then in touching the Cord of the one, it will  
give

give a sensible motion to the Cord of the other:  
and not onely so but also a harmony.

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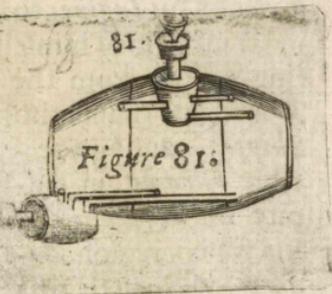
PROBLEM. LXXIII.

Of a vessell which contains three severall kinds  
of liquor, all put in at one bung-hole, and  
drawne out at one tappe severally  
without mixture.

**T**He vessell is thus made, it must be divided  
into three *sells* for to containe the three li-  
quors, which admit to be *Sacke*, *Clarret*, and  
*Whitewine*: Now in the *bung-hole* there is an  
*Engine* with three *pipes*, each extending to his  
proper *sell*, into which there is put a *broach* or  
*funnell* pierced in three places, in such sort that  
placing one of the *holes* right against the *pipe*  
which answereth unto him, the other two *pipes*  
are stopped; then when it is full, turne the *fun-  
nell*, and then the former hole will be stopped  
and another open, to cast in other wine with-  
out mixing it with the other.

Now to draw out also without mixture, at  
the bottome of the vessell there must be placed  
a *pipe* or *broach* which may have three *pipes*,  
and a *cocke* pierced with three holes so artificia-  
lly done, that turning the *cocke*, the hole which  
answereth to such of the *pipes* that is placed at  
the bottome, may issue forth such *wine* as be-  
longeth to that *pipe*, and turning the *Cocke* to  
another *pipe*, the former *hole* will be stopped:  
and

and so there will issue forth another kinde of wine without any mixtures; but the Cocke may bee so ordered that there may come out by it two wines together, or all three kinds at once: but it seemes best when that in one vessel and at one Cocke, a man may draw severall kinds of wine, and which he pleaseth to drinke.



PROBLEM. LXXV.

Of Burning-glasses.

IN this ensuing discourse I will shew the invention of *Prometheus* how to steale fire from *Heaven*, and bring it downe to the *Earth*; this is done by a little round *Glasse*, or made of *steele*, by which one may light a *Candle* and make it flame, kindle *Fire-brans* to make them burne, melt *Lead*, *Tinne*, *Gould*, and *Silver*, in a little time: with as great ease as though it had bene put into a *Cruzet* over a great fire.

Have you not read of *Archimedes* of *Syracuse*, who when he could not come to the Ships of *Marcellus*, which assieged that place, to binder and impeach their approach, hee flung huge

K

stones

stones by his *Inginer* to sinke them into the Sea and transformed himselfe into *Iupiter*; thundering downe from the highest *Towers* of the *Towne*, his thunderbolts of lightning into the *Shippes*, causing a terrible *burning*, in despite of *Neptune* and his watery region: *Zonaras* witnesseth that *Proclus* a brave *Mathematician*, burned in the same manner the *Shippes* of *Vitalian*, which was come to assaige *Constantinople*; and dayly experience

may let you see great effects of *burning*, for a *Bowle* of *Cryskill* polished, or a *Glasse* thicker in the middle than at the edges, will burne exceedingly; nay a bottle full of water exposed to the *Sunne* will burne when the *Sunne* shineth hot, and *children* use with a *Glasse* to burne *Flies* which are against the walles, and their fellows cloathes.

But this is nothing to the burning of those *Glasses* which are hollow, namely these which are of *steele* well polished, according to a *parabolicall* or *ovall* section: A *sphaerickall* *Glasse*, or that which is according to the segment of a *Sphere*, burnes very effectually about the fourth part of the *Diameter*; notwithstanding the *Parabolic* and *Eclipticke* sections have a great effect: by which *Glasses* there is also diverse figures



figures represented forth to the eye.

The cause of this burning is the uniting of the beames of the Sunne, which heates mightily in the point of *concourse* or *inflammation*, which is either by transmission or reflection: Now it is pleatant to behold when one breatheth in the point of *concourse*, or throweth small dust there, or sprinkles vapours of hot water in that place; by which the *pyramidall* point, or point of *inflammation* is knowne. Now some *Authors* promifeth to make *Glasses* which shall burne a great distance off, but yet not scene vulgarly produced, of which if they were made, the *Parabolic* makes the greatest effect, and is generally held to bee the invention of *Archimedes* or *Proclus*.

*Maginus* in the 5. Chap. of his Treatise of sphericall *Glasses*, shewes how one may serve himselfe with a *concave* *Glasse*, to light fire in the shaddow, or neare such a place where the Sunne shines not, which is by helpe of a flat *Glasse*, by which may be made a percussion of the beames of the Sunne into the *concave* *Glasse*, adding unto it that it serves to good use to put fire to a *Mine*, provided that the combustible matter bee well applyed before the *concave* *Glasse*; in which hee sayes true: but because all the effect of the practice depends upon the placing of the *Glasse* and the *Powder* which he speakes not of: I will deliver here a rule more generall.

How one may place a *Burning-glasse* with his combustible matter in such sort, that at a con-

venient houre of the day, the Sunne shining, it shall take fire and burne: Now it is certaine that the point of *inflammation* or *burning*, is changed as the Sunne changeth place, and no more nor lesse, then the shaddow turnes about the *stile* of a Dyall; therefore have regard to the Suns motion, and his height and place: a *Bowle* of *Crystall* in the same place that the toppe of the *stile* is, and the *Powder* or other combustible matter under the *meridian*, or houre of 12, 1, 2, 3, &c. or any other houre, and under the Sunnes arch for that day: now the Sunne comming to the houre of 12, to 1, 2, 3, &c. the Sunne casting his beames through the *Crystall Bowle*, will fire the *materiall* or combustible thing, which meets in the point of burning: the like may be observed of other *Burning-glasses*.



### EXAMINATION.

**I**T is certaine in the first part of this Probleme that Conicall concave and sphericall Glasses, of what matter soever, being placed to receive the beames of the Sunne will excite heate, and that heate is so much the greater, by how much it is neere the point of concurse or inflammation. But that Archimedes or Proclus did fire or burne Shippes with such Glasses, the ancient Histories are silent, yea themselves say nothing: besides the great difficultie that doth oppose it in

remotenesse, and the matter that the effect is to  
 worke upon: Now by a common Glasse wee fire  
 things neere at hand, from which it seemes very  
 facill to such which are lesse read, to doe it at a  
 farre greater distances, and so by relation some  
 deliver to the world by supposition that which  
 never was done in action: this we say the rather,  
 not to take away the most excellent and admir-  
 able effect which are in Burning-glasses, but to  
 shew the variety of antiquity, and truth of Histo-  
 ry; and as touching to burne at a great distance as  
 is said of some, it is absolutely impossible; and  
 that the Parabolicall and Ovall Glasses were of  
 Archimedes and Proclus invention, is much un-  
 certaine: for besides the construction of such  
 Glasses, they are more difficult than the obtuse  
 concave ones are, and further, they cast not a  
 great heate but neere at hand; for if it bee cast  
 farre off, the effect is little, and the heate weak-  
 or otherwise such Glasses must be greatly exten-  
 ded to contract many beames to amasse a suffi-  
 cient quantity of beames in Parabolicall and  
 Conicall Glasses, the point of inflammation ought  
 to concur in a point, which is very difficult to bee  
 done in a due proportion: Moreover if the place  
 be farre remote as is supposed before, such a Glasse  
 cannot be used but at a great inclination of the  
 Sunne, by which the effect of burning is dimini-  
 shed, by reason of the weakenesse of the Sunne-  
 beames.

And here may be noted in the last part of this  
 Probleme, that by reason of obstacles if one plain  
 Glasse be not sufficient; a second Glasse may bee

applied to help it: that so if by one simple reflexion it cannot be done, yet by a double reflexion the Sun-beames may be cast into the said Caverne or Mine; and though the reflected beames in this case be weake, yet upon a fit cumbustible matter it will not faile to doe the effect.

## PROBLEM. LXXVI.

Containing many pleasant Questions by way of Arithmeticke.

**I** Will not insert in this *Probleme* that which is drawne from the *Greeke Epigrams*, but proposing the *Question* immediatly will give the answer also, without staying to shew the manner how they are answered; in this I will not be tyed to the *Greeke termes*, which I account not proper to this place, neither to my purpose; let these reade that will *Diophanta Schubelius* upon *Euclide* and others, and they may be satisfied.

Of the *Asse* and the *Mule*.

**I**T happened that the *Mule* and the *Asse* upon a day making a voyage, each of them carryed a *Barrell* full of *wine*: now the lasie *Asse* felt her selfe over loaden, complained and bowed under her burthen; which the *Mule* seeing, said unto her being angry, (for it was in the time when beasts spake) thou great *Asse*, wherefore

com-

complainest thou? if I had but onely one measure of that which thou carriest, I should be laden twice as much as thou art, and if I should give a measure of my loading to thee, yet my burthen would be as much as thine.

Now how many *measures* did each of them carry? Answer, the *Mule* did carry 7 *measures*, and the *Asse* 5 *measures*: for if the *Mule* had one of the *measures* of the *Asses* loading, then the *Mule* would have 8 *measures*, which is double to 4: and giving one to the *Asse*, each of them would have equall burthens: to wit, 6 *measures* a peece.

*Of the number of Souldiers that fought before old Troy.*

**H**omer being asked by *Hesiodus* how many *Grecian* Souldiers came against *Troy*, who answered him thus; the *Grecians*, said *Homer*, made 7 *fires* or had 7 *Kitchins*, and before every *fire*, or in every *Kitchin* there was 50 *broaches* turning to rost a great quantitie of *flesh*, and each *broach* had meate enough to satisfie 900 men: now judge how many *men* there might be. Answer, 315000. that is, three hundred and fiftene thousand men, which is cleare by multiplying 7 by 50, and the product by 900 makes the said 315000.

Of the number of Crownes that  
two men had.

**I**ohn and Peter had certain number of crownes, Iohn said to Peter, if you give me 10 of your crownes, I shall have three times as much as you have: but Peter said to Iohn if you give me 10 of your crownes I shall have 5 times as much as you have: how much had each of them? Answer, Iohn had 15 crownes and 5 sevenths of a crowne, and Peter had 18 crownes, and 4 sevenths of a crowne. For if you adde 10 of Peters crownes to these of Iohns, then should Iohn have 25 crownes and 5 sevenths of a crowne, which is triple to that of Peters, viz. 8, and 4 sevenths: and Iohn giving 10 to Peter, Peter should have then 28 crownes, and 4 sevenths of a crowne, which is Quintupla, or 5 times as much as Iohn had left, viz. 5 crownes and 5 sevenths.

In like manner two Gamesters playing together, A. and B: after play A. said to B, give me 2 crownes of thy money, and I shall have twice as much as thou hast: and B. said to A. give me 2 crownes of thy money, and I shall have 4 times as much as thou hast: now how much had each? Answer, A. had 3 and 5 sevenths, and B. had 4 and 6 sevenths.

*About the houre of the day.*

Some one asked a *Mathematician* what a clocke it was, who answered that the rest of the day is foure thirds of that which is past: now judge what a clocke it is. Answer, if the day were according to the *Jewes* and ancient *Romans*, which made it alwayes to bee 12. houres, it was then the 5. houre, and one seventh of an houre, so there remained of the whole day  $6\frac{6}{7}$  that is, 6 houres, and 6 seventhes of an houre. Now if you take the  $\frac{1}{3}$  of  $5\frac{1}{7}$  it is  $\frac{13}{7}$  or 1 and  $\frac{6}{7}$  which multiplied by 4 makes 6 and  $\frac{6}{7}$  which is the remainder of the day as before: but if the day had beene 24 houres, then the houre had beene 10 of the clocke, and two seventhes of an houre, which is found out by dividing 12, or 24 by  $\frac{7}{3}$ .

There might have beene added many curious propositions in this kinde, but they would bee too difficult for the most part of people: therefore I have omitted them.

*Of Pythagoras Schollers.*

*Pythagoras* being asked what number of *Schollers* hee had, answered, that halfe of them studied *Mathematickes*, the fourth part *Physicke*, the seventh part *Rethoricke*, and besides he had 3 *women*: now judge you saith he, how many *Schollers* I have. Answer, he had in all 28; the halfe of which is 14, the quarter of

of which is 7, and the seventh part of which is 4: which 14, 7, and 4, makes 25, and the other 3 to make up the 28, were the 3 women.

*Of the number of Apples given amongst the Graces and the Muses.*

THE three Graces carrying Apples upon a day, the one as many as the other, meet with the 9 Muses, who asked of them some of their apples; so each of the Graces gave to each of the Muses alike, and the distribution being made, they found that the Graces and the Muses had one as many as the other: The question is how many apples each Grace had, and how many they gave to each Muse. To answer the question, joyne the number of Graces and Muses together which makes 12, and so many apples had each Grace: Now may you take the double, triple, &c. of 12. that is 24, 36, &c. conditionally, that if each Grace had but 12, then may there be allotted to each Muse but one onely; if 24, then to each 2 apples; if 36, then to each Muse 3 apples; and so the distribution being made, they have a like number, that is, one as many as the other.

*Of the Testament or last Will of a dying Father.*

A Dying Father left a thousand crownes amongst his two children; the one being legitimate, and the other a Bastard, conditionally

nally that the fifth part which his legitimate *Sonne* should have, should exceed by 10, the fourth part of that which the *Bastard* should have: what was each ones part? Answer, the legitimate *Sonne* had 577 *crownes*, and  $\frac{7}{5}$  and the *Bastard* 422 *crownes* and  $\frac{2}{5}$ : now the fifth part of 577 and 7 ninches is 115, and  $\frac{5}{5}$  and the fourth part of 422 and  $\frac{2}{5}$  is 105 and  $\frac{5}{5}$  which is lesse then 115  $\frac{5}{5}$  by 10, according to the Will of the *Testator*.

*Of the Cuppes of Crasus.*

*Crasus* gave to the *Temple* of the *Gods* sixe *Cups* of *Gould*, which weighed together 600 *Drammes*, but each *Cup* was heavier one than another by one *Dramme*: how much did each of them therefore weigh? Answer, the first weighed 102 *Drammes* and a halfe; the second 101 *Drammes* and a halfe; the third 100 *Drammes* and  $\frac{1}{2}$ ; the fourth 99 and a halfe; the fifth 98 and a halfe; and the sixth *Cup* weighed 79 *Drammes* and a halfe: which together makes 600 *Drammes* as before.

*Of Cupids Apples.*

*Cupid* complained to his mother that the *Muses* had taken away his apples, *Clio*, said he, tooke from me the fifth part, *Euterpe* the twelfth part, *Thalia* the eighth part, *Melpomene* the twentieth part, *Erates* the seventh part, *Terpomene* the fourth part: *Polyhymnia* tooke away 30, *Vrania* 120, and *Calliope* 300: so there

there were left me but 5. Apples; how many had he in all at the first, I answer 3360.

There are an infinite of such like questions amongst the Greeke Epigrammes: but it would be unpleasant to expresse them all: I will onely adde one more, and shew a generall rule for all the rest.

Of a Mans Age.

A Man was said to passe the halfe part of his life in *childhood*, the fourth part in his *youth*, the third part in *Manhood*, and 18. yeares besides in olde age: what might his Age be? the answer is, 72. yeares: which and all others is thus resolved: multiplie  $\frac{1}{2}$ .  $\frac{3}{4}$ . and  $\frac{2}{3}$ . together, that is, 6. by 4. makes 24. and that againe by 3. makes 72. then take the third part of 72. which is 24. the fourth part of it, which is 18. and the sixth part of it which is 12. these added together make 54. which taken from 72. rests 18. this divided by 18. (spoken in the *Question*) gives 1, which multiplied by the summe of the parts, viz. 72. makes 72. the *Answer* as before.

Of the Lion of Bronze placed upon a Fountaine with his Epigramme.

Of my right eye if I let water passe, I can fill the *Cisterne* in 2. dayes: if I let it passe out of the left eye, it wil be filled in 3. dayes, if it passe out of my feete the *Cisterne* will bee 4. dayes a filling; but if I let the water passe out of my mouth, I can fill the *Cisterne* then in 6. houres:

*houres*: in what time should I fill it, if I powre forth the water at all the passages at once.

The *Greekes* (the greatest talkers in the world) variously applie this *question* to divers *statues*, and pipes of *Fountaines*: and the solution is by the Rule of 3, by a generall Rule, or by *Algeber*.

They have also in their *Anthologic* many other *questions*, but because they are more proper to exercise, than to recreate the *spirit*, I passe them over as before with silence.

PROBLEM. LXXVII.

*Divers excellent and admirable experiments upon Glasses.*

There is nothing in the world so beautifull as *light*: and nothing more recreative to the *sight*, than *Glasses* which reflect: therefore I will now produce some experiments upon them, not that I will dive into their depth (that were to lay open a misterious thing) but that which may delight and recreate the spirits: Let us suppose therefore these principles, upon which is built the demonstration of the apparances which is made in all sort of *Glasses*.

*First*, that the rayes or beames, which reflecteth upon a *Glasse*, maketh the Angle of *Incident* equall to the Angle of *Reflection*, by the first Theo. of the *Caroptick*, of *Enc*.

*Secondly*, that in all plaine *Glasses*, the *Images* are scene in the perpendicular line to the *Glasse*  
as

as farre within the *Glasse* as it is without it.

*Thirdly*, in Concave, or Convex *Glasses*, the *Images* are seene in the right line which passeth from the object and through the Center in the *Glasse*. Theo. 17. and 18.

And here you are to understand that there is not meant onely these which are simple *Glasses* or *Glasses* of steele, but all other bodies, which may represent the visible *Image* of things by reason of their reflection, as *water*, *marble*, *mettle*, or such like. Now take a *Glasse* in your hand and make experiment upon that which followeth.

*Experiment upon flat and plaine Glasses.*

**F***irst*, a man cannot see any thing in these *Glasses*, if he be not directly and in a perpendicular line before it, neither can hee see an object in these *Glasses*, if it be not in such a place, that makes the Angle of *incidence* equall to the Angle of *reflexion*: therefore when a *Glasse* stands upright, that is, perpendicular to the *Horizon*, you cannot see that which is above, except the *Glasse* be placed downe flat: and to see that on the right hand, you must bee on the left hand, &c.

*Secondly*, an *Image* cannot bee seene in a *Glasse*, if it be not raised above the surface of it; or place a *Glasse* upon a wall, you shall see nothing which is upon the plaine of the wall; and place it upon a *Table* or *Horizontall Plaine*, you shall see nothing of that which is upon the *Table*.

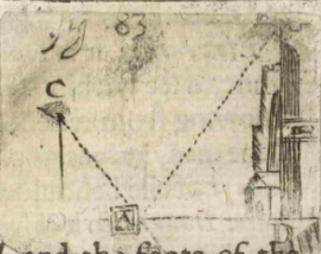
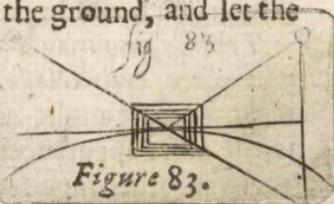
*Thirdly*,

Thirdly, in a plaine *Glasse* all that is seene appears or seemes to sinke behinde the *Glasse*, as much as the *Image* is before the *Glasse*: as before is said.

Fourthly, as in *water* a *Glasse* lying downe flat, or *Horizontall*, *Towers*, *Trees*, *Men*, or any height doth appeare, inversed or upside downe; and a *Glasse* placed upright, the right hand of the *Image* seemes to bee the left, and the left seemes to be the right.

Fifthly, will you see in a *Chamber* that which is done in the street, without being seene: then a *Glasse* must bee disposed, that the line upon which the *Images* come on the *Glasse*, make the Angle of *incidence* equall to that Angle of *reflexion*.

Sixthly, an height (as suppose *DE*.) may be measured by a plaine *Glasse*; as let the *Glasse* be *G*. placed downe upon the ground, and let the eye bee at *C*. so farre removed from the *Glasse*, that the eye at *C*. may see the toppe of the *Tree E*: in the Angle or edge of the *Glasse* at *A*; but in the line of *reflexion CA*; then measure the distance betweene your foote *B*, and the point *A*: and also the distance betweene the *Glasse A*, and the foote of the *Tree D*, viz. *AD*. Now as often as *AB*. is found



found in  $AD$ , so often doth the height of the Tree  $ED$ . containe the distance from your eye to the foote, *viz.*  $CB$ : for the *Triangles*  $A, B, C$ , and  $A, D, E$ , are like *Triangles*: therefore as  $BA$ . to  $AD$ , so  $CB$ , to  $ED$ , or alternately as  $BA$ . to  $BC$ , so  $AD$ . to  $DE$ .

*Seventhly*, present a *Candle* upon a plaine *Glasse*, and looke stauntingly upon it, so that the *Candle* and the *Glasse* bee neere in a right line, you shall see 3. 4. 5. &c *Images*; from one and the same *Candle*.

*Eighthly*, take two plaine *Glasses*, and hold them one against the other, you shall alternately see them often times one within the other, yea within themselves, againe and againe.

*Ninthly*, if you hold a plaine *Glasse* behind your *head*, & another before your *face*, you may see the hinder part of your *head*, in that *Glasse* which you hold before your *face*.

*Tenthly*, you may have a fine experiment if you place two *Glasses* together, that they make an acute angle, and so the lesser the angle is, the more apparances you shall see, the one direct, the other inverfed, the one approaching, and the other retyring.

*Elevently*, it is wonder and astonishment to some, to see within a *Glasse* an *Image* without knowing from whence it came, and it may be done many wayes: as place a *Glasse* higher than the *eye* of the behoulder, and right against it is some *Image*; so it resteth not upon the behoulder, but doth cast the *Image* upwards. Then place another object, so that it reflect, or cast the

the *Image* downward to the *eye* of the *spectator*, without perceiving it being hid behind something, for then the *Glasse* will represent a quite contrary thing, either than that which is before the *Glasse*, or that which is about it.

*Twelfthly*, if there bee ingraved behind the backside of a *Glasse*, or drawne any *Image* upon it, it will appear before as an *Image*, without any appearance : or portrature to be perceived.



## EXAMINATION.

**T**His 12. Article of ingraving an *Image* behind the *Glasse*, will be of no great consequence, because the linaments will seeme so obscure, but if there were painted some *Image*, and then that covered according to the usuall covering of *Glasses* behind, and so made up like an ordinary looking *Glasse* having an *Image* in the middle, in this respect it would be sufficient pleasure: and that which would admire the *Ignorant*, and able to exercise the most subtillest, and that principally if the *Glasse* bee in an obscure place, and the light which is given to it be somewhat farre off.

**P**Lace a *Glasse* neare the floare of a *Chamber*, and make a hole through the place under the *Glasse*, so that these which are below may not perceive it, and dispose a bright *Image* under

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the hole so that it may cast his species upon the *Glasse*, and it will cause admiration to those which are below that know not the cause; The same may be done by placing the *Image* in a *Chamber* adjoining, and so make it to be seene upon the side of the wall.

14 In these *Chanell Images* which shew one side a *deaths head*, and another side a *faire face*: and right before some other thing: it is a thing evident, that setting a plaine *Glasse* sidewise to this *Image* you shall see in it a contrary thing, then that which was presented before sidewise.

15 *Lastly*, it is a fine secret to present unto a plaine *Glasse* writing with such industry, that one may reade it in the *Glasse*, & yet out of the *Glasse* there is nothing to be knowne, which will thus happen, if the writing be writ backward: But that which is more strange, to shew a kind of *writing* to a plaine *Glasse*, it shall appeare another kind of writing both against sence and forme, as if there were presented to the *Glasse* WEL, it would shew it MER if it were written thus MIV, and presented to the *Glasse*, it would appeare thus VIM; for in the first, if the *Glasse* ly flat then the things are inverfed that are perpendicular to the *Glasse*, if the *Glasse* and the object be upright, then that on the right hand, is turned to the left, at in the latter.

And here I cease to speake further of these plaine *Glasses*, eyther of the Admirable *multiplications*, or appearances, which is made in a great number of them; for to content the sight

in this particular, one must have recourse to the Cabinets of great Personages who enrich themselves with most beautiful ones.

*Experiments upon Gibbous, or convex Sphericall Glasses.*

If they be in the forme of a *Bowle*, or part of a great *Globe of Glasse*, there is singular contentment to contemplate on them.

First, because they present the objects lesse and more gracious, and by how more the *Images* are separated from the *Glasse*, by so much the more they deminish in *Magnitude*.

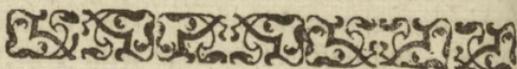
Secondly, they that shew the *Images* playting, or foulding, which is very pleasant, especially when the *Glasse* is placed downe, and behold in it some *Blanching, seeling, &c.* The upper part of a *Gallerie*, the porch of a *Hall, &c.* for they will be represented as a great vessel having more belly in the middle then at the two ends, and *Posts*, and *Joists* of *Timber* will seeme as *Circles*.

Thirdly, that which ravisherh the spirits, by the eye, and which shames the best perspective *Painting* that a *Painter* can make, is the beautifull contraction of the *Images*, that appeare within the sphericitie of these small *Glasses*, for present the *Glasse* to the lower end of a *Gallerie*, or at the Corner of a great *Court* full of *People*; or towards a great *street, Church, fortification, an Army of men, to a whole Cittie*; all the faire *Architecture*, and apparances will

be seene contracted within the circuit of the *Glasse* with such varietie of *Colours*, and distinctions in the lesser parts, that I know not in the world what is more agreeable to the sight and pleasant to behold, in which you will not have an exact proportion but it will be variable according to the distance of the Object from the *Glasse*.

*Experimentss upon hollow, or Concave  
Sphericall Glasses.*

I Have heretofore spoken how they may burne, being made of *Glasse*, or *Mettle*, it remains now that I deliver some pleasant uses of them, which they represent unto our sight, and so much the more notable it will be, by how much the greater the *Glasse* is, and the *Globe* from whence it is extracted.

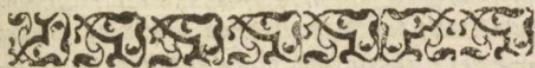


EXAMINATION.

I *N* this we may observe that a section of 2, 3, or 4. Inches in diamiter, may be segments of *sphcares* of 2. 3. or 4. foote, nay of so many fadome. for it is certaine that amongst these which comprehend a great portion of a lesser *sphcaere*, and these which comprehend a little segment of a great *sphcaere* whether they be equall or not in section, there will happen an evident difference

in one and the same experiment, in the number, situation, quantitie, and figure of the Images of one or many different objects.

**M**Aginus, in a little Tractat that he had upon these Glasses, witnesseth of himselfe that he hath caused many to bee polished for sundry great Lords of Italy, and Germanie, which were segments of Globes of 2. 3. and 4. foot diamiter; and I wish you had some such like to see the experiments of that which followeth; it is not difficult to have such made, or bought here in Towne, the contentment herein, would beare with the cost.

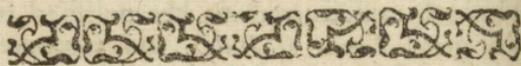


## EXAMINATION.

**T**ouching Maginus hee hath nothing ayded us to the knowledge of the truth by his extractout of Vitelius, but left it: expecting it from others, rather than to be plunged in the search of it himselfe, affecting rather the forging of the matter, and composition of the Glasses, than Geometrically to establish their effects.

**F**irst therefore in Concave Glasses, the Images are seene sometimes upon the surface of the Glasses, sometimes as though they were within it and behind it, deeply sunke into it, sometimes they are seene before, and without the Glasse, sometimes betweene the object and the

Glasse; sometimes in the place of the eye, sometimes farther from the *Glasse* then the object is; which comes to passe by reason of the divers concurrence of the beames, and change of the place of the *Images* in the line of flexion.



### EXAMINATION.

**T**He relation of these apparances passe curram amongst most men, but because the curious may not receive prejudice in their experiments, some thing ought to bee said thereof to give it a more lively touch, in the true causes of these apparances; in the first place it is impossible that the *Image* can be upon the surface of the *Glasse*, and it is a principall point to declare truly in which place the *Image* is seene in the *Glasse*: these that are more learned in *Opicall* knowledge asse firme the contrary, and nature it selfe gives it a certaine place according to its position; being alwayes seene in the line of reflection, which *Alhazen*, *Vicellious*, and others full of great knowledge, have confirmed by their writings: but in their particular they were too much occupied by the authority of the *Ancients*, who were not sufficiently circumspect in experience, upon which the principles of this subject ought to be built, and searched not fully, into the true cause of these apparances, seeing they leave unto posterities many falcities in their writings, and these that fol-

lowed

lowed them for the most part fell into the like errors.

As for the Images to bide in the eye, it cannot be but is impertinent and absurd; but it followeth that, by how much neerer the object approacheth to the Glasse, by so much the more the appearances seemes to come to the eye: and if the eye be without the point of concurrence, and the object also; as long as the object approacheth thereto, the representation of the Image cometh neere the eye, but passing the point of concurrence it goes backe agains: these appearances thus approaching doth not a little astonish those which are ignorant of the cause: they are inversed, if the eye be without the point of concurrence untill the object bee within, but contrarily if the eye be betweene the point of concurrence and the Glasse, then the Images are direct: and if the eye or the object be in the point of concurrence, the Glasse will be enlightened, and the Images confused; and if there were but a sparke of fire in the said point of concurrence, all the Glasse would seeme a burning fire-brand, and we dare say it would occurre without chance, and in the night be the most certaine and subtilest light that can be, if a Candle were placed there. And whosoever shall enter into the serch of the truth of new experiments in this subject, without doubt hee will confirme what wee here speake of: and will finde new lights with a convenient position to the Glasse, he will have reflexion of quantities, of truth, and fine secrets in nature, yet not knowne, which he may easily comprehend if he have but an indifferent sight, and may assure

himselfe that the Images cannot exceed the sight, nor trouble it; a thing too much absurd to nature.

And it is an absolute verity in this science, that the eye being once placed in the line of reflexion of any object, and moved in the same line, the object is seene in one and the same place immutable; or if the Image and the eye move in their owne lines, the representation in the Glasse seemes to invest it selfe continually with a different figure.

Now the Image comming thus to the eye, these which know not the secret drawe their sword when he sees an Image thus to issue out of the Glasse, or a Pistoll which some one holds behinde: and some Glasses will shew a sword wholly drawne out, separated from the Glasse, as though it were in the aire: and it is daily exercised, that a man may touch the Image of his hand or his face out of the Glasse, which comes out the farther, by how much the Glasse is great and the Center remote.



### EXAMINATION.

Now that a Pistolle being presented to a Glasse behinde a man, and should come out of the Glasse and make him afraid, that stands before seeming to shoote at him: this cannot bee,  
for

for no object whatsoever presented to a concave Glasse, if it be not neerer to the Glasse then the eye is, it comes not out to the sight of the party; therefore he needes not feare that which is said to be behinde his backe, and comes out of the Glasse, for if it doth come out, it must then necessarily be before his face: so in a concave Glasse, whose Center is farre remote; if a sword, sticke, or such like be presented to the Glasse, it shall totally be seene to come forth of the Glasse, and all the hand that holds it. And here generally note, that if an Image bee seene to issue out of the Glasse to come towards the face of any one that stands by, the object shall be likewise seene to thrust towards that face in the Glasse, and may easily be knowne to all the standers by: so many persons standing before a Glasse, if one of the company take a sword and would make it issue forth towards any other that stands there: let him chuse his image in the glasse, and carry the sword right towards it, and the effect will follow. In like manner ones hand being presented to the Glasse, as it is thrust towards the Center, so the representation of it comes towards it: and so the hands will seeme to be united, or to touch one another.

**F**ROM which may bee concluded, if such a Glasse be placed at the ceiling or planching of a Hall, so that the face bee *Horizontall* and looke downward; one may see under it as it were a man hanging by the feete, and if there were many placed so, one could not enter into that place without great feare or scaring: for

one should see many men in the aire as if they were hanging by the feete.



### EXAMINATION.

**T**ouching a Glasse tyed at a feeling or planching, that one may see a man hang by the feete in the aire, and so many Glasses, many men may be seene: without caution this is very absurd, for if the Glasse or Glasses bee not so great that the Center of the sphaere upon which it was made, extend not neere to the head of him that is under it, it will not pleasantly appeare; and though the Glasse should be of that capacitie that the Center did extend so farre, yet will not the Images bee seene to them which are from the Glasse, but onely to these which are under it, or neere unto it: and to them it will notably appeare, and it would be most admirable to have a Gallerie vated over with such Glasses, which would wonderfully astonish any one that enters into it: for all the things in the Gallery would be seene to hang in the aire, and you could not walke without incountring ayrie apparitions.

**S**econdly, in flat or plaine Glasses the Image is seene equall to his object, and to represent a whole man, there ought to be a Glasse as great as the Image is: In convex Glasses the Images are seene alwaies lesse, in concave Glasses they

they may be seene greater or lesser, but not truly proportionable, by reason the diverse reflexions which contracts or enlargeth the Species: when the eye is betweene the Center and the surface of the *Glasse*, the *Image* appeares sometimes very great and deformed, and those which have but the appearance of the beginning of a *beard* on their *chinne*, may cheare up themselves to see they have a great *beard*; these that seeme to be faire will thrust away the *Glasse* with despiight, because it will transforme their beautie: these that put their hand to the *Glasse* will seeme to have the hand of a *Gyant*, and if one puts his finger to the *Glasse* it will be seene as a great *Pyramide* of flesh, inverfed against his finger.

*Thirdly*, it is a thing admirable that the eye being approached to the point of concurrence of the *Glasse*, there will bee seene nothing but an intermixture or confusion: but retyring backe a little from that point, (because the rayes doth there meete,) he shall see his *Image* inverted, having his head below and his feet above.

*Fourthly*, the diverse appearances caused by the motion of objects, either retiring or approaching: whether they turne to the *right hand* or to the *left hand*, whether the *Glasse* be hung against a *wall*, or whether it bee placed upon a *Pavement*, as also what may be represented by the mutuall aspect of concave *Glasses*, with plaine and convex *Glasses*: but I will with silence passe them over, onely say some thing of two rare experiments more as followeth.

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The first is to represent by helpe of the *Sun*, such letters as one would upon the front of a *house*: so that one may reade them; *Maginus* do. h deliver the way thus. Write the *letters* saith he sufficiently bigge, but inverted upon the surface of the *Glasse* with some kinde of *colour*, or these letters may bee written with *wax*; (the easier to bee taken out againe:) for then placing the *Glasse* to the *Sunne*, the letters which are written there will bee reverberated, or reflected upon the *wall*: hence it was perhaps that *Pythagoras* did promise with this invention to write upon the *Moone*.

In the second place, how a man may sundry wayes helpe himselfe with such a *Glasse*, with a lighted *Torch* or *Candle*, placed in the point of *concourse* or *inflammation*, which is neare the fourth part of the *Diamiter*: for by this meanes the light of the *Candle* will be reverberated into the *Glasse*, and will be cast backe againe very farre by parrallell lines, making so great a light that one may cleerely see that which is done farre off, yea in the campe of an *Enemie*: and those which shall see the *Glasse* a farre off, will thinke they see a *Silver Basin* inlightened, or a fire more resplendent then the *Torch*. It is this way that there are made certaine *Lanthornes* which dazell the eyes of those which comes against them; yet it serves singular well to enlighten those which carry them, accomodating a *Candle* with a little hollow *Glasse*, so that it may successively bee applied to the point of *inflammation*.

In like manner by this reflected light, one may reade farre off, provided that the letters be indifferent great, as an *Epitaph* placed high, or in a place obscure; or the letter of a friend which dares not approach without perill or suspension.



## EXAMINATION.

**T**His will not bee scarce senceible upon a wall remote from the Glasse, and but indifferently scene upon a wall which is neare the Glasse, and withall it must be in obscuritie or shadowed: or else it will not be seen. To cast light in the night to a place remote, with a Candle placed in the point of concurrence or inflammation, is one of the most notablest properties which can be shewne in a concave Glasse: for if in the point of inflammation of a parabolicall section, a Candle bee placed, the light will bee reflected by parallell lines, as a columnne or Cylinder; but in the sphericall section it is defective in part, the beames being not united in one point, but somewhat scattering: notwithstanding it casteth a very great beautifull light.

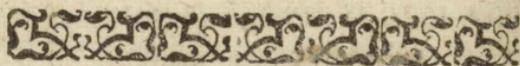
**L**Astly, these which feare to hurt their sight by the approach of *Lampes* or *Candles*, may by this artifice place at some corner of a Chamber, a *Lampe* with a hollow *Glasse* behinde it,

it, which will commodiously reflect the light upon a *Table*, or to a place assigned: so that the *Glasse* bee somewhat raised to make the light to streeke upon the *Table* with sharpe Angles, as the *Sunne* doth when it is but a little elevated above the *Horizon*: for this light shall exceed the light of many *Candles* placed in the *Roome*, and bee more pleasant to the sight of him that useth it.

*Of other Glasses of pleasure.*

**F**irst, the *Columnary* and *Pyramidall Glasses* that are contained under right lines, doth represent the *Images* as plaine *Glasses* doe; and if they bee bowing, then they represent the *Image*, as the concave and convex *Glasses* doe.

Secondly, those *Glasses* which are plaine, but have ascents of Angles in the middle, will shew one to have foure *eyes*, two *mouthes*, two *noses*, &c.



EXAMINATION.

**T**hese experiments will be found different according to the diverse meeting of the *Glasses*, which commonly are made scuing wise at the end, by which there will be two diverse superficies in the *Glasse*, making the exterior Angle somewhat raised, at the interior onely one superficies, which

which may bee covered according to ordinary Glasses to cause a reflexion, and so it will be but one Glasse, which by refraction according to the different thicknesse of the Glasse, and different Angles of the sening forme, doe differently present the Images to the eye, as foure eyes, two mouthes, two noses; sometimes three eyes, one mouth, and one nose, the one large and the other long, sometimes two eyes onely: with the mouth and the nose deformed, which the Glasse (impenetrable) will not shew. And if there be an interior solid Angle, according to the difference of it, (as if it be more sharpe) there will be represented two distinct double Images, that is, two entire visages, and as the Angle is open, by so much the more the double Images will reunite and enter one within another, which will present sometimes a whole visage extended at large, to have foure eyes, two noses, and two mouthes; and by moving the Glasse the Angle will vanish, and so the two superficies will be turned into one, and the duplicite of Images will also vanish and appeare but one onely: and this is easily experimented with two little Glasses of steell, or such like so united, that they make diverse Angles and inclinations.

**T**Hirdly, there are Glasses which make men seeme pale, red, and coloured in diverse manners, which is caused by the dye of the Glasse, or the diverse refraction of the Species: and these which are made of Silver, Latine, Steele, &c. doth give the Images a diverse colour also.

In

In which one may see that the appearances by some are made *faire, younger* or *older* than they are; and contrarily others will make them *foule* and *deformed*: and give them a contrary *visage*: for if a *Glasse* bee cut as it may be, or if many peeces of *Glasse* bee placed together to make a convenient reflexion: there might be made of a *Mole* (as it were) a *mountaine*, of one *Haire* a *Tree*, a *Fly* to be as an *Elephant*: but I should be too long if I should say all that which might be said upon the property of *Glasses*. I will therefore conclude this discourse of the properties of these *Glasses* with these fourre recreative *Problemes* following.

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PROBLEM: LXXVIII.

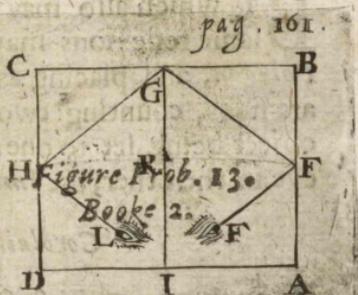
1. *How to shew to one that is suspicious, what is done in another Chamber or Roome: notwithstanding the interposition of the wall.*

**F**OR the performance of this, there must be placed three *Glasses* in the two *Chambers*, of which one of them shall bee tyed to the planching or feeling, that it may be common to communicate the *Species* to each *Glasse* by reflexion, there being left some hole at the top of the *wall* against the *Glasse* to this end: the two other *Glasses* must be placed against the two *walls* at right *Angles*, as the figure here sheweth at *B.* and *C.*

Then

Then the sight at *E*. by the line of incidence *FE*, shall fall upon the *Glasse* *BA*, and reflect upon the superficies of the *Glasse* *BC*, in the point *G*; so that if the eye be at *G*, it should see *E*, and *E*. would reflect upon the third *Glasse* in the point *H*, and the eye that is at *L*, will see the *Image* that is at *E*. in the point of the *Catheri*:

which *Image* shall come to the eye of the suspicious, viz. at *L*. by helpe of the third *Glasse*, upon which is made the second reflexion, and so brings unto the eye the object, though a wall be betweene it.



Corolaire. 1.

BY this invention of reflexions the assi-  
gents of a *Towne* may be seene upon the  
*Rampart*: notwithstanding the *Parapet*; which  
the assiaged may doe by placing a *Glasse* in the  
hollow of the *Ditch*, and placing another  
upon the toppe of the wall, so that the line of  
incidence comming to the bottome of the  
*Ditch*, make an Angle equal to the Angle of re-  
flexion, then by this scituation and reflexion,  
the *Image* of the assiement will bee seene to  
him that is upon the *Rampart*.

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## Corolaire. 2.

**B**Y which also may bee inferred, that the same reflexions may bee seene in a *Regular Polygon*, and placing as many *Glasses* as there are sides, counting two for one; for then the object being set to one of the *Glasses*, and the eye in the other, the *Image* will be seene easily.

## Corolaire. 3.

**F**Arther, notwithstanding the interposition of many *Walls, Chambers, or Cabinets*, one may see that which passeth through the most remotest of them, by placing of many *Glasses* as there are openings in the *walls*, making them to receive the incident *Angles* equall: that is, placing them in such sort by some *Geometrical* assistant, that the incident points may meet in the middle of the *Glasses*: but here all the defect will be, that the *Images* passing by so many reflexions, will be very weake and scarce observable.

## PROBLEM. LXXIX.

How with a *Musket* to strike a marke, not looking towards it, as exact as one aymed at it.

**A**S let the eye be at *O*, and the marke *C*; place a plaine *Glasse* perpendicular as *AB*: so the marke *C* shall bee seene in *Casseri C A*,

viz. in  $D$ , and the line of reflexion is  $D$ : now let the *Musket*  $FE$ , upon a rest, bee moved to and fro untill it be seene in the line  $OD$ , which admit to be  $HG$ : so giving fire to the *Musket*, it shall undoubtedly strike the marke.



Corolaires.

From which may be gathered, that one may exactly shoote out of a *Musket* to a place which is not seene, being hindered by some obstacle, or other interposition.

As let the eye be at  $M$ , the marke  $C$ , and the wall which keeps it from being seene, admit to be  $QR$ : then set up a plaine *Glasse* as  $AB$ , and let the *Musket* be  $GH$ , placed upon his rest  $PO$ . Now because the marke  $C$  is seene at  $D$ , move the *Musket* to and fro untill it doth agree with the line of reflexion  $MB$ ,



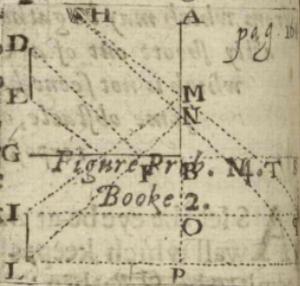
which

which suppose at  $LI$ , so shall it be truly placed, and giving fire to the *Musket*, it shall not faile to strike the said marke at  $C$ .

PROBLEM. LXXX.

*How to make an Image to be seene hanging in the aire, having his head downward.*

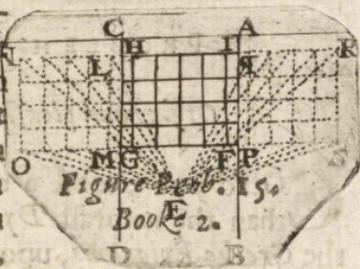
TAKE two *Glasses*, and place them at right Angles one unto the other, as admit  $AB$ , and  $CB$ , of which admit  $CB$  *Horizontal*, & let the eye be at  $H$ , & the object or image to be  $D$   $E$ ; so  $D$  will be reflected at  $F$ , so to  $N$ , so  $D$  to  $H$ ,  $E$ : then at  $G$ , so to  $M$  and then to  $H$ ; and by a double reflexion  $ED$  will seeme in  $QR$ , the highest point  $D$  in  $R$ , and the point  $E$  in  $Q$  inverted as was said, taking  $D$  for the head, and  $E$  for the feete; so it will be a man inverted, which will seeme to be flying in the aire: if the *Image* had wings unto it, and had secretly some motion: and if the *Glasse* were bigge enough to receive many reflexions, it would deceive the sight the more by admiring the changing of colours that would be seene by that motion.



PROBLEM. LXXXI.

How to make a company of representative Soldiers seeme to be a Regiment, or how few in number may bee multiplied to seeme to be many in number.

TO make the experiment upon men, there must be prepared two great Glasses; but instead of it we will suppose two lesser, as *G H*. and *F I*. one placed right against another perpendicular to the Horizon, upon a plain levell Table: between which Glasses let there bee ranged in Battalion-wise upon the same Table an number of small men, according to the square *G, H, I, F*, or in any other forme or posture: then may you evidently see how the said battle will bee multiplied and seeme farre bigger in the appearance than it is in effect.



Corolaire.

BY this invention you may make a little Cabinet of foure foote long, and two foote large, (more or lesse) which being filled with

M 3

Rockes

Rokes or such like things, or there being put into it *Silver, Gould*, stones of luster, *lemels, &c.* and the walls of the said *Cabinet* being all covered or hung with plaine *Glasse*; these visibles will appeare manifoldly increased, by reason of the multiplicite of *reflexions*, and at the opening of the said *Cabinet*, having see something which might hide them from being seene, those that looke into it will be astonished to see so few in number which before seemed to be so many.

## PROBLEM. LXXXII.

*Of fine and pleasant Dyalls:*

COULD you choose a more ridiculous one than the naturall *Dyall* written amongst the *Greeke Epigrams*, upon which some found *Poet* made verses; shewing that a man carryeth about him alwaies a *Dyall* in his face by means of the *nose* and *teeth*: and is not this a jolly *Dyall*, for he neede not but open the *mouth*, the lines shall bee all the *teeth*, and the *nose* shall serve for the *stile*.

*Of a Dyall of hearbes.*

CAN you have a finer thing in a *Garden*, or in the middle of a *Compartement*, than to see the *lines* and the number of *houres* represented with little bushie *hearbes*, as of *Hysse* or

or such which is proper to be cut in the borders; and at the top of the *stile* to have a *fanne* to shew which way the *winde* bloweth: this is very pleasant and usefull.

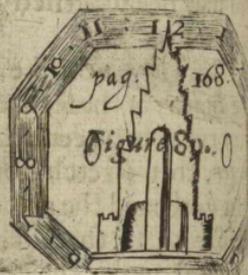
*Of the Dyall upon the fingers and the hand.*

IS it not a commoditie very agreeable, when one is in the *field* or in some *village* without any other *Dyall*, to see onely by the *hand* what of the *clocke* it is, which gives it very neare; and may bee practised by the *left hand* in this manner.

Take a *straw* or like thing of the length of the *Index*, or the second *finger*, hold this *straw* very right betweene the *thumbe* and the *right finger*, then stretch forth the *hand* and turne your *backe* and the *palme* of your *hand* towards the *Sunne*; so that the *shaddow* of the *muscle* which is under the *thumbe* touch the line of *life*, which is betweene the middle of the two other great lines, which is scene in the *palme* of the *hand*; this done, the end of the *shaddow* will shew what of the *clocke* it is: for at the end of the *great finger* it is 7 in the *morning* or 5 in the *evening*; at the end of the *Ring finger* it is 8 in the *morning*, or 4 in the *evening*; at the end of the *little finger* or first *joynt*, it is 9 in the *morning*, or 3 in the *afternoone*; 10 and 2 at the second *joynt*, 11 and 1 at the third *joynt*, and *midday* in the line following, which comes from the end of the *Index*.

Of a Dyall which was about an Obeliske at Rome.

**VV**As not this a pretty fetch upon a pavement, to choose an Obeliske for a Dyall, having 106 foote in height, without removing the Basis of it? *Plinie* assures us in his 26 booke and 8 Chap. that the *Emperour Augustus* having accommodated in the field of *Mars* an Obeliske of this height, he made about it a pavement, and by the industry of *Manilius* the *Mathematician*, there was enchaiced markes of Copper upon the Pavement, and placed also an apple of *Gould* upon the toppe of the said Obeliske, to know the houre and the course of the *Sunne*, with the increase and decrease of dayes by the same shadow: and in the same manner doe some by the shadow of their head or other stile, make the like experiments in *Astronomie*.



Of Dyalls with Glasses.

**P***Tolonie* writes, as *Cardannus* reports, that long agoe there were Glasses which served for Dyalls, and presented the face of the beholder

houlder as many times as the *houre* ought to be, twice if it were 2 of the *clocke*; 9 if it were 9, &c. But this was thought to be done by the helpe of *water*, and not by *Glasses*; which did leake by little and little out of the vessell, discovering anon one *Glasse*, then anon two *Glasses*, then 3, 4, 5 *Glasses*, &c. to shew so many *faces* as there were *houres*, which was onely by leaking of *water*.

*Of a Dyall which hath a Glasse in the place of the Still.*

What will you say of the invention of *Mathematicians*, which finde out dayly so many fine and curious *novelties*? they have now a way to make *Dyalls* upon the wainscote or seeling of a *Chamber*, and there where the *Sunne* can never shine, or the beames of the *Sunne* cannot directly strike: and this is done in placing of a little *Glasse* in the place of the *stile* which reflecteth the light, with the same condition that the *shadow* of the *stile* sheweth the *houre*: and it is easie to make experiment upon a common *Dyall*, changing onely the disposition of the *Dyall*, and tying to the end of the *stile* a peece of plaine *Glasse*. The *Almaines* use it much, who by this way have no greater trouble, but to put their *noses* out of their *beds* and see what a *clocke* it is; which is reflected by a little *hole* in the *window* upon the *wall* or seeling of the *Chamber*.

EXAMINA-



## EXAMINATION.

*I*N this there is two experiments considerable, the first is with a very little Glasse placed so that it may be open to the beames of the Sunne; the other hath respect to a spacious or great Glasse placed to a very little hole, so that the Sun may shine on it, for then the shadow which is cast upon the Dyall is converted into beames of the Sunne, and will reflect and bee cast upon a plaine opposite: and in the other it is a hole in the window or such like, by which may passe the beames of the Sunne which representeth the extremitie of the stile, and the Glasse representeth the plaine of the Dyall, upon which the beames being cast in manner of shadows reflecteth upon a plaine opposite: and it is needfull that in this second way the Glasse may be spacious as before to receive the delineaments of the Dyall.

Otherwise you may draw the lineaments of a Dyall upon any plaine looking-glasse which reflecteth the Sunne-beames, for the applying a stile or a pearle at the extremitie of it: and placed to the Sunne, the reflexion will be answerable to the delineaments on the Glasse: but here note that the Glasse ought to be great, and so the delineaments thereon.

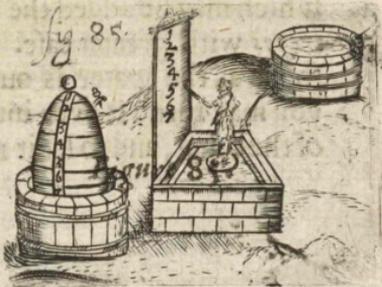
But that which is most noble is to draw houre lines upon the outside of the Glasse of a window,  
and

and placing a stile thereto upon the outside, the shadow of the stile will be seene within, and so you have the houre more certaine without any difficultie.

Of Dyalls with water.

SUCH kinde of Dyalls were made in ancient times, and also these of sand: before they had skill to make Sun-dyalls or Dyalls with wheeles; for they used to fill a vessell with water, and having experience by tryall that it would runne out all in a day, they did marke within the vessell the houres noted by the running of the water; and some did set a peece of light board in the vessell to swimme upon the top of the water, carrying a little statue, which with a small sticke did point out the houre upon a columnne or wall, figured with houre notes as the vessell was figured within.

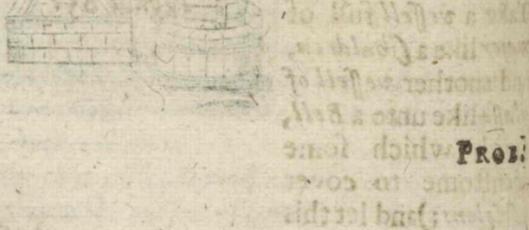
Vitruvius writes of another manner of water-Dyall more difficult; and Baptiste a Porta amongst his naturall secrets, delivers this invention following. Take a vessell full of water like a Chaldron, and another vessell of glasse like unto a Bell, (with which some accustome to cover Melons:) and let this



vessell

vessell of glasse bee almost as great as the Chaldron, having a small hole at the bottome, then when it is placed upon the water, it will sinke by little and little: by this one may marke the houres on the surface of the Glasse to serve another time. But if at the beginning one had drawn the water within the same vessell of glasse in sucking by the little hole, the water would not fall out, but as fast as the aire would succeed it; entering slowly at the little hole: or contrarily the houres might bee distinguished by diminution of water, or by augmentation.

Now it seemes a safer way that the water passe out by drop and drop, and drop into a Cylindricall Glasse by helpe of a Pipe: for having marked the exterior part of the Cylinder in the houre notes, the water it selfe which falls within it, will shew what of the clocke it is, farre better than the running of sand; for by this may you have the parts of the houres most accurate, which commonly by sand is not had: and to which may be added the houres of other Countreyes with greater ease. And here note that as soone as the water is out of one of the Glasses you may turne it over into the same againe out of the other, and so let it runne an new.



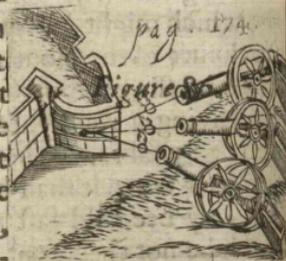
## PROBLEME. LXXXIII.

Of Cannons or great Artillery. Souldiers, and others would willingly see this Probleme, which containes three or foure subtile questions: The first is how to charge a Cannon without Powder.

This may be done with aire and water only, having throwne cold water into the Cannon, which might be squirted forceably in by the closure of the mouth of the Peece, that so by this pressure the aire might more condence; then having a round peece of wood very just, and oyled well for the better to slide, and thrust the Bullet when it shall be time: This peece of wood may bee held fast with some Pole, for feare it be not thrust out before his time: then let fire bee made about the Trunion or hinder part of the Peece to heate the aire and water, and then when one would shoote it, let the pole be quickly loosened: for then the aire searching a greater place, and having way now offered, will thrust out the wood and the bullet very quicke: the experimence which wee have in long trunkes shooting out pellets with aire only, sheweth the verity of this Probleme.

2. In the second question it may be demanded, how much time doth the Bullet of Cannon spend in the aire before it falls to the ground.

THE resolution of this *Question* depends upon the goodnesse of the *Peerce* and charge thereof, seeing in each there is great difference. It is reported that *Ticho Brahe*, and the *Landgrave* did make an experiment upon a Cannon in Germany, which being charged and shot off; the *Bullet* spent two minutes of time in the aire before it fell: and the distance was a *German mile*, which distance proportionated to an houres time, makes 120. *Italian miles*.



3. In the third question it may be asked, how it comes to passe, that a Cannon shooting upwards, the *Bullet* flies with more violence than being shot point-blanke, or shooting downward.

IF we regard the effect of a Cannon when it is to batter a wall, the *Question* is false, seeing it is most evident that the blowes which fall perpen-

perpendicular upon a wall, are more violent than these which strikes by a-wise or glancingly.

But considering the strength of the blow onely, the *Question* is most true, and often experimented to be found true: a Peece mounted at the best of the *Randon*, which is neare halfe of the right, conveyes her Bullet with a farre greater violence than that which is shot at, *Point blanke* or mounted paralell to the *Horizon*.

The comon reason is, that shooting high, the fire carries the *bowle* a longer time in the *aire*, and the *aire* moves more facill upwards, than downwards, because that the *ayrie circles* that the motion of the *bullet* makes are soonest broken. Howsoever this be the generall tenet, it is curious to find out the inequality of moving of the *aire*; whether the *Bullet* fly upward, downward, or right forward, to produce a sensible difference of motion: and some thinke that the *Cannon* being mounted, the *Bullet* pressing the *Powder* maketh a greater resistance, and so causeth all the *Powder* to be inflamed before the *Bullet* is throwne out, which makes it to be more violent than otherwise it would be. Whenthe *Cannon* is otherwise disposed, the contrary arives, the fire leaves the *Bullet*, and the *Bullet* rouling from the *Powder* resists lesse: and it is usually seene, that shooting out of a *Musket* charged onely with *Powder*; to shoote to a marke of *Paper* placed *Point blanke*, that there are seene many small holes in the  
paper,

paper, which cannot be other than the graines of Powder which did not take fire: but this latter accident may happen from the overcharging of the Peece, or the length of it, or windy, or dampnesse of the Powder.

From which some may thinke, that a Cannon pointed right to the Zenith, should shoote with greater violence, than in any other mount or forme whatsoever: and by some it hath bene imagined, that a Bullet shot in this fashion hath bene consumed, melt, and lost in the aire, by reason of the violence of the blow, and the activitie of the fire; and that sundry experiments hath bene made in this nature, and the Bullet never found. But it is hard to beleve this assertion: it may rather be supposed that the Bullet falling farre from the Peece cannot be discerned where it falls: and so comes to be lost.

4. In the fourth place it may be asked, whether the discharge of a Cannon be so much the greater, by how much it is longer.

IT seemeth at the first to bee most true, that the longer the Peece is, the more violent it shootes: and to speake generally, that which is direction by a Trunke, Pipe, or other concavities, is conveyed so much the more violent, or better, by how much it is longer; either in respect of the sight, hearing, water, fire, &c. and the reason seemes to hold in Cannons, becaute in these that are long, the fire is retained a longer time in the concavities of the Peece, and so hrowes

throwes out the *Bullet* with more violence; and experience lets us see that taking *Cannons* of the same boare, but of diversitie of length from 8 foote to 12; that the *Cannon* of 9 foote long hath more force than that of 8 foot long, and 10 more than that of 9, and so unto 12 foote of length. Now the usuall *Cannon* carries 600 *Paces*, some more, some lesse; yea, some but 200 *Paces* from the *Peece*, and may shoote into soft earth 15 or 17 foote, into sand or earth which is loose, 22 or 24 foote; and in firme ground, about 10 or 12 foot, &c.

It hath bene seene lately in *Germany*, where there was made *Peeces* from 8 foote long to 17 foote of like boare, that shooting out of any *Peece* which was longer than 12 foote; the force was diminished, and the more in length the *Peece* increaseth, the lesse his force was; therefore the length ought to bee in a meane measure; and it is often seene, the greater the *Cannon* is, by so much the service is greater: but to have it too long or too short, is not convenient, but a meane proportion of length to bee taken; otherwise the flame of the *fire* will bee overpressed with *aire*: which hinders the motion in respect of substance, and distance of getting out.



PROB-

## PROBLEM: LXXXIII.

Of prodigious progression and multiplication,  
of Creatures, Plants, Fruites, Numbers,  
Gold, Silver, &c. when they are al-  
ways augmented by certaine  
proportion.

**H**ere we shall shew things no lesse admir-  
able, as recreative, and yet so certaine and  
easie to be demonstrated, that there needes not  
but *Multiplication* only, to try each particular:  
and first,

*Of graines of Mustard-seed.*

**F**irst, therefore it is certaine that the increafe  
of one graine of *Mustard-seed* for 20 years  
space, cannot bee contained within the visible  
world, nay if it were a hundred times greater  
than it is: and holding nothing besides from the  
Center of the earth even unto the firmament,  
but onely small graines of *Mustard-seed*. Now  
because this seemes but words, it must be pro-  
ved by *Art*; as may bee done in this wise, as  
suppose one *Mustard-seed* sowne to bring forth  
a tree or branch, in each extendure of which  
might be a thousand graines: but we will sup-  
pose onely a thousand in the whole tree, and  
let us proceed to 20 years, every seed to bring  
forth yearly a thousand graines; now multiply-  
ing alwayes by a thousand, in lesse then 17 years  
you

you shall have so many graines which will surpass the *sands*, which are able to fill the whole *firmament*: for following the supposition of *Archimedes*, and the most probable opinion of the greatnesse of the *firmament* which *Tico Brahe* hath left us; the number of graines of *sand* will be sufficiently expressed with 49 *Ciphers*, but the number of graines of *Mustard-seed* at the end of 17 *years* will have 52 *Ciphers*: and moreover graines of *Mustard-seed*, are farre greater than these of the *sands*: it is therefore evident that at the seventeenth *year*, all the graines of *Mustard-seed*, which shall successively spring from one graine onely, cannot be contained within the limits of the whole *firmament*; what should it be then, if it should be multiplied againe by a thousand for the 18 *year*: and that againe by a thousand for every *year* increase untill you came to the 20 *years*? its a thing as cleare as the day, that such a heap of *Mustard-seed* would be a hundred thousand times greater than the *earth*: and being onely but the increase of one graine in 20 *years*,

### Of Pigges.

**S**econdly, is it not a strange proposition, to say that the great *Turke* with all his *Revenues*, is not able to maintaine for one *year* time, all the *Pigges* that a *Sow* may pigge with all her race, that is, the increase with the increase unto 12 *years*: this seemes impossible, yet it is most true; for let us suppose and put the case

that a Sow bring forth but 6, two males, and 4 females, and that each female shall bring forth as many every yeare, during the space of 12 yeares, at the end of the time there will be found above 33 millions of Pigges: now allowing a crowne for the maintenance of each Pigge for a yeare, (which is as little as may be, being but neare a halfe of a farthing allowance for each day;) there must bee at the least so many crownes to maintaine them, one a yeare, viz. 33 millions, which exceeds the Turkes revenue by much.

Of graines of Corne.

**T**Hirdly, it will make one astonished to thinke that a graine of Corne, with his increase successively for the space of 12 yeares will produce in grains 24414062500000000000, which is able to load almost all the creatures in the world.

To open w<sup>ch</sup>, let it be supposed that the first yeare one graine being sowed brings forth 50, (but sometimes there is seen 70, sometimes 100 fold) which graines sowed the next yeare, every one to produce 50, and so consequently the whole and increase to be sowed every yeare, untill 12 yeares bee expired, there will bee of increase the aforesaid prodigious summe of grains, viz. 24414062500000000000, which will make a cubicall heape of 6258522 graines every way, which is more than a cubicall body of 3 miles every way: for allowing 40 graines  
in

in length to each foote, the Cube would bee 156463 foot every way: from which it is evident that if there were two hundred thousand *Cities* as great as *London*; allowing to each 3 miles square every way, and 100 foot in height, there would not bee sufficient roome to containe the aforefaid quantitie of *Corne*: and suppose a bushell of *Corne* were equall unto two Cubicke fecte, which might containe twenty hundred thousand graines, then would there be 12207046250000 bushells, and allowing 30 bushells to a *Tunne*, it would bee able to loade 8138030833 vessells, which is more than eight thousand one hundred and thirty eight millions, shippe loadings of 500 *Tunne* to each shippe: a quantitie so great that the Sea is scarce able to beare, or the universall world able to finde vessells to carry it: And if this *Corne* should bee valued at halfe a crowne the bushell, it would amount unto 15258807812500 pounds sterling, which I thinke exceeds all the *Treasures* of all the *Princes*, and of other particular men in the whole world: and is not this good husbandry to sowe one graine of *Corne*, and to continue it in sowing, the increase onely for 12 yeares to have so great a profit.

*Of the increase of Sheep.*

**F**ourthly, those that have great flockes of *Sheepe* may bee quickly rich if they would preserve their *Sheepe* without killing or selling of them: so that every *Sheepe* produce one each

N 5                      yeare,

yeare, for at the end of 16 yeares, 100 *Sheepe* will multiply and increase unto 6168900, which is above 60 millions, and 16 hundred thousand *Sheepe*: now supposing them worth but a crowne a peece, it would amount unto 15422400 pounds sterling, which is above 15 millions, and foure hundred and twenty thousand pounds, a faire increase of one *Sheepe*: and a large portion for a *Childe* if it should bee allotted.

*Of the increase of Cod-fish, Carpes, &c.*

**F***irstly*, if there be any creatures in the world that doth abound with increase or fertilitie, it may be rightly attributed to fish; for they in their kindes produce such a great multitude of egges, and brings forth so many litle ones, that if a great part were not destroyed continually, within a little while they would fill all the *Sea*, *Ponds*, and *Rivers* in the world; and it is easie to see how it would come so to passe, onely by supposing them to increase without taking or destroying them for the space of 10 or 12 yeares: having regard to the soliditie of the waters which are allotted for to lodge and containe these creatures, as their bounds and place of rest to live in.

*Of the increase and multiplication of men.*

**S***ixtly*, there are some that cannot conceive how it can be that from eight persons (which was

was saved after the *deluge* or *Noahs flood*) should spring such a world of people to begin a Monarchie under *Nimrod*, being but 200 *yeares* after the *flood*, and that amongst them should be raised an *army of two hundred thousand fighting Men*: But it is easily proved if we take but one of the *Children of Noah*, and suppose that a new *generation* of people begun at every 30 *yeares*, and that it be continued to the seventh *generation* which is 200 *yeares*; for then of one onely *family* there would be produced *one hundred and eleven thousand soules, three hundred and five* to begin the world: though in that time men lived longer, and were more capable of multiplication and increase: which number springing onely from a simple production of one yearely, would be farre greater, if one man should have many wives, which in ancient times they had: from which it is also that the *Children of Israel*, who came into *Egypt* but onely 70 *soules*, yet after 210 *yeares* captivity, they came forth with their hostes; that there was told *six hundred thousand fighting men*, besides old people, *women* and *children*; and he that shall separate but one of the *families of Ioseph*, it would be sufficient to make up that number: how much more should it be then if wee should adjoyne many *families* together?

*Of the increase of numbers.*

**S***eventhly*, what summe of money shall the *Citie of London* be worth, if it should be sold, and the mony be paid in a yeare after this manner

manner: the first *weeke* to pay a *pinne*, the second *weeke* 2 *pinnes*, the third *weeke* 4 *pinnes*, the fourth *weeke* 8 *pinnes*, the fifth *weeke* 16 *pinnes*: and so doubling untill the 52 *weekes*, or the yeare be expired.

Here one would thinke that the value of the *pinnes* would amount but to a small matter, in comparifon of the *Treasures*, or *riches* of the whole *Citie*: yet it is most probable that the number of *pinnes* would amount unto the sum of 4519599628681215, and if we should allow unto a quarter a hundred thousand *pinnes*, the whole would containe nintie eight millions, foure hundred thousand Tunne: which is able to loade 45930 *Shippes* of a thousand Tunne a peece: and if wee should allow a thousand *pinnes* for a penny, the summe of money would amount unto above *eighteene thousand, eight hundred and thirty millions* of pounds sterling, an high price to sell a *Citie* at: yet certaine, according to that first proposed. So if 40 *Townes* were sold upon condition to give for the first a penny, for the second 2 pence, for the third 4 pence, &c. by doubling all the rest unto the last, it would amount unto this number of pence, 1099511627775, which in pounds is 4581298444, that is foure thousand five hundred and fourescore millions of pounds and more.

*Of a man that gathered up Apples, Stones,  
or such like upon a condition.*

**E**ightly, admit there were an hundred *Apples,*  
*Stones,* or such like things that were placed  
in a straight line or right forme, a *pace* one from  
another, and a basket being placed a *pace* from  
the first: how many *paces* would there be made  
to put all these *Stones* into the basket, by fetch-  
ing one by one: this would require neare halfe  
a day to doe it, for there would be made *tenne*  
*thousand and a hundred paces* before he should  
gather them all up.

*Of Changes in Bells, in muscalle Instruments,  
transmutation of places, in numbers,  
letters, men or such like.*

**N**Intly, is it not an admirable thing to con-  
sider how the skill of *numbers* doth easily  
furnish us with the knowledge of mysterious  
and hidden things, which simply looked into  
by others that are not versed in *Arithmeticke*,  
doe present unto them a world of confusion  
and difficultie.

As in the first place, it is often debated a-  
mongst our common *Ringers*, what number  
of *Changes* there might be made in 5, 6, 7, 8,  
or more *Bells*: who spend much time to an-  
swere their owne doubts, entering often into a  
*Labyrinth* in the serch thereof: or if there were  
10 *voyses*, how many severall notes might there  
be?

be? These are propositions of such facilitie, that a child which can but multiply one number by another, may easily resolve it, which is but only to multiply every *number* from the unitie successively in each others product, unto the terme assigned: so the 6. *number* that is against 6. in the Table, is 720, and so many *Changes* may be made upon 6 *Bells*, upon 5 there are 120, &c.

In like manner against 10 in the Table is 3628800, that is, three millions, sixe hundred twen y eight thousand, eight hundred & fourescore: which shewes that 10 voyces may have so many consorts, each man keeping his owne note, but onely altering his place; and so of stringed *Instruments*: & the *Gamanth* may be varied according to which, answerable to the number against X, viz. 1124001075070399680000 notes, from which may be drawne this, or the like proposition.

Suppose that 7 *Schollers* were taken out of a free *Schoole* to bee sent to an *Universitie*, there to be entertained in some *Colledge* at commons for a certaine summe of money, so that each of them have two meales dayly, and no longer to continue there, that sitting all together upon one bench or forme at every meale, there might be a diverse transmutation of place, of account in some one of them, in comparison of another, and never the whole company to be twice alike in situation: how long may the *Steward* entertaine them? (who being not skilled in this fetch may answer unadvisedly.) It is most certaine that there will bee *five thousand and forty*

forty severall positions or changings	1	a	1
in the seatings, which makes 7	2	b	2
years time not wanting 20 days:	6	c	3
Hence frō this mutabilitie of	24	d	4
transmutation, it is no marvell	120	e	5
that by 24 letters there ariseth	720	f	6
and is made such variety	5040	g	7
of languages in the world,	40320	h	8
and such infinire number	362880	i	9
of words in each lan-	3628800	k	10
guage; seeing the di-	39916800	l	11
versitie of syllables	479001600	m	12
produceeth that ef-	6227020800	n	13
fect; and also by	87178291200	o	14
the interchange-	1307674368000	p	15
ing and placing	20922789888000	q	16
of letters a-	355687537996000	r	17
mongst the	6402375683928000	s	18
vowels, and	121645137994632000	t	19
amongst	2432902759892640000	u	20
thēselves	51090957957745440000	w	21
maketh	1124001075070399680000	x	22
these	25852024726619192640000	y	23
sylla-	620448593438860623360000	z	24

bles: w<sup>ch</sup> alphabet of 24 letters may be varied so many times, vi. 620448593438860623360000 which is sixe hundred twenty thousand, foure hundred forty eight millions, five hundred ninety three thousand, foure hundred thirty eight millions of millions, and more.

Now allowing that a man may reade or speake one hundred thousand words in an houre, which is twice more words than there are contained

tained in the *Psalmes of David*, (a taske too great for any man to doe in so short a time) and if there were *four thousand six hundred and fifty thousand millions of men*, they could not speake these words; (according to the houely proportion aforesaid in *threescore and ten thousand yeares*; which variation and transmutation of letters, if they should bee written in *bookes*, allowing to each leafe 28000 words, (which is as many as possibly could bee inserted,) and to each booke a reame or 20 quire of the largest and thinnest printing paper; so that each book being about 15 inches long, 12 broad, and 6 thicke: the bookes that would be made of the transmutation of the 24 letters aforesaid, would bee at least 38778037089928788: and if a *Library* of a *mile square* every way, of 50 foot high, were made to containe 250 *Galleries* of 20 foote broad a peece, it would containe *four hundred millions* of the said bookes: so there must be to containe the rest no lesse than 96945092 such *Libraries*; and if the bookes were extended over the surface of the *Globe* of the *earth*, it would a decuple covering unto it: a thing seeming most incredible that 24 letters in their transmutation should produce such a prodigious number; yet most certaine and infallible in computation.

*Of a Servant hired upon certaine conditions.*

**A** *Servant* said unto his master, that hee would dwell with him all his life time, if he

he would but onely lend him land to sowe one graine of *Corne* with all his increase for 8 yeares time; how thinke you of this bargaine: for if he had but a quarter of an intch of ground for each graine, and each graine to bring forth yearly of increase 40 graines; the whole sum would amount unto, at the terme aforesaid, 655360000000 graines: and seeing that three thousand and sixe hundred millions of inches doe but make one mile square in the superficies, it shall bee able to receive fourteene thousand and foure hundred millions of graines, which is 14400000000: thus dividing the aforesaid 655360000000, the Quotient will bee 455, and so many square miles of land must there be to sow the increase of one graine of *Corne* for 8 yeares, which makes at the least foure hundred and twenty thousand Acres of land, which rated but at five shillings the Acre per Annum, amounts unto one hundred thousand pound; which is twelve thousand and five hundred pound a yeare, to bee continued for 8 yeares; a pretty pay for Master Servants 8 yeares service.

## PROBLEM: LXXXV.

*Of Fountaines, Hydriatiques, Machinecke,  
and other experiments upon water,  
or other liquor.*

1. *First how to make water at the foote of a  
mountaine to ascend to the top of it, and so to  
descend on the other side.*

**T**O doe this there must bee a *Pipe* of lead, which may come from the *Fountaine A*, to the top of the *Mountaine B*; and so to descend on the other side a little lower than the *Fountaine*, as at *C*: then make a hole in the *Pipe* at the toppe of the *Mountaine*, as at *B*, and stop the end of the *Pipe* at *A* and *C*; and fill this *Pipe* at *B* with water: and close it very carefully againe at *B*, that no aire get in: then unstop the end at *A*, and at *C*; then will the water perpetually runne up the hill, and descend on the other side, which is an invention of great consequence to furnish *Villages* that want water.



2. *Secondly,*

2. Secondly, how to know what wine or other liquor there is in a vessell without opening the bung-hole, and without making any other hole, than that by which it runs out at the toppe.

**I**N this *Probleme* there is nothing but to take a bowed pipe of *Glasse*, and put it into the *fancets hole*, and stopping it close about: for then you shall see the wine or liquor to ascend in this *Pipe*, untill it bee just even with the liquor in the *vessell*; by which a man may fill the *vessell*, or put more into it: and so if need were, one may empty one *vessell* into another without opening the *bung-hole*.

3. Thirdly, how is it that it is said that a *vessell* holds more water being placed at the foote of a *Mountaine*, than standing upon the toppe of it.

**T**HIS is a thing most certaine, because that water and all other liquor disposeth it selfe spherically about the Center of the earth; and by how much the *vessell* is nearer the Center, by so much the more the surface of the water makes a lesser *sphere*, and therefore every part more *gibbous* or swelling, than the like part in a greater *sphere*: and therefore when the same *vessell* is farther from the Center of the earth, the surface of the water makes a greater *sphere*, and therefore lesse *gibbous*, or swelling over the *vessell*:

*vessel*: from whence it is evident that a *vessel* neare the Center of the *earth* holds more *water* than that which is farther remote from it; and so consequently a *vessel* placed at the bottome of the *Mountaine* holds more *water*; than being placed on the top of the *Mountaine*: First, therefore one may conclude, that one and the same *vessel* will alwayes hold more: by how much it is nearer the center of the *earth*. Secondly, if a *vessel* be very neare the Center of the *earth*, there will bee more *water* above the brims of it, than there is within the *vessel*. Thirdly, a *vessel* full of *water* comming to the Center will spherically increase, and by little and little leave the *vessel*; and passing the Center, the *vessel* will be all emptied. Fourthly, one cannot carry a Paile of *water* from a low place to a higher, but it will more and more run out and over, because that in ascending it lies more leuell, but descending it swelles and becomes more gibbous.

4. Fourthly, to conduct *water* from the toppe of one *Mountaine*, to the top of another.

AS admit on the top of a *Mountaine* there is a spring, and at the toppe of the other *Mountaine*



Mountain there are inhabitants which wants water: now to make a bridge from one Mountain to another, were difficult and too great a charge; by way of Pipes it is easie and of no great price: for if at the spring on the toppe of the Mountain be placed a Pipe, to descend into the valley, and ascend to the other Mountain, the water will runne naturally, and continually, provided that the spring be somewhat higher than the passage of the water at the inhabitants.

5. Fifthly, of a fine Fountaine which spouts water very high, and with great violence by turning of a Cocke.

Let there be a vessell as *AB*, made close in all his parts, in the middle of which let *C* be a Pipe open at *D* neare the bottome, and then with a Squirt squirt in the water at *C*, stopped above by the cocke or fauceet *C*, with as great violence as possible you can; and turne the Cocke immediately. Now there being an indifferent quantitie of water & aire in the vessell, the water keeps it selfe in the bottome, and the aire which was greatly pressed, seekes for more place, that



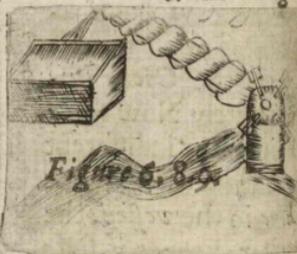
○

turning

turning the *cocke*, the *water* issueth forth at the *Pipe*, and flies very high; and that especially if the *vessell* bee a little heated: some make use of this for an *Ewer* to wash hands withall, and therefore putting a moveable *Pipe* above *C*, such as the figure sheweth: which the *water* will cause to turne very quicke, pleasurable to behold.

6. *Sixty*, of *Archimedes* *screw*, which makes *water* ascend by descending.

THIS is nothing else but a *Cylinder*, about the which is a *Pipe* in forme of a *screw*, and when one turnes it, the *water* descends alwaies in respect of the *Pipe*: for it passeth from one part which is higher to that which is lower, and at the end of the *engine* the *water* is found higher than it was at the spring. This great *engine* admirable in all *Mathematicall Arts* invented this *Instrument* to wash King *Hieroes* great *vessells*, as some *Authors* sayes, also to water the fields of *Egypt*, as *Diodorus* witnesseth: and *Cardanus* reporteth that a *Citizen* of *Milan* having made the like *engine*, thinking himselfe to bee the first *inventer*, conceived such exceeding joy, that he became *fool*, 2.



Againe a thing may ascend by ~~descending~~, if a *spirall line* bee made having many *circulations* or revolutions; the last being alwayes lesser than the first, yet higher than the Plaine supposed: it is most certaine that then putting a ball into it, and turning the *spirall line* so, that the first *circulation* may bee perpendicular, or touch alwayes the supposed Plaine: the ball shall in descending continually ascend, untill at last it come to the highest part of the *spirall line*, & so fall out. And here especially may be noted, that a moving body as *water*, or a *Bullet*, or such like, will never ascend if the *helicall revolution* of the screw be not inclining to the *Horizon*: so that according to this inclination the ball or liquor, may descend alwayes by a continuall motion and revolution. And this experiment may be more usefull, naturally made with a threed of *iron*; or *latine* turned or bowed *helicallly* about a *Cylinder*, with some distinction of distances betweene the *Helices*; for then having drawne out the *Cylinder*, or having hung or tied some weight at it in such sort, that the water may easily drop if one lift up the said threed: these *helices* or revolutions, notwithstanding will remaine inclining to the *Horizon*, and then turning it about forward, the said weight will ascend, but backward it will descend. Now if the revolutions bee alike, and of equallitie amongst themselves; and the whirling or turning motion be quicke, the sight will be so deceived, that producing the action it will seeme to the ignorant no lesse than a *miracle*.

7. Seventhly, of another fine Fountaine  
of pleasure.

THIS is an engine that hath two wheeles with cogges, or teeth as *AB*, which are placed within an *Ovall CD*, in such sort, that the teeth of the one, may enter into the notches of the other; but so just that neither aire nor water may enter into the *Ovall* coffer, either by the middle or by the sides, for the wheele must joyne so neare to the sides of the coffer, that there be no vacuitie: to this there is an axeltree with a handle to each wheele, so that they may be turned, and *A* being turned, that turneth the other wheele that is opposite: by which motion the aire that is in *E*, and the water that is carried by the hollow of the wheeles of each side, by continual motion, is constrained to mount and flie out by the funnell *F*: now to make the water runne what way one would have it, there may be applied upon the toppe of the Pipe *F*, two other moveable Pipes inserted one within another; as the figure sheweth. But here note that there may accrue some inconveniency in this *machanicke*, seeing that by quicke turning the cogges



Or *teeth* of the wheeles running one against another, may neare breake them, and so give way to the *aire* to enter in, which being violently inclosed will escape to occupie the place of the *water*, whose weight makes it so quicke: howsoever, if this *Machine* be curiously made as an able workeman may easily doe, it is a most soveraigne *engine*, to cast water high and farre off for to quench fires. And to have it to raine to a place assigned, accommodate a socket having a *Pipe* at the middle, which may point towards the place being set at the top thereof, and so having great discretion in turning the Axis of the wheele, it may worke exceeding well, and continue long.

8. *Eighthly*, of a fine watering pottle  
for gardens.

THIS may be made in forme of a *Bottle* according to the last figure or such like, having at the bottome many small holes, & at the necke of it another hole somewhat greater than these at the bottome, which hole at the toppe you must unstop when you would fill this watering *pot*, for then it is nothing but putting the lower end into a paille of water, for so it will fill it selfe by degrees: and being full, put your thumbe on the hole at the necke to stop it, for then may you carry it from place to place, and it will not sensibly runne out, yet something will if it were so close stopped, and all in time contrary to to the ancient tenet in *Philosophy*, that *aire* will not penetrate.

- 9 Ninthly, how easily to take wine out of a vessell at the bung-hole, without piercing of a hole in the vessell.

IN this there is no need but to have a *Cane* or *Pipe* of *Glasse* or such like, one of the ends of which may be closed up almost, leaving some small hole at the end; for then if that end be set into the *vessell* at the *bung-hole*, the whole *Cane* or *Pipe* will be filled by little and little, and once being full, stopps the other end which is without: and then pull out the *Cane* or *Pipe*, so will it be full of *wine*; then opening a little the toppe above, you may fill a *Glasse* or other *Potte* with it, for as the *wine* issueth out, the *aire* commeth into the *Cane* or *Pipe* to supply vacuity.



10. Tenthly, how to measure irregular bodies by helpe of water.

SOME throw in the *body* or *magnitude* into a *vessell*, and keepe that which floweth out over, saying it is alwayes equall to the thing cast into the *water*: but it is more neater this way to powre into a *vessell* such a quantity of *water*, which

which may be thought sufficient to cover the body or *magnitude*, and make a marke how high the water is in the *vessel*, then powre out all this water into another *vessel*, and let the body or *magnitude* be placed into the first *vessel*; then powre in water from the second *vessel*, untill it ascend unto the former marke made in the first *vessel*; so the water which remains in the second *vessel*, is equall to the *body* or *magnitude* put into the water: but here note that this is not exact or free from error, yet nearer the truth than any *Geometrician* can otherwise possibly measure, and these *bodies* that are not so full of powers are more truly measured this way, than others are.

### II. To finde the weight of water.

Seeing that  $\frac{574}{1000}$  part of an ounce weight, makes a cubicall inch of water: and every pound weight *Haverdepoise* makes 27 cubicall intches, and  $\frac{2}{10}$  fere, and that 7 Gallons and a halfe wine measure makes a foote cubicall, it is easie by inversion, that knowing the quantitie of a *vessel* in Gallons, to finde his content in cubicall feete or weight: and that late famous *Geometrician* *Master Briggs* found a cubicall foote of water to weigh neare 62 pound weight *Haverdepoize*. But the late learned *Simon Stevin* found a cubicall foote of water to weigh 65 pound, which difference may arise from the inequallitie of water; for some waters are more ponderous than others, and some difference

may be from the weight of a pound, and the measure of a foote: thus the weight and quantitie of a solid foote settled, it is easie for *Arithmeticians* to give the contents of *vessells* or *bodies* which containe liquids.

12. To finde the charge that a vessell may carry, as *Shippes, Boates, or such like.*

**T**His is generally conceived, that a *vessell* may carry as much weight as that water weigheth, which is equall unto the *vessell* in bignesse, in abating onely the weight of the *vessell*: we see that a barrell of *wine* or *water* cast into the *water*, will not sinke to the bottome but swimme easily, and if a *Shippe* had not *iron* and other ponderosties in it, it might swimme full of *water* without sinking: in the same manner if the *vessell* were loaden with *lead*, so much should the *water* weigh: hence it is that *Mariners* calls *Shippes* of 50 thousand *Tunnes*, because they may containe one or two thousand *Tunne*, and so consequently carry as much.

13. How comes it that a *Shippe* having safely sayled in the vaste *Ocean*, and being come into the *Port* or *harbour*, without any tempest will sinke downe right.

**T**He cause of this is that a *vessell* may carry more upon some kinde of *water* than upon other; now the *water* of the *Sea* is thicker and heavier than that of *Rivers, Wells, or Fountains*; there-

herefore the loading of a *vessell* which is accounted sufficient in the *Sea*, becomes too great in the *harbour* or sweet *water*. Now some thinke that it is the depth of the *water* that makes *vessells* more easie to swimme, but it is an abuse; for if the loading of a *Shippe* bee no heavier than the *water* that would occupie that place, the *Ship* should as easily swim upon that *water*, as if it did swim upon a thousand fathom deepe of *water*; and if the *water* be no thicker than a leafe of *paper*, and weigheth but an ounce under a heavy body, it will support it, as well as if the *water* under it weighed ten thousand pound weight: hence it is if there be a *vessell* capable of a little more than a thousand pound weight of *water*, you may put into this *vessell* a peece of *wood*, which shall weigh a thousand pound weight; (but lighter in his kinde than the like of magnitude of *water*;) for then powring in but a quarte of *water* or a very little quantitie of *water*, the *wood* will swimme on the top of it, (provided that the *wood* touch not the sides of the *vessell*;) which is a fine experiment, and seemes admirable in the performance.

14. How a grosse body of mettles may swimme upon the water.

THIS is done by extending the mettles into a thinne *Plate*, to make it hollow in forme of a *vessell*; so that the greatnesse of the *vessell* which the *aire* with it containeth, be equall to the

the magnitude of the *water*, which weighes as much as it; for all bodies may swimme without sinking, if they occupie the place of *water* equall in weight unto them, as if it weighed 12 pound, it must have the place of 12 pound of *water*: hence it is that wee see floating upon the *water* great *vessells* of *Copper* or *Brasse*, when they are hollow in forme of a *Chaldron*. And how can it be otherwise conceived of *I-lands* in the *Sea* that swimme and floate? is it not that they are hollow and some part like unto a *Boate*, or that their *earth* is very light and spongeous, or having many concavities in the body of it, or much *wood* within it.

And it would bee a pretty proposition to shew how much every kinde of *mettle* should bee enlarged, to make it swimme upon the *water*: which doth depend upon the proportions that is betweene the weight of the *water* and each *mettle*. Now the proportion that is betweene *mettles* and *water* of equall magnitude, according to some Authors is as followeth.

A magnitude of 10 pound weight of water will require for the like magnitude of	Gould.	187 $\frac{1}{2}$
	Lead.	116 $\frac{1}{2}$
	Silver.	104
	Copper.	91
	Iron.	81
	Tinne.	75

From which is inferred, that to make a peece of *Copper* of 10 pound weight to swimme, it must bee so made hollow, that it may hold 9 times that weight of *water* and somewhat more, that is to say, 91 pound: seeing that Cop-  
per

per and water of like magnitudes in their ponderosities, are as before, as 10 to 91.

15. How to weigh the lightnesse<sup>s</sup> of the aire.

Place a *Ballance* of wood turned upside downe into the *water*, that so it may swim, then let *water* be inclosed within some body, as within a *Bladder* or such like; and suppose that such a quantitie of *aire* should weigh one pound, place it under one of the *Ballances*, and place under the other as much weight of lightnesse as may counter-ballance and keepe the other *Ballance* that it rise not out of the *water*: by which you shall see how much the lightnesse is.

But without any *Ballance* doe this; take a Cubicall hollow *vessell*, or that which is *Cylindrical*, which may swimme on the *water*, and as it sinketh by placing of weights upon it, marke how much; for then if you would examine the weight of any body, you have nothing to doe but to put it into this *vessell*, and marke how deepe it sinkes; for so many pound it weighes as the weights put in doth make it so to sinke.



16. Being given a body, to marke it about, and shew how much of it will sinke in the water, or swimme above the water.

**T**HIS is done by knowing the weight of the body which is given, and the quantitie of water, which weighes as much as that body; for then certainly it will sinke so deepe, untill it occupieth the place of that quantitie of water.

17. To finde how much severall mettles or other bodies doe weigh lesse in the water than in the aire.

**T**AKE a Ballance and weigh (as for example) 9 pound of Gould, Silver, Lead, or Stone in the aire, so it hang in *equilibrio*; then comming to the water, take the same quantitie of Gould, Silver, Lead, or Stone, and let it softly downe into it, and you shall see that you shall neede a lesse counterpoise in the other Ballance to counter-balance it: wherefore all *solids* or *bodies* weigh lesse in the water than in the aire, and so much the lesse it will be, by how much the water is grosse and thicke, because the weight findes a greater resistance, and therefore the water supports more than aire: and further, because the water by the ponderositie is displeased, and so strives to be there againe, pressing to it, by reason of the other waters that are about it, according to the proportion of his

his weight. *Archimedes* demonstrateth, that all bodies weigh lesse in the *water* (or in like liquor) by how much they occupie place: and if the *water* weigh a pound weight, the magnitude in the *water* shall weigh a pound lesse than in the *aire*.

Now by knowing the proportion of *water* and mettles, it is found that *Gould* loseth in the *water* the 19 part of his waight: *Copper* the 9 part, *Quickefilver* the 15 part, *Lead* the 12 part, *Silver* the 10 part, *Iron* the 8 part, *Tinne* the 7 part and a little more: wherefore in materiall and absolute weight, *Gould* in respect of the *water* that it occupieth weigheth 18, and  $\frac{3}{4}$  times heavier than the like quantitie of *water*, that is, as  $18 \frac{3}{4}$  to the *Quickefilver* 15 times: *Lead* 11 and  $\frac{3}{7}$ , *Silver* 10 and  $\frac{2}{7}$ , *Copper* 9 and  $\frac{1}{10}$ , *Iron* 8 and  $\frac{2}{7}$ , and *Tinne* 8 and  $\frac{1}{2}$ . Contrarily in respect of greatnesse, if the *water* be as heavy as the *Gould*, then is the *water* almost 19 times greater than the magnitude of the *Gould*, and so may you judge of the rest.

18. How is it that a ballance having like weights in each scale, and hanging in equilibrio in the *aire*: being placed in another place, (without removing any weight) it shall cease to hang in equilibrio sensibly: yea by a great difference of weight.

**T**His is easie to be resolved by considering different mettles, which though they weigh

weigh equall in the *aire*, yet in the *water* there will bee an apparant difference; as suppose so that in the scale of each *Ballance* be placed 18 pound weight of severall *mettles*, the one *Gould* and the other *Copper*, which being in *equilibrio* in the *aire*, placed in the *water*, will not hang so, because that the *Gould* loseth neare the 18 part of his weight, which is about 1 pound, and the *Copper* loseth but his 9 part, which is 2 pound: wherefore the *Gold* in the *water* weigheth but 17 pound, and the *Copper* 16 pound, which is a difference most fencible to confirme that point.

19. To shew what waters are heavier one than another, and how much.

**P**hysitians have an especiall respect unto this, judging that *water* which is lightest is most healthfull and medicinall for the body; and *Sea-men* know that the heaviest *waters* doe beare most, and it is knowne which *water* is heaviest thus. Take a peece of *waxe* and fasten *lead* unto it, or some such like thing that it may but precisely swimme, for then it is equall to the like magnitude of *water*; then put it into another *vessell* which hath contrary *water*, and if it sinke, then is that *water* lighter than the other: but if it sinke not so deepe, then it argueth the *water* to be heavier or more grosser than the first *water*; or one may take a peece of *wood*, and marke the quantitie of sincking of it into severall *waters*, by which you may

may judge which is lightest or heaviest, for in that which it sinkes most, that is infallibly the lightest; and so contrarily.

20. *How to make a Pound of water weigh as much as 10, 20, 30, or a hundred pound of Lead; nay as much as a thousand, or ten thousand pound weight.*

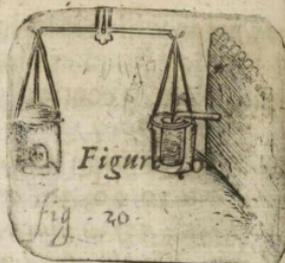
**T**His proposition seemes very impossible, yet water inclosed in a vessel, being constrained to dilate it selfe, doth weigh so much as though there were in the concavities of it a solid body of water.

There are many wayes to experiment this proposition, but to verifie it, it may be sufficient to produce two excellent ones onely: which had they not beene really acted, little credit might have beene given unto it.

The first way is thus: Take a *Magnitude* which takes up as much place as a hundred or a thousand pound of water, & suppose that it were tied to some thing that it may hang in the aire; then make a *Ballance* that one of the *scales* may environ it, yet so that it touch not the sides of it: but leave space enough for one pound of water: then having placed 100 pound weight in the other *scale*, throw in the water about the *Magnitude*, so that one pound of water shall weigh downe the hundred pound in the other *Ballance*.

The second way is yet more admirable: take a common *Ballance* that is capable to receive

10 or 20 pound of water, then put into it a magnitude which may take up the place of 9 or 19 pound of water, which must bee hung at some Iron or beame which is placed in a wall; so that it hang quiet: (now it is not materiall whether the magnitude be hollow or massie) so that it touch not the Ballance in which it is put: for then having put the lead or weight into the other Ballance, powre in a pound of water into the Ballance where the magnitude is, and you shall see that this one pound of water shall counterpoise the 10 or 20 pound of lead which is set in the other Ballance.



PROBLEM. LXXXVI.

*Of sundry Questions of Arithmeticke, and first of the number of sands.*

**I**T may be said incontinent, that to undertake this were impossible, either to number the sands of Libya, or the sands of the Sea; and it was this that the Poets sung, and that which the vulgar beleeves; nay, that which long agoe certaine Philosophers to Gelon King of Sici-  
ly

ly reported, that the graines of *sand* were innumerable: But I answer with *Archimedes*, that not onely one may number these which are at the border and about the *Sea*; but these which are able to fill the whole world: if there were nothing else but *sand*, and the graines of *sands* admitted to bee so small, that 10 may make but one graine of *Poppy*: for at the end of the account there neede not to expresse them, but this number 30840979456, and 35 *Ciphers* at the end of it. *Clavius* and *Archimedes* makes it somewhat more; because they make a greater firmament than *Ticho Brahe* doth; and if they augment the *Vniverse*, it is easie for us to augment the number, and declare assuredly how many graines of *sand* there is requisite to fill another world, in comparison that our visible world were but as one graine of *sand*, an atome or a point; for there is nothing to doe but to multiply the number by it selfe, which will amount to ninety places, whereof twenty are these, 95143798134910955936, and 70 *Ciphers* at the end of it: which amounts to a most prodigious number, and is easily supputated: for supposing that a graine of *Poppy* doth containe 10 graines of *sand*, there is nothing but to compare that little bowle of a graine of *Poppy*, with a bowle of an inch or of a foote, and that to be compared with that of the *earth*, and then that of the *earth* with that of the *firmament*; and so of the rest.

2. Divers mettles being melted together in one body, to finde the mixture of them.

THIS was a notable invention of *Archimedes*, related by *Utrivious* in his *Architecture*, where he reporteth that the *Gould-smith* which *King Hiero* employed for the making of the *Goulden Crowne*, which was to be dedicated to the gods, had stolen part of it and mixed *Silver* in the place of it: the *King* suspicious of the worke proposed it to *Archimedes*, if by Art he could discover without breaking of the *Crowne*, if there had beene made mixture of any other mettle with the *Gould*. The way which he found out was by bathing himselfe, for as hee entred into the vessell of *water*, (in which he bathed himselfe) so the *water* ascended or flew out over it, and as hee pulled out his body the *water* descended: from which he gathered that if a Bowle of pure *Gould*, *Silver*, or other mettle were cast into a vessell of *water*, the *water* proportionally according to the thing cast in would ascend; and so by way of *Aristometricke* the question lay open to bee resolved: who being so intensively taken with the invention, leapes out of the *Bath* all naked, crying as a man transported, *I have found, I have found*, and so discovered it.

Now some say that he tooke two *Masses*, the one of pure *Gould*, and the other of pure *Silver*, each equall to the weight of the *Crowne*, and therefore unequal in magnitude or greatnesse; and

and then knowing the severall quantities of *water* which was answerable to the *Crowne*, and the severall *Masses*, he subtilly collected, that the *Crowne* occupied more place within the *water* than the *Masse* of *Gold* did: it appeared that there was *Silver* or other mettles melt with it. Now by the rule of position, suppose that each of the three *Masses* weighed 18 pound a peece, and that the *Masse* of *Gold* did occupie the place of one pound of *water*, that of *Silver* a pound and a halfe, and the *Crowne* one pound and a quarter only: then thus he might operate: the *Masse* of *Silver* which weighed 18 pounds, cast into the *water*, did cast out halfe a pound of *water* more than the *Masse* of *Gold*, which weighed 18 pound; and the *Crowne* which weighed also 18 pound, being put into a vessel full of *water*, threw out more *water* than the *Masse* of *Gold* by a quarter of a pound, (because of mixt mettles which was in it:) therefore by the rule of proportion, if halfe a pound of *water* (the excesse) be answerable to 18 pound of *Silver*, one quarter of a pound of excesse shall be answerable to 9 pound of *Silver*, and so much was mixed in the *Crowne*.

Some judge the way to bee more facill by weighing the *Crowne* first in the *aire*, then in the *water*; in the *aire* it weighed 18 pound, and if it were pure *Gold*, in the *water* it would weigh but 17 pound; if it were *Copper* it would weigh but 16 pound; but because wee will suppose that *Gold* and *Copper* is mixed together, it will weigh lesse then 17 pound.

yet more than 16 pound, and that according to the proportion mixed: let it then be supposed that it weighed in the water 16 pound and 3 quarters, then might one say by proportion, that the difference of one pound of losse, (which is betweene 16 and 17) bee answerable to 18 pound, to what shall one quarter of difference be answerable to, which is betweene 17 and  $16\frac{3}{4}$ , and it will be 4 pound and a halfe; and so much Copper was mixed with the Gould.

Many men have delivered sundry wayes to resolve this proposition since *Archimedes* invention, and it were tedious to relate the diversities.

*Baptista Benedictus* amongst his *Arithmeticall Theoremes*, delivers his way thus: if a Masse of Gold, of equall bignesse to the Crowne did weigh 20 pound, and another of Silver of a capacitie or bignesse at pleasure, as suppose did weigh 12 pound, the Crowne or the mixt body would weigh more than the Silver, and lesser than the Gould; suppose it weighed 16 pound which is 4 pound lesse than the Gould by 8 pound, then may one say, if 8 pound of difference come from 12 pound of Silver, from whence comes 4 pound which will be 6 pound, and so much Silver was mixed in it, &c.

Three men bought a quantitie of wine, each paid alike, and each was to have alike; it happened at the last partition that there was 21 Barrells, of which 7 were full, 7 halfe full, and 7 empty, how must they share the wine and vessells, that each have as many vessells one as another, & as much wine one as another.

This may be answered two wayes as followeth, and these numbers 2, 2, 3; or 3, 3, 1, may serve for direction, and signifies that the first person ought to have 3 Barrells full, & as many empty ones, and one which is halfe full; so hee shall have 7 vessells and 3 Barrells, and a halfe of liquor: and one of the other shall in like manner have as much, so there will remaine for the third man 1 Barrell full, 5 which are halfe full, and 1 empty, and so every one shall have alike both in vessells and wine. And generally to answer such questions, divide the number of vessells by the number of persons, and if the Quotient be not an intire number, the question is impossible; but when it is an intire number, there must be made as many parts as there are 3 persons, seeing that each part is lesse than the halfe of the said Quotient: as dividing 21 by 3 there comes 7 for the Quotient, which may be parted in these thre parts, 2, 2, 3, or 3, 3, 1, each of which being lesse than halfe of 7.

4. There is a Ladder which stands upright against a wall of 10 foote high; the foot of it is pulled out 6 foote from the wall upon the pavement: how much hath the top of the Ladder descended.

The answer is, 2 foot; for by Pythagoras rule the square of  $DB$ , the Hypotenuse is equall to the square of  $DA$  6, and  $AB$  10. Now if  $DA$  bee 6 foot, and  $AB$  10 foot, the squares are 36 and 100, which 36 taken from 100 rests 64, whose *Roote-quadrat* is 8; so the foot of the Ladder being now at  $D$ , the toppe will bee at  $C$ , 2 foote lower than it was when it was at  $B$ .

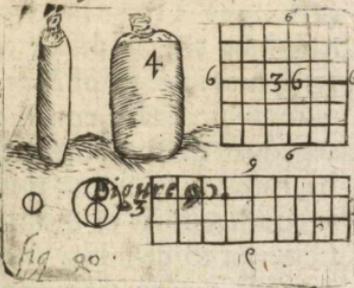


PROBLEM. LXXXVII.

*Witty suits or debates betweene Cains and Sempronius, upon the forme of figures; which Geometricians call Isoperimeter, or equall in circuit or compasse.*

Marvell not at it if I make the *Mathematickes* take place at the Barre, and if I set forth

forth here *Bartoleus*, who witnesseth of himselfe, that being then an ancient Doctor in the Law, he himselfe tooke upon him to learne the elements and principles of *Geometry*, by which he might set forth certaine *Lawes* touching the divisions of *Fields, Waters, Ilands*, and other incident places: now this shall be to shew in passing by, that these sciences are profitable and behovefull for *Judges, Counselors*, or such, to explaine many things which falles out in *Lawes*, to avoid ambiguities, contentions, and suits often.



1. Incident.

*Cains* had a field which was directly square, having 24 measures in Circuit; that was 6 on each side: *Sempronius* desiring to fit himselfe, prayed *Cains* to change with him for a field which should bee equivalent unto his; and the bargaine being concluded, he gave him for counterchange a peece of ground which had just as much in circuit as his had; but it was not square, yet *Quadrangular* and *Rectangled* having 9 measures in length for each of the two longest sides, and 3 in bredth for each shorter side: Now *Cains* which was not the most sub-

tillest nor wifest in the world excepted his bargain at the first, but afterwards having conferred with a *Land measurer* and *Mathematitian*, found that he was overreached in his bargain, and that his field contained 36 square measures, and the other field had but 27 measures, (a thing easie to be knowne by multiplying the length by the bredth :) *Sempronius* contested with him in suite of *Law*, and argued that figures which have equall *Perimeter* or *circuit*, are equall amongst themselves: my field, saith he, hath equall *circuit* with yours, therefore it is equall unto it in quantitie. Now this was sufficient to delude a *Judge* which was ignorant in *Geometricall* proportions, but a *Mathematician* will easily declare the deceit, being assured that figures which are *Isoperimeter*, or equall in *circuit*, have not alwayes equall capacitie or quantitie: seeing that with the same *circuit*, there may bee infinite figures made which shall be more and more capable, by how much they have more Angles, equall sides, and approach nearer unto a *circle*, (which is the most capablest figure of all,) becaute that all his parts are extended one from another, and from the middle or Center as much as may be: so we see by an infallible rule of experience, that a square is more capable of quantitie than a *Triangle* of the same *circuit*, and a *Pentagone* more than a *square*, and so of others, so that they be *regular figures* that have their sides equall, otherwise there might be that a regular *Triangle*, having 34 measures in *circuit* might

might have more capacitie than a rectangled *Parallelogram* which had also 24 measures of *circuit*, as if it were 11 in length and 1 in breadth, the *circuit* is still 24; yet the quantitie is but 11: and if it had 6 every way, it gives the same *Perimeter*, viz. 24. but a quantitie of 36 as before.

## 2. Incident.

**S**empronius having borrowed of Caius a Sacke of *Corne*, which was 6 foot high and 2 foote broad, and when there was question made to repay it, *Sempronius* gave *Caius* backe two sackes full of *Corne*, which had each of them 6 foot high and 1 foot broad: who believed that if the sackes were full hee was repaid, and it seemes to have an appearance of truth barely looked on. But it is most evident in demonstration, that the two sackes of *Corne* paid by *Sempronius* to *Caius*, is but halfe of that one sacke which he lent him: for a *Cylinder* or sacke having one foot of diameter, and 6 foot of length, is but the  $\frac{1}{4}$  part of another *Cylinder*, whose length is 6 foot, and his diameter is 2 foot: therefore two of the lesser *Cylinders* or sackes is but halfe of the greater; and so *Caius* was deceived in halfe his *Corne*.

## 3. Incident.

**S**ome one from a common *Fountain* of a *Citie* hath a *Pipe* of water of an inch diameter;

ter; to have it more commodious, he hath leave to take as much more *water*, whereupon hee gives order that a *Pipe* be made of two inches diameter. Now you will say presently that it is reason to bee so bigge, to have just twice as much *water* as he had before: but if the *Magistrate* of the *Citie* understood *Geometricall* proportions, hee would soone cause it to bee amended, and shew that hee hath not onely taken twice as much *water* as hee had before, but foure times asmuch; for a *Circular* hole which is two inches diameter is foure times greater than that of one inch; and therefore will cast out foure times asmuch *water*, as that of one inch, and so the deceit is double also in this.



Moreover if there were a heape of *Corne* of 20 foot every way, which was borrowed to be paid next yeare: the party having his *Corne* in heapes of 12 foote every way, and of 10 foote every way, proffers him 4 heapes of the greater, or 7 heapes of the lesser, for his owne heape of 20 every way, which was lent: here it seemes that the proffer is faire, nay with advantage, yet the losse would be neare 1000 foot. Infinite of such causes doe arise from *Geometricall figures*, which are able to deceive a *Indge* or *Magistrate*,

*Magistrate, which is not somewhat seene in  
Mathematicall Documents.*

PROBLEM. LXXXVIII.

*Containing sundry Questions in matter  
of Cosmography.*

**F**irst, it may be demanded, where is the middle of the world; I speake not here *Mathematically*, but as the vulgar people who aske where is the middle of the world: in this sence to speake absolutely there is no point which may be said to be the middle of the surface; for the middle of a *Globe* is every where: notwithstanding the *Holy Scriptures* speaketh respectively, and makes mention of the middle of the *earth*, and the interpreters apply it to the Citie of *Ierusalem* placed in the middle of *Palestina*, and the habitable world; that in effect taking a mappe of the world, and placing one foot of the *Compasses* upon *Ierusalem*, and extending the other foot to the extremity of *Europe*, *Asia*, and *Africa*; you shall see that the Citie of *Ierusalem* is as a Center to that Circle.

2. Secondly, how much is the depth of the *earth*, the height of the heavens, and the compass of the world.

**F**rom the surface of the *earth* unto the Center according to ancient traditions, is 3436 miles.

miles, so the whole thickenesse is 6872 miles, of which the whole compasse or circuit of the earth is 21600 miles.

From the Center of the earth to the *Moone* there is neare 56 *Semidiameters* of the earth, which is about 192416 miles: unto the *Sunne* there is 1142 *Semidiameters* of the earth, that is in miles 3924912; from the *starry firmament* to the Center of the earth there is 14000 *Semidiameters*, that is, 48184000 miles, according to the opinion and observation of that learned *Ticho Brahe*.

From these measures one may collect by *Arithmeticall* supputations, many pleasant propositions in this manner.

*First*, if you imagine there were a hole through the earth, and that a *milstone* should bee let fall downe into this hole, and to move a mile in each minute of time, it would be more than two dayes and a halfe before it would come to the Center, and being there it would hang in the *aire*.

*Secondly*, if a man should goe every day 20 miles, it would bee three yeares wanting but a fortnight, before he could goe once about the earth; and if a *Bird* should fly round about it in two dayes, then must the motion be 450 miles in an houre.

*Thirdly*, the *Moone* runnes a greater compasse each houre, than if in the same time shee should runne twice the *Circumference* of the whole earth.

*Fourthly*, admit it bee supposed that one should

should goe 20 miles in ascending upwards the heavens every day, hee should bee above 15 yeares before hee could attaine to the *Orbe* of the *Moone*.

*Fifthly*, the *Sunne* makes a greater way in one day than the *Moone* doth in 20 dayes, because that the *Orbe* of the *Sunnes* circumference is at the least 20 times greater than the *Orbe* of the *Moone*.

*Sixthly*, if a *milstone* should descend from the place of the *Sunne* a thousand miles every houre, (which is above 15 miles in a minute, farre beyond the proportion of motion) it would be above 163 dayes before it would fall downe to the *earth*.

*Seventhly*, the *Sunne* in his proper sphere moves more than seven thousand five hundred and seventy miles in one minute of time: now there is no *Bullet* of a *Cannon*, *Arrow*, *Thunderbolt*, or tempest of winde that moves with such quickenesse.

*Eighthly*, it is of a farre higher nature to consider the exceeding and unmoveable quicknesse of the *starry firmament*, for a *starre* being in the *Equator*, (which is just betweene the *Poles* of the *world*) makes 12598666 miles in one houre, which is two hundred, nine thousand nine hundred and ninety foure miles in one minute of time: & if a *Horseman* should ride every day 40 miles, hee could not ride such a compasse in a thousand yeares as the *starry firmament* moves in one houre, which is more than if one should move about the *earth* a thousand times

times in one houre, and quicker than possible thought can be imagined: and if a *starre* should fly in the *aire* about the *earth* with such a prodigious quickenesse, it would burne and consume all the *world* here below. Behold therefore how time passeth and death hasteth on: this made *Copernicus*, not unadvisedly to attribute this motion of *Primum mobile* to the *earth*, and not to the *starry firmament*: for it is beyond humane sence to apprehend or conceive the rapture and violence of that motion being quicker than thought; and the word of *God* testifieth that the *Lord* made all things in *number, measure, weight, and time.*

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PROBLEM. LXXXII.

To finde the *Bissextile* yeare, the *Dominicall* letter, and the letters of the moneth.

**L**ET 123, or 124, or 125, or 26, or 27, (which is the remainder of 1500, or 1600) be divided by 4, which is the number of the *Leape* yeare, and that which remaines of the division shewes the *Leape* yeare; as if one remaine, it shewes that it is the first yeare since the *Bissextile* or *Leape* yeare: if two, it is the second yeare, &c. and if nothing remaine, then it is the *Bissextile* or *Leape* yeare, and the *Quotient* shewes you how many *Bissextiles* or *Leape* yeares there are contained in so many yeares.

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To finde the Circle of the Sun by the fingers.

Let 123, 24, 25, 26, or 27, bee divided by 28, (which is the Circle of the Sonne, or whole revolution of the Dominicall letters) and that which remaines is the number of joynts, which is to bee accounted upon the fingers by *Filius esto Dei, calum bonus accipe gratis*: and where the number ends, that finger it sheweth the yeare which is present, and the words of the verse shewes the Dominicall letter.

Example.

Divide 123 by 28 for the yeare, (and so of other yeares) and the Quotient is 4, and there remaineth 11, for which you mult account 11 words; *Filius esto Dei, &c.* upon the joynts beginning from the first joynt of the Index, and you shall have the answer.

For the present to know the Dominicall letter for each moneth, account from *January* unto the moneth required, including *January*; and if there bee 8, 9, 7, or 5, you must begin upon the end of the finger from the thumbe and account, *Adam degebat, &c.* as many words as there are moneths, for then one shall have the letter which begins the moneth; then to know what day of the moneth it is, see how many times 7 is comprehended in the number of dayes, and take the rest: suppose 4. account upon the first finger within and without by the joynts  
unto

unto the number of 4, which ends at the end of the *finger*: from whence it may be inferred that the day required was *Wednesday*, *Sunday* being attributed to the first *joynt* of the first *finger* or *Index*: and so you have the present *yeare*, the *Dominicall letter*, the letter which begins the *Moneth*, and all the dayes of the *Moneth*.

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PROBLEM. LXXXIII.

To finde the *New* and *Fall Moone* in each *Moneth*.

ADde to the *Epact* for the *yeare*, the *Moneth* from *March*; then subtract that surplus from 30, and the rest is the day of the *Moneth* that it will bee *New Moone*, and adding unto it 14, you shall have that *Full Moone*.

*Note.*

THAT the *Epact* is made alwayes by adding 11 unto 30, and if it passe 30, subtract 30, and adde 11 to the remainder: and so *ad infinitum*: as if the *Epact* were 12, adde 11 to it makes 23 for the *Epact*, next *yeare*, to which adde 11 makes 34; subtract 30, rests 4: the *Epact* for the *yeare* after, and 15 for the *yeare* following that, and for the next, and 7 for the next, &c.

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## PROBLEM. LXXXIII.

To finde the Latitude of a Countrey.

THEse that dwell betweene the *North Pole* and the *Tropicke of Cancer*, have their *spring* and *summer* betweene the 10. of *March*, and the 13. of *September*: and therefore in any day betweene that time, get the sunnes distance by instrumentall observation from the zenith at noone, and adde the declination of the sunne for that day to it: so the Aggragate, or such is the *Latitude*, or *Poles height* of that *Countrey*. Now the *declination* of the sunne for any day is found out by *Tables* calculated to that end: or *Mechanically* by the *Globe*, or by *Instrument* it may be indifferently had: and here note that if the day be betweene the 13. of *September* and the 10. of *March*, then the sunnes *declination*, for that day must be taken out of the distance of the sunne from the *zenith* at noone, so shall you have the *Latitude*, as before.

## PROBLEM. LXXXV.

Of the *Climats* of countries, and to finde in what *Climate* any countrey is under.

*Climats* as they are taken *Geographically* signifie nothing else but when the length

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of the longest day of any place, is halfe an houre longer, or shorter than it is in another place (and so of the shortest day) and this account to begin from the *Equinoctiall Circle*, seeing all *Countries* under it have the shortest and longest day that can bee but 12. houres; But all other *Countries* that are from the *Equinoctiall Circle* either towards the *North* or *South* of it unto the *Poles* themselves, are sayd to bee in some one *Climate* or other, from the *Equinoctiall* to either of the *poles Circles*, (which are in the Latitude of 66. gr. 30. m.) betweene each of which *poles Circles* and the *Equinoctiall Circle* there is accounted 24 *Climats*, which differ one from another by halfe an *hours* time: then from each *Poles Circle*, to each *Pole* there are reckoned 6. other *Climats* which differ one from another by a months time: so the whole *earth* is divided into 60. *Climats*, 30 being allotted to the *Northerne Hemisphere*, and 30. to the *Southerne Hemisphere*. And here note that though these *Climats* which are betweene the *Equinoctiall* & the *poles Circles* are equall one unto the other in respect of time, to wit, by halfe an *houre*, yet the *Latitude*, *breadth*, or *internall*, contained betweene *Climate* and *Climate*, is not equall: & by how much any *Climate* is farther from the *Equinoctiall* than another *Climate*, by so much the lesser is the *internall* betweene that *Climate* and the next: so these that are nearest the *Equinoctiall* are largest; and these w<sup>ch</sup> are farthest off most contracted: & to find what *Climate* any *Countrey* is under: subtract

subtract the length of an *Equinoctiall day* to wit, 12. *houres* from the length of the longest day of that *Country*; the remainder being doubled shewes the *Cimate*: So at *London* the longest day is neare 16. *houres* and a halfe; 12. taken from it there remains 4. *houres* and a halfe which doubled makes 9. halfe *houres*, that is, 9. *Climats*; so *London* is in the 9. *Cimate*.

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PROBLEM. I XXXXVI.<sup>1</sup>

Of Longitude and Latitude of the Earth  
and of the Startes.

**L**ongitude of a *Country*, or *place*, is an arcke of the *Equator* contained betweene the *Meridian* of the *Azores*, and the *Meridian* of the *place*; and the greatest *Longitude* that can be is 360 degrees.

*Note.*

That the first *Meridian* may be taken at pleasure upon the *Terrestriall Globe* or *Mappe*, for that some of the ancient *Astronomers* would have it at *Hercules Pillars*, which is at the straights at *Gibraltar*: *Ptolomy* placed it at the *Canary Iland*, but now in these latter times it is held to bee neare the *Azores*. But why it was first placed by *Ptolomy* at the *Canary Ilands*, was because that in his time these *Ilands* were the farthest westerne parts of the world that was then discovered: And why it retaines his place now at *Saint Michels* neare the

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*Azores*

*Azores*, is that because of many accurate observations made of late by many expert Navigators and Mathematicians, they have found the Needle there to have no variation, but to point North and South: that, is to each Pole of the world: and why the Longitude from thence is accounted Eastwards, is from the motion of the Sunne Eastward; or that Ptolomy and others did hold it more convenient to begin from the western part of the world and so account the Longitude Eastward from Countrey to Countrey that was then knowne; till they came to the Easterne part of *Aſia*, rather than to make a beginning upon that which was unknowne: and having made up their account of reckoning the Longitude from the Western part to the Easterne part of the world knowne, they supposed the rest to be all sea, which since their deaths hath beene found almost to be another habitable world.

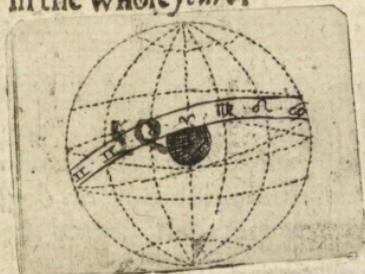
*To finde the Longitude of a Countrey.*

IF it be upon the *Globe*, bring the Countrey to the *Braſen Meridian*, and whatſoever degree that *Meridian* cuts in the *Equinoctiall*, that degree is the Longitude of that Place: if it be in a *Mappe*, then marke what *Meridian* passeth over it; so have you the Longitude thereof: if no *Meridian* passe over it, then take a paire of *Compasses*, and measure the distance betweene the Place and the next *Meridian*, and apply it

to the divided parallel or *Equator*; so have you the *Longitude* required.

Of the *Latitude* of *Countries*.

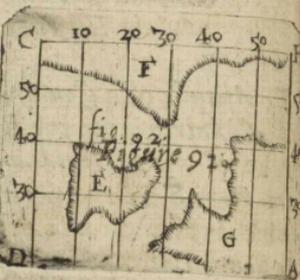
**L**atitude of a *Country* is the distance of a *Country* from the *Equinoctiall*, or it is an *Arke* of the *Meridian* contained betweene the *Zenith* of the place and the *Equator*; which is twofold, viz. either *North Latitude* or *South Latitude*, eyther of which extendeth from the *Equinoctiall* to eyther *Pole*; so the greatest *Latitude* that can be is but 90. degrees: If any *Northerne Country* have the *Articke Circle* verticall, which is in the *Latitude* of 66. gr. 30. m. the *sunne* will touch the *Horizon* in the *North* part thereof, and the longest day will be there then 24. houres: if the *Country* have lesse *Latitude* than 66. degrees 30. m. the *sunne* will rise and set; but if it have more *Latitude* than 66. gr. 30. m. it will bee visible for many *dayes*: and if the *Country* bee under the *Pole*, the *sunne* will make a *Circular* motion above the *Earth* and be visible for a halfe *yeare*: so under the *Pole* there will be but one *day*, and one *night* in the whole *yeare*.



To

## To finde the Latitude of Countries.

**I**F it be upon a *Globe*, bring the place to the *Brasen Meridian*, and the number of degrees which it meeteth therewith, is the *Latitude* of the place. Or with a paire of *Compasses* take the distance betweene the *Country* and the *Equinoctiall*; which applyed unto the *Equinoctiall* will shew the *Latitude* of that *Country*; which is equall to the *Poles* height; if it be upon a *Mappe*. Then marke what parallel passeth over the *Country* and where it crosseth the *Meridian*, that shall be the *Latitude*: but if no parallel passeth over it, then take the distance betweene the place and the next parallel, which applyed to the divided *Meridian* from that parallel will shew the *Latitude* of that place.



## To finde the distance of Places.

**I**F it be upon a *Globe*: then' with a paire of *Compasses* take the distance betweene the two places, and apply it to the divided *Meridian* or *Aequator*, and the number of degrees shall shew the distance; each degree beeing 60 miles,

miles. If it be in a *Mappe* (according to *Wright's projection*) take the distance with a paire of *Compasses* betweene the two places, and apply this distance to the divided *Meridian* on the *Mappe* right against the two places; so as many degrees as is contained betweene the feete of the *Compasses*, so much is the distance betweene the two places. If the distance of two places be required in a particular *Mappe* then with the *Compasses* take the distance betweene the two places, and apply it to the scale of *Miles*, so have you the distance: if the scale be too short, take the scale betweene the *Compasses*, and apply that to the two *Places* as often as you can, so have you the distance required.

*Of the Longitude, Latitude, Declination, and distance of the Starres.*

**T**HE *Declination* of a *starre* is the nearest distance of a *starre* from the *Aequator*; the *Latitude* of a *starre* is the nearest distance of a *starre* from the *Eclipticke*: the *Longitude* of a *starre* is an *Arke* of the *Eclipticke* contained betweene the beginning of *Aries*, and the *Circle* of the *Starres Latitude*, which is a *Circle* drawne from the *Pole* of the *Ecliptick* unto the *starre*, and so to the *Eclipticke*. The distance betweene two *starres* in heaven is taken by a *Crosse staffe* or other *Instrument*, and upon a *Globe* it is done by taking betweene the feet of the *Compasses* the two *starres*, and applying it

to the *Aquator*, so have you the distance betweene those two *starres*.

*How it is that two Horses or other creatures being foled or brought forth into the world at one and the same time, that after certaine dayes travell the one lived longer than the other, notwithstanding they dyed together in one and the same moment also.*

**T**His is easie to be answered: let one of them travell towards the West and the other towards the East: then that which goes towards the West followeth the Sunne: shall have the day somewhat longer than if there had beene no travell made: and that which goes East by going against the Sunne, shall have the day shorter: and so respect of travell though they dye at one and the selfe same houre and moment of time, the one shall be older than the other.

From which consideration may be inferred that a Christian, a Jew, and a Zarazen, may have their Sabbaths all upon one and the same day, though notwithstanding the Zarazen holds his Sabath upon the Friday, the Jew upon the Saturday, and the Christian upon the Sunday: For being all three resident in one place, if the Zarazen and the Christian begin their travell upon the Saturday, the Christian going West: and the Zarazen Eastwards, shall compass the  
 a Globe

Globe of the earth, the Christian at the conclusion shall gaine a day and the Zarazen shall lose a day, and so meete with the Jew every one upon his owne Sabbath.

*Certaine fine Observations.*

**V**nder the *Equinoctiall* the *Needle* hangs in 1  
*æquilibrium*, but in these parts it inclines under the *Horizon*, and being under the *Pole* it is thought it will hang *verticall*.

In these *Countries* which are without the 2  
*Tropicall Circles*, the *Sunne* comes *East* and *West* every day for a halfe yeare; but being under the *Equinoctiall* the *Sunne* is never *East*, nor *West* but twice in the yeare, to wit, the 10. of *March* and the 13. of *September*.

If a *shippe* be in the *Latitude* of 23. gr. 30. m. 3  
 that is, if it have eyther of the *Tropickes verticall*: then at what time the *Sunnes Altitude* is equall to his distance from any of the *Equinoctiall points*, then the *Sunne* is due *East* or *West*.

If a *shippe* be betweene the *Equinoctiall* and 4  
 eyther of the *Tropicks*, the *Sunne* will come twice to one point of the *Compassse* in the forenoone, that is, in one and the same position.

Vnder the *Equinoctiall* neare *Guinea* there is 5  
 but two sorts of *winds* all the yeare, 6. months a *Northerly winde*, and 6. months a *Southerly winde*, and the flux of the *Sea* is accordingly.

If two *ships* under the *Equinoctiall* be 100. 6  
*leagues* asunder, and should sayle *Northerly*  
 untill

untill they were come under the *Articke Circle*, they should then be but 50. leagues asunder.

7 These which have the *Articke Circle* verticall: when the *Sunne* is in the *Tropicke of Cancer*: the *Sunne* setteth not but toucheth the western part of the *Horizon*.

8 If the complement of the *Sunnes* height at noone be found equall to the *Suns Declination* for that day, then the *Equinoctiall* is verticall: or a *Shippe* making such an observation, the *Equinoctiall* is in the *Zenith* or direct over them: by which *Navigators* know when they crosse the line, in their travels to the *Indies*, or other parts.

9 The *Sunne* being in the *Equinoctiall*, the extremity of the still in any *Sunne dyall* upon a plaine; maketh a right line, otherwise it is *Ellipticall, Hyperbolicall, &c.*

0 When the shadow of a man, or other thing upon a *Horizontall* plaine is equall unto it in length, then is the *Sunne* in the middle point betwene the *Horizon* and the *Zenith*, that is, 45. degrees high.

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PROBLEME LXXXVII.

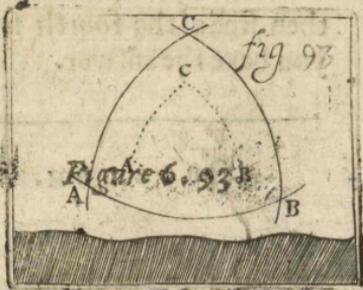
To make a Triangle that shall have three right Angles.

Open the *Compasses* at pleasure: and upon *A*, describe an Arke *BC*. then at the same opening, place one of the feet in *B*, and describe

scribe the Arke  $AC$ .

Lastly, place one of the feet of the *Compasses* in  $C$ . and describe the Arke  $AB$ . so shall you have the *spherical Equilaterall Triangle*  $ABC$ .

right angled at  $A$ , at  $B$ , and at  $C$ . that is, each angle comprehended  $90$ . degrees: which can never be in any plaine *Triangle*, whether it be *Equilaterall*, *Isocelle*, *scaleve*, *Orthogonall*, or *Opigonall*.



PROBLEM. LXXXXVIII.

To divide a line in as many equall parts as one will, without compasses, or without seeing of it.

THIS *Proposition* hath a fallacie in it, and cannot be practised but upon a *Maincordion*: for the *Mathematicall* line which procedes from the flux of a point, cannot be divided in that wise: One may have therefore an *Instrument* which is called *Maincordion*, because there is but one cord: and if you desire to divide your line into 3. parts, run your finger upon the frets untill you found a third in musicke: if you would have the fourth part of the line, then

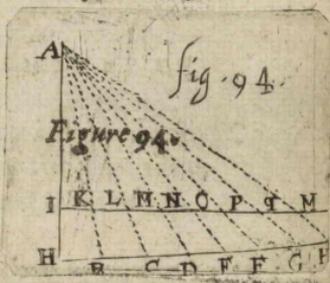
then finde the fourth sound, a fift, &c. so shall you have the answer.

PROBLEM. LXXXVIII.

To draw a line which shall incline to another line, yet never meete: against the Axiome of Parallels.

THIS is done by helpe of a *Conoyde* line, produced by a right line upon one and the same plaine, held in great account amongst the Ancients, and it is drawne after this manner.

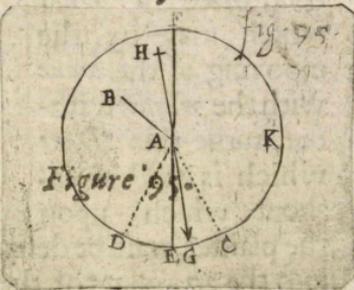
Draw a right line infinitely, and upon some end of it, as at *I*, draw a perpendicular line *IA*. augment it to *H*. then frō *A*. draw lines at pleasure to intersect the line *I. M.* in each of which lines from the right line, *I. M.*: transerre *I. H.*: viz. *KB. LC. OD. PE. QF. MG.* then from those points draw the line *H. B. C. D. E. F. G.* which will not meet with the line *I. M.* and yet incline nearer and nearer unto it.



PROBLEM. C.

To observe the variation of the compasses, or  
needle in any places.

First describe a Circle upon a plaine, so that  
the Sunne may shine on it both before noone  
and afternoone: in the center of which Circle  
place a Gnomon or wire perpendicular as *AB*.  
and an hour before noone marke the extremi-  
tie of the shadow of *AB*. which suppose it  
be at *C*. describe a Circle at that semidiameter  
*CD*. then after noone marke when the top of  
the shadow of *AB*. toucheth the Circle, which  
admit in *D*; deuide the distance *CD*, into two  
equall parts which suppose at *E*. draw the line  
*EAF*. which is the Meridian line, or line of  
North & South: now  
if the Arke of the  
Circle *CD*. bee de-  
uided into degrees:  
place a Needle *GH*,  
upon a plaine set up  
in the Center, & marke  
how many degrees  
the point of the Nec-  
dle *G*, is from *E*. so  
much doth the Nec-  
dle vary from the  
North in that place.

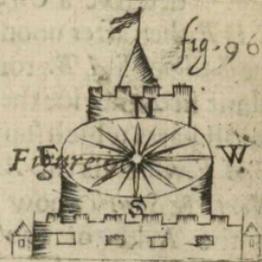


PROB-

## PROBLEM. CI.

How to finde at any time which way the wind  
is in ones Chamber, without go-  
ing abroad.

Vpon the *Planching* or *floore* of a *Chamber*,  
*Parlor*, or *Hall*, that you intend to have  
this devise, let there come downe from the top  
of the *house* a hollow post, in which place an  
*Iron rod* that it ascend above the *house* 10, or 6.  
foote with a *vane* or  
a *scooben* at it to  
shew the *winds* with-  
out: and at the lower  
end of this rod of  
*Iron*, place a *Dart*  
which may by the  
mooving of the *vane*  
with the *winde* with-  
out, turne this *Dart*  
which is within: a-  
bout which upon  
the *plaster* must be described a *Circle* divided  
into the 32. points of the *Mariners Compasse*  
pointed and distinguished to that end: then may  
it be marked by placing a *Compass* by it: for ha-  
ving noted the *North point*, the *East*, &c. it is  
easie to note all the rest of the points: and so at  
any time comming into this *Room*, you have  
nothing to doe but to looke up to the *Dart*,  
which will point you out what way the *winde*  
bloweth at that instant.

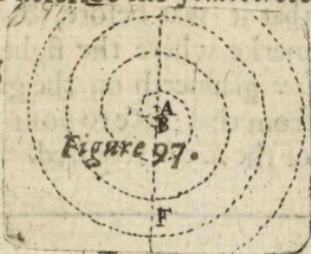


PRO-

PROBLEM. CII.

How to draw a parallell sphericall line  
with great ease.

First draw an obscure line  $GF$ . in the middle of it make two points  $AB$ , (which serves for Centers) then place one foote of the *Compasses* in  $B$ , and extend the other foote to  $A$ , and describe the *semicircle*  $AC$ : then place one foot of the *Compasses* in  $A$ , and extend the other foote to  $C$ , and describe the *semicircle*  $CD$ . Now place the *Compasses* in  $B$ , and extend the other foote unto  $D$ , and describe the *semicircle*  $DE$ , and so ad infinitum; which being done neatly, that there bee no right line seene nor where the *Compasses* were placed, will seeme very strange how possibly it could bee drawne with such exactnes, to such which are ignorant of that way.



PROB

## PROBLEM. CIII.

To measure an inaccessible distance : as the  
breadth of a River with the helpe of  
ones hat onely.

**T**He way of this is easie, for having ones  
hat upon his head, come neare to the banke  
of the River, and houlding your head upright  
(which may bee by putting a small sticke to  
some one of your buttons to prop up the chin)  
plucke downe the brim or edge of your hat un-  
till you may but see the other side of the water;  
then turne about the body in the same posture  
that it was before, towards some plaine, and  
marke where the sight by the brimme of the  
hat glaunceth on the ground; for the distance  
from that place to your standing, is the bredth  
of the River required.

## PROBLEM. CIIII.

How to measure a height with two frames or  
two small sticket.

**T**Ake two frames or two sticket which are  
one as long as another, and place them at  
right Angles one to the other, as  $AB$ . and  $AC$ .  
then houlding  $AB$ . parallel to the ground, place  
the end  $A$ . to the eye at  $A$ . and looking to the  
other top  $B$   $C$ . at  $C$ . by going backward or for-  
ward

ward untill you may see the top of the Tower or Tree, which suppose at *E*. So the distance from your standing to the Tower or Tree, is equal to the height thereof above the level of the eye : to which if you adde your owne height you have the whole height.



Otherwise.

TAKE an ordinary square wch Carpenters or other workemen use, as *HKL*. and placing *H*. to the eye so that *HK*. be levell, goe backe or come nearer untill that by it you may see the top *M*. for then the distance from you to the height is equal to the height.



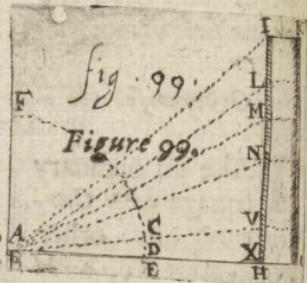
R

PROB-

## PROBLEM. C.V.

How to make statues, letters, bowles, or other things which are placed in the side of a high building, to be seene below of an equall bignesse.

Let  $BC$ . be a Pillar 27. yards high, and let it be required that three yards above the level of the eye  $A$ , viz. at  $B$ . be placed a Globe and 9 yards above  $B$ . be placed another, and 22. yards above that be placed another Globe: how much shall the Diameter of these Globes be, that at the eye, at  $A$ , they may all appear to be of one and the same Magnitude: It is thus done, first draw a line as  $AK$ . & upon  $K$ . erect a perpendicular  $KX$ . divide this line into 27. parts, and according to  $AK$ . describe an Arke  $KY$ . then from  $K$ . in the perpendicular  $KX$ , account 3. parts. viz. at  $L$ , which shall represent the former three yardes, and draw the line  $LA$ : from  $L$ , in the sayd perpendicular reckon the diameter of the lesser Globe of what Magnitude it is intended to be: suppose  $SL$ . and draw the line  $SA$ . cutting the Arke  $KY$ . in  $N$ . then from  $K$ . in the perpendicular account 9. yards, which admit at  $T$ . draw  $TA$ . cutting  $TK$ . in  $O$ . transfere the Arke  $MN$ . from



A to P. and draw  $AP$ . which will cut the perpendicular in  $V$ . so a line drawne from the middle of  $VF$ . unto the visuall lines  $AT$ , and  $AV$ , shall be the diamiter of the next *Globe*: Lastly, account from  $K$ . in the perpendicular  $XK$ , 22 parts, and draw the line  $WA$ . cutting  $YK$ , in  $Q$ . then take the Arke  $MN$ , and transerre it from  $Q$ . to  $R$ . and draw  $AR$ . which will cut the perpendicular in  $X$ . so the line which passeth by the middle of  $XW$ . perpendicular to the visuall line  $AW$ , and  $AX$ . be the *Diamiter* of the third *Globe*, to wit 5, 6. which measures transferred in the Pillar  $BC$ . which sheweth the true *Magnitude of the Globes* 1, 2, 3. from this an Architect doth proportion his *Images*, and the foulding of the *Robes* which are most deformed at the eye below in the making, yet most perfect when it is set in his true height above the eye.

## PROBLEM. CVI.

How to disguise or disfigure an Image, as a head, an arme, a whole body, &c. so that it hath no proportion, the eares to become long: the nose as that of a swan, the mouth as a coaches entrance, &c. yet the eye placed at a certaine point will be seene in a direct and exact proportion.

I Will not strive to set a Geometricall figure here for feare it may seeme too difficult to understand,

derstand, but I will indeavour by discourse how Mechanically with a *Candle* you may perceive it sensible: first there must be made a figure upon *Paper* such as you please, according to his just proportion, and paint it as a *Picturo* (which painters know well enough to doe) afterwards put a *Candle* upon the *Table*, and interpose this figure obliquely, betweene the said *Candle* and the *Bookes* of *Paper*, where you desire to have the figure disguised in such sort that the height passe athwart the hole of the *Picture*; then will it carry all the forme of the *Picture* upon the *Paper*, but with deformity; follow these tracts and marke out the light with a *Coles blacke head* or *Inke*: and you have your desire.

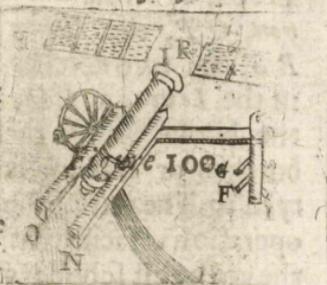
To finde now the point where the *eye* must see it in his naturall forme: it is accustomed according to the order of *Perspective*, to place this point in the line drawne in height, equal to the largeness of the narrowest side of the deformed square, and it is by this way that it is performed.

## PROBLEM. CVII.

*How a Canon after that it hath shot, may be covered from the battery of the enemy.*

**L**ET the mouth of a *Canon* be *I*. the *Canon* *M*. his charge *N O*. the *wheele* *L*. the *axle-tree* *P B*. upon which the *Canon* is placed, at which

which end towards *B*, is placed a pillar *AE*. supported with props *DC, E, F, G*. about which the *Axeltree* turneth: now the Cannon being to shoot, it retires to *H*. which cannot be directly because of the *Axeltree*, but it make a segmet of a Circle, & hides himselfe behind the wall *QR*, and so preserves it selfe from the *Enimies* battery, by which meanes one may avoyd many inconveniences which might arise: and moreover one man may more easily replace it againe for another shot by helpe of poles tyed to the wall, or other helps which may multiply the strength.



PROBLEM. CVIII.

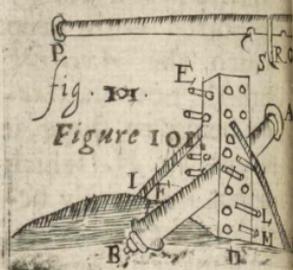
*How to make a Lever by which one man may alone place a Cannon upon his carriage, or raise what other weight he would.*

**F**irst place two thicke boards upright, as the figure sheweth, pierced with holes, alike opposite one unto another as *CD*, and *EF*: and let *L*, and *M*, be the two barrs of Iron which passeth through the holes *GH*, and *F, K*; the

R 3

two

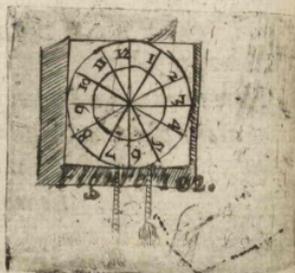
two supports, or  
 props, *A B*. the *Can-*  
*non*, *OP*, the *Lever*  
*RS*, the two notches  
 in the *Lever*, and *Q*,  
 the hooke where the  
 burthen or *Cannon* is  
 tyed to. The rest of the  
 operation is facill, that  
 the young est schollers  
 or learners cannot  
 faile to performe it :  
 to teach *Minerva* were in vaine, and it were to  
*Mathematicians* injury in the succeeding  
 Ages.



PROBLEM. CIX.

*How to make a Clocke with one onely wheele.*

**M**Ake the body  
 of an ordinary  
*Dyall*, and divide the  
 houre in the *Circle*  
 into 12. parts : make  
 a great wheele in  
 height above the *Ax-*  
*eltree*, to the which  
 you shall place the  
 cord of your coun-  
 terpoise, so that it may  
 descend, that in 12



houres of time your *Index* or *Needle* may make one revolution, which may bee knowne by a watch which you may have by you: then put a *balance* which may stop the course of the *wheele*, and give it a regular motion, and you shall see an effect as just from this as from a *Clocke* with many *wheelies*.

PROBLEM. CX.

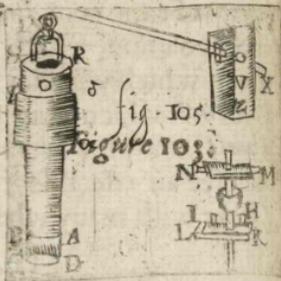
How by helpe of two *wheelies* to make a *Child* to draw up alone a *hogshead* of water at a time: and being drawne up shall cast out it selfe into another *vessell* as one would have it.

Let *R* be the *Pit* from whence water is to be drawne; *P*, the *hooke* to throw out the water when it is brought up (this *hooke* must be moveable) let *AB*, bee the *Axis* of the *wheelies* *S F*, which *wheele* hath divers *forkes* of *Iron* made at *G*, equally fastened at the *wheele*; let *I*, be a *Card*, which is drawne by *K*, to make the *wheele* *S*, to turne, which *wheele* *S*, beares proportion to the *wheele* *T*, as 8 to 2: let *N* be a *Chaine* of *Iron* to which is tyed the *vessell* *O*: and the other which is in the *Pit*: *E F* is a peece of *wood* which hath a mortise in 1, and 2, by which the *Cord* *I*, passeth, tyed at the *wall*, as *K H*, and the other peece of *Timber* of the little *wheele* as *M*, mortised in likewise for the

R 4

chains

chaine to passe through:  
 draw the Cord I, by  
 K, and the wheele will  
 turne, and so conse-  
 quently the wheele T,  
 which will cause the  
 vessell O, to raise:  
 which being empty,  
 draw the Cord againe  
 by Y, and the other  
 vessell which is in the  
 pit will come out by  
 the same reason. This is an invention which will  
 save labour if practised; but here is to be noted  
 that the pit must be large enough, to the end  
 that it containe two great vessells to passe up and  
 downe one by another.

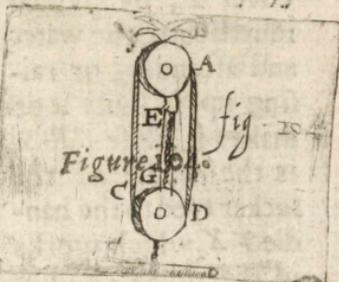


PROBLEM. CXI.

To make a Ladder of Cords which may be  
 carryed in ones pocket : by which  
 one may easly mount up a  
 Wall, or Tree alone.

**T**Ake two Pullies A, and D, unto that of A,  
 let there be fastned a Crampe of Iron as B;  
 and at D, let there be fastned a staffe of a foote &  
 a halfe long as F, then the Pully A: place a hand  
 of Iron, as E, to which tie a Cord of an halfe  
 inch thicke (which may be of silke because it is  
 for the pocket:) then strive to make fast the  
 Pully

Pully *A*, by the helpe of the *Crampe* of Iron *B*, to the place that you intend to scale; and the *Staffe* *F*, being tyed at the *Pully* *D*, put it betweene your *legges* as though you would sit upon it: then houlding the *Cord* *C*, in your hand, you may guide your selfe to the place required: which may be made more facill by the multiplying of *Pullies*. This secret is most excellent in *Warre*, and for lovers, its supportableness avoyds suspension.

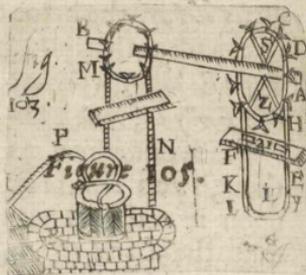


PROBLEM. CXII.

How to make a Pumpe whose strength is marvellous by reason of the great weight of water that it is able to bring up at once, and so by continuance.

Let  $ab\gamma\delta$ , be the height of the *Case* about two or three foote high, and broader according to discretion: the rest of the *Case* or concavity let be *O*: let the sucker of the *Pumpe* which is made, be just for the *Case* or *Pumpes* head  $ab\gamma\delta$ , & may be made of wood or *brasse* of 4. inches thick, having a hole at *E*, which descending

ascending raiseth up the cover *P*, by which issueth forth the water and ascending or raising up it shuts it or makes it close: *RS*, is the handle of the sucker tyed to the handle *TX*, which works in the post *VZ*. Let *A, B, C, D*, be a peece of *Brasse*, *G* the peece which enters into the hole to *F*, to keepe out the *Ayre*. *H, I, K, L*, the peece tyed at the funnell or pipe: in which playes the *Iron rod* or *axis G*, so that it passe through the other peece *MN*, which is tyed with the end of the pipe of *Brasse*.



Note, that the lower end of the *Cisterne* ought to be rested upon a *Grediron* or *Iron Grate*, which may be tyed in the pit; by which meane lifting up and putting downe the handle, you may draw ten times more *water* than otherwise you could.

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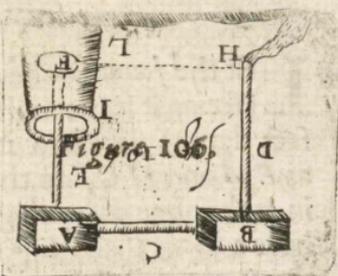
PROBLEM. CXIII.

How by meanes of a *Cisterne*, to make *water* of a *Pit* continually to ascend without strength, or the assistance of any other *Pumpe*.

Let *IL*, be the *Pit* where one would cause *water* to ascend continually to each office of

of a house or the places which are separated from it: let there be made a receiver as *A*, well closed up with lead or other matter that ayre enter not in, to which fasten a pipe of lead as at *E*, which may have vent at pleasure: then let there bee made a Cisterne as *B*, which may bee communicative to *A*,

by helpe of the pipe *G*, from which Cisterne *B*, may issue the water of pipe *D*, which may descend to *H*, which is a little below the levell of the water of the pit as much as is *GH*: to the end of which shall be souldred close a Cocke



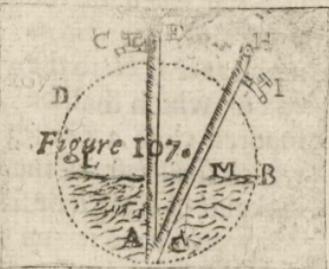
which shall cast out the water by *KH*. Now to make use of it, let *B* be filled ful of water, & whe you would have it run turne the Cocke, for then the water in *B*, will descend by *K*: and for feare that there should be vacuity, nature which abhors it, will labour to furnish and supply that emptinesse out of the spring *F*, and that the Pit dry not, the Pipe ought to bee small of an indifferent capacitie according to the greatnesse or smalnesse of the spring.

PROB.

## PROBLEM. CXIII.

How out of a fountaine to cast the wa-  
ter very high: different from  
a Probleme formerly  
delivered.

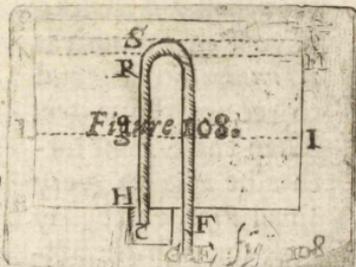
**L** Et the fountaine be  $B D$ , of a round forme  
(seeing it is the most capable and most per-  
fect figure) place into it two pipes conjoynd  
as  $E A$ , and  $H C$ , so that no Ayre may enter  
in at the place of joyning: let each of the Pipes  
have a Cocke  $G$ , and  $L$ :  
the Cocke at  $G$ , being  
closed, open that at  $I$ ,  
and so with a squirt  
force the water  
through the hole at  
 $H$ , then close the  
Cocke at  $A$ , and draw  
out the squirt, and o-  
pen the Cocke at  $G$ :  
the Aire being be-  
fore rarified will ex-  
tend his dimensions  
and force the water with such violence, that it  
will amount above the height of one or two  
Pikes: and so much the more by how much  
the Machine is great: this violence will last  
but a little while if the Pipe have too great an  
opening, for as the Ayre approacheth to his na-  
turall place, so the force will diminish.



PROBLEME CXV.

How to empty the water of a Cisterne by a Pipe, which shall have a motion of it selfe.

Let  $AB$ , be the vessell;  $CDE$ , the Pipe:  $HG$ , a little vessell under the greater, in which one end of the Pipe is, viz.  $C$ , and let the other end of the Pipe  $E$ , passe through the bottome of the vessell at  $F$ , then as the vessell filleth so will the Pipe, & when the vessell shall be full as farre as  $PO$ , the Pipe will begin to runne at  $E$ , of his owne accord, and never cease untill the vessell bee wholly empty.



PROBLEM. CXVI.

How to squirt or spout out a great height, so that one pot of water shall last a long time.

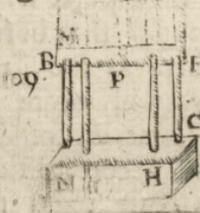
Let there be prepared two vessells of Brasse, Lead, or of other matter of equall substance, as are the two vessells  $AB$ , and  $BD$ , & let them be joyned together by the two Pillars  $MN$ , and  $EF$ : then let there be a pipe  $HG$ . which may passe through the cover of the vessell  $CD$ , and passe through  $AB$ , into  $G$ , making a little bunch or rising in the cover of the vessell  $AB$ , so that the pipe touch it not at the bottome: then

then let there be sodered fast another *Pipe I L*, which may be separated from the bottome of the *vessell*, and may have his bunchie swelling as the former without touching the bottome: as is represented in *L*, and passing through the bottome of *AB*, may be continued unto *I*, that is to say, to make an opening to the cover of the *vessell AB*, & let it have a little mouth as a *Trumpet*: to that end to receive the *water*.

Then there must further be added a very small *Pipe* which may passe through the bottome of the *vessell AB*, as let it be *OP*, and

let there be a bunch, or swelling over it as at *P*, so that it touch not also the bottome: let there be further made to this lesser *vessell* an edge in forme of a *Basen* to receive the *water*, which being done powre *water* into the *Pipe I L*, untill the *vessell CD*, be full: then turne the whole *machine* upside downe that the *vessell CD*, may be uppermost, and *AB*, undermost: so by helpe of the *Pipe GH*, the *water* of the *vessell CD*, will runne into the *vessell AB*, to have passage by the *Pipe PO*. This motion is pleasant at a feast in filling the said *vessell* with wine, which will spout it out as though it were from a *boyling fountaine*, in the forme of a thred very pleasant to behold.

Figure 109.



## PROBLEM. CXVII.

*How to practise excellently the reanimation of simples; in case the plants may not be transported to be replanted by reason of distance of places.*

**T**AKE what simple you please, burne it and take the ashes of it, and let it bee calcinated two *houres* betweene two *Creusets* well luted, and extract the salt: that is, to put *water* into it in moving of it; then let it settle, and doe it two or three times, afterwards evaporate it, that is, let the *water* be boyled in some *vessel*, untill it bee all consumed: then there will remaine a salt at the bottome, which you shall afterwards sowe in good *Ground* well prepared: such as the Theater of husbandry sheweth, and you shall have your desire.

## PROBLEM. CXVIII.

*How to make an infalliable perpetuall motion.*

**M**IXE 5. or 6. ounces of  $\gamma$  with his equall weight of  $\psi$ , grinde it together with 10. or 12. ounces of sublimate dissolved in a celler upon a *Marble* the space of 4. dayes, and it will become like *Oyle Olive*, which destill with fire of chaffe or driving fire, and it will sublime

sublime dry substance, then put water upon the earth (in forme of Lye) which will be at the bottome of the Limbecke, and dissolve that which you can; filter it, then distill it, and there will bee produced very subtrill Antomes, which put into a bottle close stopped, and keepe it dry, and you shall have your desire, with astonishment to all the world, and especially to these which have travelled herein without fruit.

---

PROBLEM. CXIX.

*Of the admirable invention of making the Philosophers Tree, which one may see with his eye to grow by little and little.*

**T**AKE two ounces of *Aqua fortis* and dissolve in it halfe an ounce of fine *silver* refined in a *Cappell*: then take an ounce of *Aqua fortis* and two drams of *Quicke silver*: which put in it, and mixe these two dissolved things together; then cast it into a *Viole* of halfe a pound of *water*, which may be well stopped; for then every day you may see it grow both in the *Tree* and in the *branch*. This liquid serves to blacke haire which is *red*, or *white*, without fading untill they fall: but here is to be noted that great care ought to bee had in annointing the haire, for feare of touching the *flesh*: for this composition is very *Corrosive* or searching, that as soone as it toucheth the *flesh* it raiseth blisters, and bladders very painefull.

PROB-

## PROBLEM. CXX.

How to make the representation of the  
great world.

**D**raw salt niter out of salt Earth which is found along the Rivers side, and at the foote of Mountaines, where especially are Minerals of Gould and silver: mixe that Niter well clesed with  $\mathcal{U}$ , then calcinate it hermetically; then put it in a Limbecke and let the receiver be of Glasse, well luted, and alwayes in which let there be placed leaves of Gould at the bottome, then put fire under the Limbecke untill vapours arise which will cleve unto the Gould; augment your fire untill there ascend no more, then take away your receiver and close it hermetically, & make a Lampe fire under it untill you may see presented in it that which nature affords us: as Flowers, Trees, Fruits, Fountaines, Sunne, Moone, Starres, &c. Behould here the forme of the Limbecke, and the receiver: *A* represents the Limbecke, *B* stands for the receiver.



S

PROB-

## PROBLEM CXXI.

*How to make a Cone, or a Pyramidall body move upon a Table without springs or other Artificiall meanes: so that it shall move by the edge of the Table without falling.*

**T**HIS proposition is not so thornie and subtle as it seemes to be, for putting under a Cone of paper a Beetle or such like creature, you shall have pleasure with astonishment & admiration to these which are ignorant in the cause: for this animal will strive alwayes to free herselfe from the captivity in which shee is in by the imprisonment of the Cone: for comming neere the edge of the Table shee will returne to the other side for feare of falling.



## PROBLEM. CXXII.

*To cleave an Anvill with the blow of a Pistoll.*

**T**HIS is proper to a warrior, and to performe it, let the Anvill be heated red hot as one can

can possible, in such sort that all the solidity of the body bee softened by the fire: then charge the Pistoll with a bullet of silver, and so have you infallibly the experiment.

PROBLEM. CXXIII.

*How to roast a Capon carried in a Budget at a Saddle bow, in the space of riding 5. or 6. miles.*

**H**AVING made it ready and larded it, stufte it with Butter; then heate a peece of Steele which may be formed round according to the length of the Capon, and big enough to fill the Belly of it, and then stop it with Butter; then wrap it up well and inclose it in a Box in the Budget, and you shall have your desire: it is said that Count Mansfield served himselfe with no others, but such as were made ready in this kind, for that it loseth none of its substance, and it is dressed very equally.

PROBLEM. CX XIII.

*How to make a Candle burne and continue three times as long as otherwise it would.*

**V**Nto the end of a Candle halfe burned sticke a farthing lesse or more, to make it hang  
S a
per-

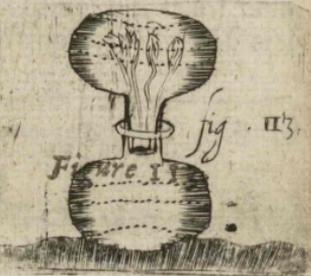
perpendicular in a vessell of water, so that it swimme above the water; then light it, and it will sustaine it selfe & floate in this manner; and being placed into a fountain, pond, or lake that runs slowly, where many people assemble, it will cause an extreame feare to these which come therein in the night, knowing not what it is.



PROBLEM. CXXV.

How out of a quantitie of wine to extract that which is most windy, and evill, that it hurt not a sicke Person.

TAke two viols in such sort that they bee of like greatnesse both in the belly and the necke; fill one of them of wine, and the other of water: let the mouth of that which hath the water be placed into the mouth of that which hath the wine, so the water shall



be uppermost: now because the *water* is heavier than the *wine*, it will descend into the other *violl*, and the wine which is highest will ascend above to supply the place of the *water*, and so there will be a mutuall interchange of liquids: and by this penetration the wine will lose her vapors.

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PROBLEM. CXXVI.

*How to make two Marmouzets one of which shall light a Candle, and the other put it out.*

**V**On the side of a wall make the figure of a *Marmouzet* or other animall or forme, and right against it on the other wall make another; in the mouth of each put a pipe or quill so *Artificially* that it be not perceived: in one of which place *salt peeter* very fine, and dry and puluerised: and at the end set a little match of *Paper*: in the other place *sulphur* beaten small: then houlding a *Candle* lighted in your hand, say to one of these *Images* by way of commaund, blow out the *Candle*: then lighting the *Paper* with the *Candle*, the *salt peeter* will blow out the *Candle* immediatly: and going to the other *Image* (before the match of the *Candle* be out) touch the sulphur with it and say, light the *Candle*, and it will immediatly be lighted, which will cause an admiration to these which see the action: if it be done with a secret dexterity.

## PROBLEM. CXXVII.

*How to keepe wine fresh as if it were in a celler  
though it were in the heate of Summer, and  
without Ice or snow, yea though it were  
carried at a saddles bow, and  
exposed to the Sunne  
all the day.*

**S**Et your wine in a violl of Glasse; and place  
it in a Box made of wood, leather, or such  
like: about which violl place salt peeter, and  
it will preserve it and keepe it very fresh: this  
experiment is not a little commodious for  
these which are not neare fresh waters, and  
whose dwellings are much exposed to the  
Sunne.

## PROBLEM. CXXVIII.

*To make a Cement which indureth or lasteth  
as marble, which resisteth ayre and wa-  
ter without ever disjoyning  
or unceasing*

**T**Ake a quantitie of strong and gluing Mor-  
ter well beaten, mixe with this as much new  
leaked Lime, and upon it cast Oyle of Olive, or  
Linscede Oyle, and it will become hard as Mar-  
ble being applyed in time.

PROB.

## PROBLEM. CXXIX.

*How to melt mettles very quicke, yea in a  
shell upon little fire.*

**M**ake a bed upon a bed of mettles with powder of Sulphur, of Salt peeter, and sandust alike; then put fire to the sayd powder with a burning Charcole, and you shall see that the mettles will dissolve incontinent and bee in a Masse. This secret is most excellent and hath beene practised by the reverend father *Mercenne* of the order of the *Mimms*.

## PROBLEM. CXXX.

*How to make Iron or Steele exceeding hard.*

**Q**uench your *Blade* or other *Instrument* seven times in the blood of a *male Hog*, mixt with *Goose grease*, and at each time dry it at the *fire* before you wet it: and it will become exceeding hard, and not brittle, which is not ordinary according to other temperings and quenchings of *Iron*: an experiment of small cost, often proved, and of great consequence for *Armore* in warlike negotiations.

## PROBLEM. CXXXI.

To preserve fire as long as you will, imitating  
the inextinguable fire of Vestales.

**A**fter that you have extracted the burning  
spirit of the salt of  $\Psi$ , by the degrees of  
fire, as is required according to the Art of  
*Chimistrie*, the fire being kindled of it selfe,  
breake the *Limbecke*, and the *Irons* which are  
found at the bottome will flame and appeare as  
burning *Coles* as soone as they feele the ayre;  
w<sup>ch</sup> if you promptly inclose in a violl of *Glasse*,  
and that you stop it exactly with some good  
*lute*: or to be more assured it may be closed up  
with *Hermes wax* for feare that the Ayre get  
not in. Then will it keepe more than a thousand  
*yeares* (as a man may say) yea at the bottome of  
the *Sea*; and opening it at the end of the time,  
as soone as it feeles the Ayre it takes fire with  
which you may light a *Match*. This secret me-  
rits to be travailed offer and put in practise,  
for that it is not common, and full of astonish-  
ment, seeing that all kind of fire lasteth but as  
long as his *matter* lasteth, and that there is no  
*matter* to be found that will so long indure.

FINIS.



## Artificial fire-Workes :

Or the manner of making of *Rockets* and *Balls* of fire, as well for the *Water*, as for the *Ayre*; with the composition of *Stars*, *Golden-raine*, *Serpents*, *Lances*, *Wheeles* of fire, and such like, pleasant and *Recreative*.

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### *Of the composition for Rockets.*



**I**N the making of *Rockets*, the cheefest thing to be regarded is the composition that they ought to be filled with, for as much as that which is proper to *Rockets* which are of a lesse sort is very improper to those which are of a more greater forme; for the fire being lighted in a great concave, which is filled with a quick composition, burnes with great violence; contrarily, a weake composition being placed into a small concave, makes no effect: therefore we shall here deliver in the first place rules and directions, which may serve for the true composition, or matter with which you may charge any *Rocket*, from *Rockets* which are charged but with one ounce of

T

Pow-

Powder unto great *Rockets* which requireth for their charge 10. pound of *Powder*, as followeth

*For Rockets of one ounce.*

Vnto each pound of good musket *Powder* small beaten, put two ounces of small *Cole dust*, and with this composition charge the *Rocket*.

*For Rockets of 2, or 3. ounces.*

Vnto every foure ounces and a halfe of powder dust, adde an ounce of *Salt-peeter*, or to every 4. ounces of powder dust, adde an ounce of *Coledust*.

*For Rockets of 4. ounces.*

Vnto every pound of *Powder dust* adde 4. ounces of *Salt peeter* & one ounce of *Coledust*: but to have it more slow, unto every 10. ounces of good dust powder adde 3. ounces of *Salt-peeter*, and 3. ounces of *Coledust*.

*For Rockets of 5. or 6. ounces.*

Vnto every pound of *Powder dust*, adde 3. ounces and a halfe of *Salt peeter*, and 2. ounces and a halfe of *Cole dust*, as also an ounce of *Sulpher* and an ounce of *fyle dust*.

*For Rockets of 7, or 8. ounces.*

Vnto every pound of *Powder dust* adde 4. ounces of *Salt peeter* and 3. ounces of *Sulpher*.

*Of Rockets of 10, or 12, ounces.*

Vnto the precedent composition adde halfe an ounce of *Sulpher*, and it will be sufficient.

*For Rockets of 14, or 15, ounces.*

Vnto every pound of *Powder dust* adde 4. ounces of *Salt peeter*, of *Cole dust*  $2\frac{1}{2}$  ounces. of *Sulpher*

Sulphur and filedust of each  $1\frac{1}{4}$  ounces.

For Rockets of 1, pound.

Vnto every pound of Powder dust adde 3 ounces of Cole dust, and one ounce of Sulphur.

Of Rockets of 2, pound.

Vnto every pound of Powder dust adde  $9\frac{1}{2}$  ounces of Salt peeter, of Cole dust  $2\frac{1}{2}$  ounces, filedust  $1\frac{1}{2}$  ounces, and of Sulphur  $\frac{1}{4}$  of ounces.

For Rockets of 3, pound.

Vnto every pound of Salt peeter adde 6 ounces of Cole dust, and of Sulphur 4, ounces.

For Rockets of 4, 5, 6, or 7, pound.

Vnto every pound of Salt peeter add 5. ounces of Cole dust and  $2\frac{1}{2}$  ounces of Sulphur.

For Rockets of 8, 9, or 10, pound.

Vnto every pound of Salt peeter, adde  $5\frac{1}{2}$  ounces of Cole dust, and of Sulphur  $2\frac{1}{2}$  ounces.

Here note that in all great Rockets, there is no Powder put, because of the greatnesse of the fire which is lighted at once, which causeth too great a violence, therefore ought to bee filled with a more weaker composition.

Of the making of Rockets and other Fireworkes.

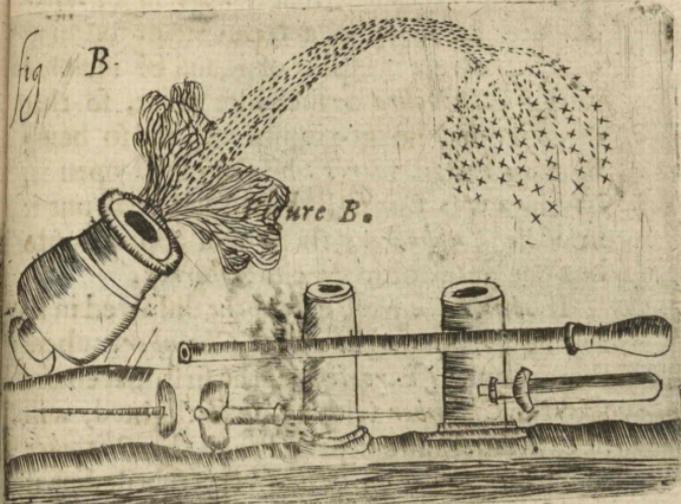
FOR the making of Rockets of sundry kinds, divers molds are to be made, with their Rowling pins, Breathes, Chargers, &c. as may be seene here in the figure. And having rowled a Case of paper upon the Rowling pin for your mould, fill it with the composition belonging to that mould as before is delivered:

now may you loade it on the top, with *Serpents, Reports, Stars, or Golden Raine*; the *Serpents* are made about the bignesse of ones little finger, by rowling a little paper upon a small sticke, and then tying one end of it and filling it with the mixt composition somewhat close, and then tying the other end. The reports are made in their paper *Cases* as the *Serpents*, but the Paper somewhat thicker to give the greater report. These are filled with



*graine Powder* or halfe *Powder* and halfe composition, and tying both ends close, they are finished. The best kind of *starres* are made with this mixture following; unto every 4. ounces of *Salt peeter*, adde 2. ounces of *Sulphur*

phur, and to it put 1. ounce of Powder dust,  
and of this composition make your *starres*, by  
putting a little of it within a small quantity of



towe; and then tying it up in the forme of a ball  
as great as an *Hafell Nut* or a little *Wallenut*,  
through which there must be drawne a little  
*Primer* to make it take fire. Touching the ma-  
king of the *Golden Raine* that is nothing but  
filling of *Quilles* with the composition of your  
*Rockets* somewhat hard: Now if the head of  
a *Rocket* be loaded with a thousand of those  
*Quilles* its a goodly sight to see how pleasant-  
ly they spread themselves in the *Ayre* and  
come downe like streames of *Gold* much like  
the falling downe of *Snow* being agitated by  
some turbulent winde.

## Of recreative fires.

1 **P**hilostrates saith, that if wine is a Platter  
bee placed upon a receiver of burning  
Coles, to exhale the spirit of it, and be inclosed  
within a Cupboard or such like place, so that  
the Ayre may not goe in, nor out, and so being  
shut up for 30. yeares: he that shall open it,  
having a wax Candle lighted, and shall put it  
into the Cupboard; there will appeare unto  
him the figure of many cleare starres.

2 If *Aquavita* have *Camphere* dissolved in it;  
and be evaporated in a close Chamber, where  
there is but a *Charcole* fire, the first that enters  
into the Chamber with a Candle lighted, will  
be extremely astonished, for all the Chamber  
will seeme to be full of fire very subtile, but it  
will be of little continuance.

3 Candles which are deceitfull are made of  
halfe Powder, covered over with Tallow; and  
the other halfe is made of cleane Tallow, or  
Waxe, with an ordinary weeke; this Candle  
being lighted and the upper halfe consumed,  
the Powder will take fire, not without great  
noyse and astonishment to those which are ig-  
norant of the cause.

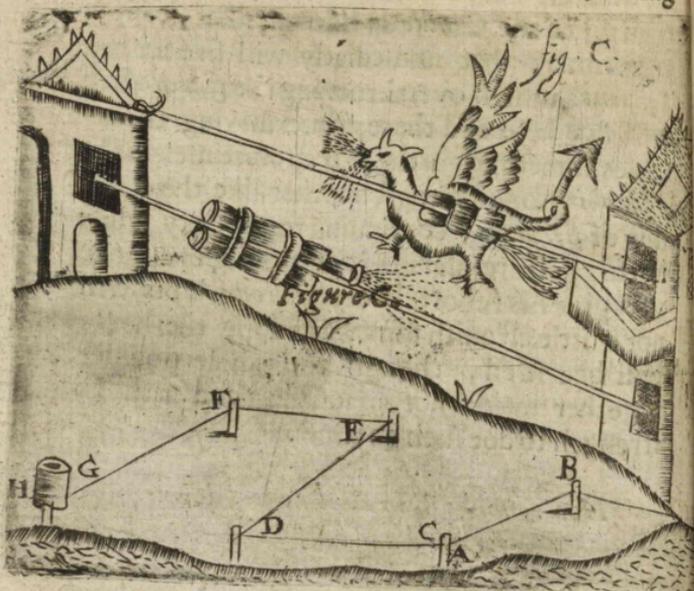
4 A dozen or twenty small *Serpents* placed se-  
cretly under a *Candlesticke* that is indifferent  
big, which may have a hole passe through the  
socket of it to the Candle, through which a  
peece of primer may be placed, and setting a  
small Candle in the socket to burne according  
to

to a time limited : which *Candlestick* may bee set on a side Table without suspicion to any; then when the *Candle* is burned, that it fires the primer, that immediatly will fire all the *Serpents*, which overthrowing the *Candlestick* will flye here and there, intermixing themselves, sometimes in the *Ayre*, sometimes in the *Planching*, one amongst another, like the crawling of *Serpents*, continuing for a pretty while in this posture, and in extinguishing every one will give his report like a *Pistoll*; This will not a little astonish some, thinking the house will bee fired, though the whole powder together makes not an ounce, and hath no strength to doe such an effect. ||

*How to make fire runne up and downe,  
forward and backward.*

**T**AKE small *Rockets*, and place the tayle of one to the head of the other, upon a *Cord* according to your fancie, as admit the *Cord* to be *A B C D E F G*. give fire to the *Rocket* at *A*, which will fly to *B*, which will come backe againe to *A*, and fire another at *C*, that will fly at *D*, which will fire another there, and fly to *E*, and that to *F*: and so from *F*, to *G*; and at *G*, may be placed a pot of fire, viz. *G H*: which fired will make good sport, because the *Serpents* which are in it will variously intermix themselves in the *Ayre*, and upon the ground, and every one will extinguish with a report : and here may you note that upon the

Rockets may be placed fierie Dragons Combats, or such like to meete one another, having

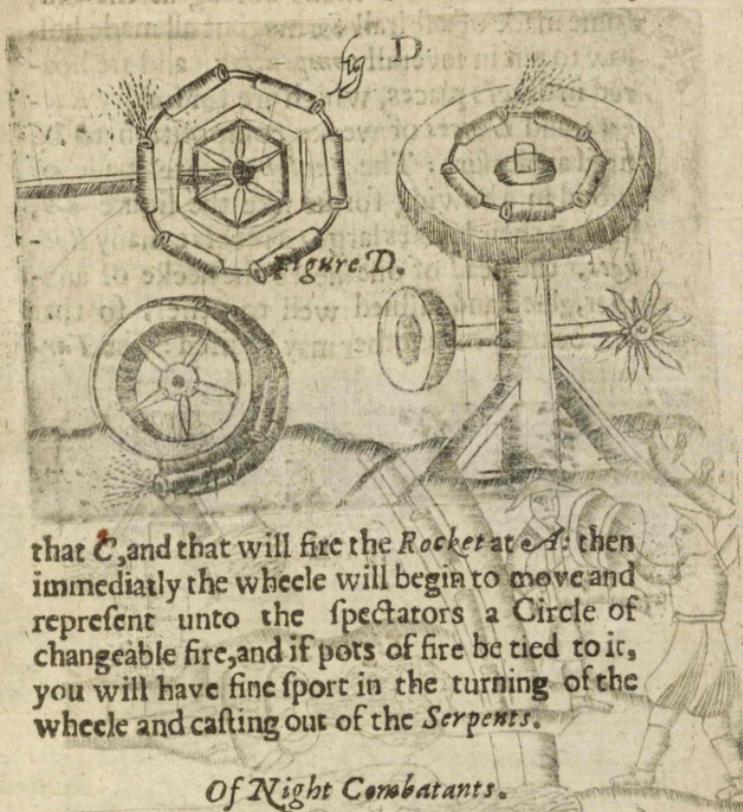


lights placed in the Concavity of their bodies, which will give great grace to the action.

*How to make Wheeles of fire.*

**T**AKE a Hoop, and place two laths a-crosse one the other; upon the crossing of which make a hole, so that it may be placed upon a pin to turne easily, as the figure 2. sheweth: upon the sides of which hoop or round Circle place your Rockets, to which you may place Lances of fire betweene each  
 Rocket

Rocket: et this wheele be placed upon a standard as here is represented, and place a peece of *Primer* from one *Lance* to another, then give fire at *G*, which will fire *F*, that *E*, that will fire *D*,



that *E*, and that will fire the *Rocket* at *A*: then immediately the wheele will begin to move and represent unto the spectators a Circle of changeable fire, and if pots of fire be tied to it, you will have fine sport in the turning of the wheele and casting out of the *Serpents*.

#### Of Night Combatants.

**C**lubbes, *Targuers*, *Faulchons*, and *Mases* charged with severall fires, doe make your nights *Combatants*, or are used to make place amongst a throng of people. The *Clubbes* at the ends are made like a round *Panier* with small

Small sticks, filled with little *Rockets* in a spirall forme, glued and so placed that they fire but one after another; the *Masses* are of divers fashions, some made oblong at the end, some made of a spirall forme, but all made hollow to put in severall *composition*, and are boared in divers places, which are for sundry *Rockets*, and *Lances* of weake composition to be fired at pleasure: The *Faulchons* are made of wood in a bowing forme like the figure *A*, having their backs large to receive many *Rockets*, the head of one neare the necke of another, glued and fastned well together, so that one being spent another may be fired: The *Tar-*

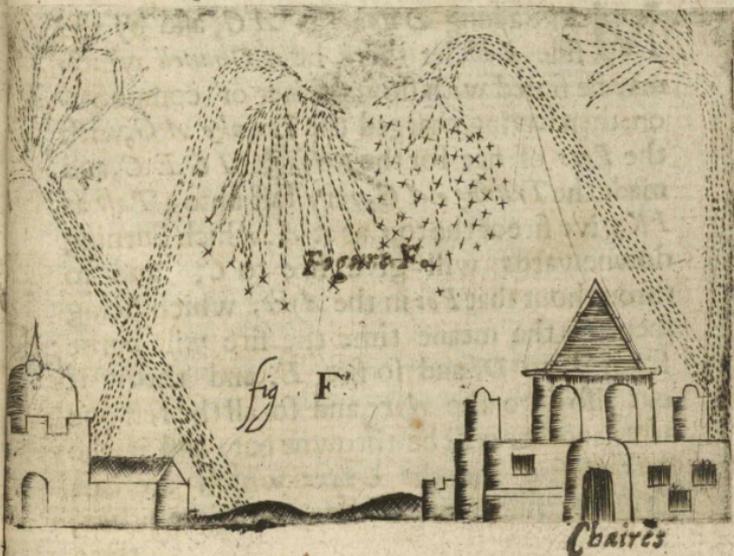


*gets* are made of wooden thinne boards, which are chaneled in spirall lines to containe primer

to fire the *Rockets* one after another, which is all covered with thinne covering of wood, or *Pastboard*, boarded with holes spirally also; which *Rockets* must be glued and made fast to the place of the *Chanells*: Now if two men the one having a *Targuet* in his hand, and the other a *Falchon*, or *Masse* of fire shall begin to fight, it will appeare very pleasant to the *Spectators*: for by the motion of fighting, the place will seeme to be full of streames of fire: and there may be adjoynd to each *Targuet* a *Sunne* or a burning *Comet* with *Lances* of fire, which will make them more beautifull and resplendent in that action.

Of *banding* Fires.

Such as are used for recreation, are *Colossus*, *Statues*, *Arches*, *Pyramedies*, *Charyots*,

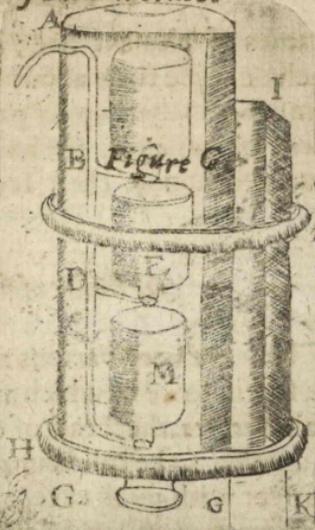


*Chaires of triumph & such like, which may be accommodated with Rockets of fire, & beautified with sundry other artificiall fires, as pots of fire for the Ayre w<sup>ch</sup> may cast forth severall figures, Scutchions, Rockets of divers sorts, Starres, Crownes, Leaters, and such like; the borders of which may be armed with sundry Lances of fire, of small flying Rockets with reports, flames, of small birds of Cypres, Lanternes of fire, Candles of divers uses, and colours in burning: and whatsoevr the fancie of an ingenious head may allude unto.*

*Of Pots of fire for the Ayre, which are throwne out of one Case one after another of a long continuance.*

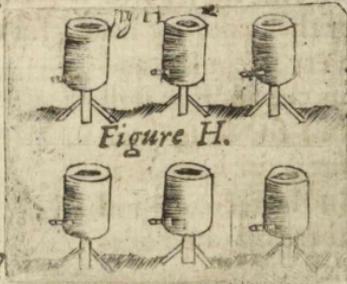
**M**ake a long Trunke as *AG*, and by the side *AH*, let there be a Chanell which may be fiered with slow primer or composition; then having charged the Trunke *AG*, with the Pots of fire for the Ayre; at *IGEC*, and made the Trunke *AG*, very fast unto a Post as *IK*, give fire at the top as at *A*, which burning downewards will give fire to *C*, and so throughout that Pot in the Ayre, which being spcut, in the meane time the fire will burne from *B*, to *D*, and so fire *E*, and throw it out also into the Ayre, and so all the rest one after another will be throwne out: and if the Pots of fire for the Ayre which are cast out, bee filled with diverse Fireworkes, they

they will bee so much the more pleasant to the beholders. These *Trunkes* of fire doe greatly adorne a Fireworke, and may conveniently bee placed at each angle of the whole worke.



Of Pots of fire for the ground.

**M**Any *Pots* of fire being fired together doe give a fine representation, and recreation to the spectators, & cause a wonderfull shout amongst the common people which are standers by; for those *Pots* being filled with *Balles* of fire and flying *Serpents* for the *Ayre*,



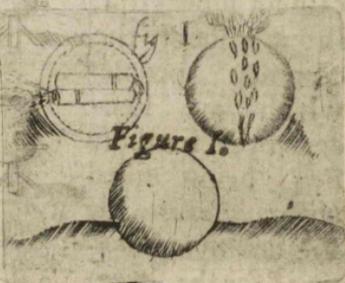
they will so intermix one within another, in flying here and there a little above the ground, and giving such a volley of reports that the *Ayre* will rebound with their noise, and the whole place bee filled with sundry streames

streams of pleasant fire; which serpents will much occupie these about the place to defend themselves in their upper parts, when they will not lesse be busied by the bailes of fire, which seemes to annoy their feete.

Of Balles of fire.

These are very various according to a mans fancie some of which are made with very small *Rockets*, the head of one tyed to the neck of another: the ball being made may be covered over with pitch except the hole to give fire to it; this *Ball* will make fine sport amongst the standers by, which will take all a fire, and rowle sometimes this way, sometimes that way, betweene the legs of those that are standers by, if they take not heede, for the motion will be very irregular, and in the motion will cast forth severall fires with reports.

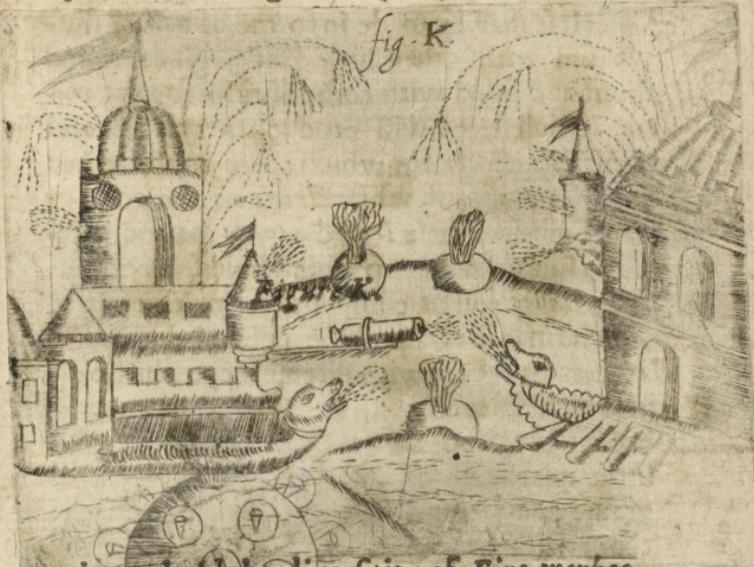
In the second kind there may be a channell of *Iron* placed in divers places in spirall manner, against which may be placed as many small peards of paper as possible may be, the Channell must be full of slow composition and may be covered as the former, and made fit with his *Rockets* in the middle: this *Ball* may bee shot out



out of a mortar *Pece* or charged on the top of a *Rocket* : for in its motion it will fly here and there, and give many reports in the Ayre : because of the discharge of the petards.

*Of fire upon the Water.*

**P**Laces which are situated upon *Rivers* or great *Ponds*, are proper to make *Recreative fires* on : and if it be required to make some of consequence, such may conveniently be made upon two *Boats*, upon which may be built two *Beasts*, *Turrets*, *Pageants*, *Castles*, or such like, to



receive or hold the diversity of *Fire workes* that may be made within it, in which may play divers *fires*, *Petards*, &c. and cast out many simple *Grenades*, *Balls* of fire to burne in the

*water*

*water serpents* and other things, and often times these boates in their incounters may hang one in another, that so the *Combatants* with the *Targuets*, and *Masses* may fight; which will give great content to the eyes of those which are lookers on, and in the conclusion fire one another, (for which end they were made:) by which the dexterity of the one may be knowne in respect of the other, and the triumph and victory of the fight gotten.

*Of Bales of fire which moves upon the water.*

These may be made in forme of a *Ball* stuffed with other little *Balls*, glued round about and filled with composition for the *water*, which fiered will produce merveilous and admirable effects, for which there must be had little *Cannons* of white *Iron*, as the ends of small funnels; these *Iron Cannons* may be peirced in sundry places, to which holes, may be set small *Balles* full of composition for the *water*, which small *Balls* must be peirced deepe and large, and covered with *Pitch*, except the hole: in which hole must bee first placed a little quantitie of *graine Powder*; and the rest of the hole filled up with composition; and note further that these *Iron Cannons*, must



be filled with a slow composition; but such which is proper to burne in the *water*: then must these *Cannons* with their small *Balls* be put so together that it may make a *Globe*, and the holes in the *Cannons* be answerable to the hollow *Balls*, and all covered over with *Pitch* and *Tallow*; afterwards pierce this *Ball* against the greatest *Cannon* (to which all the lesser should answer) unto the composition, then fire it, and when it begins to blow, throw it into the *water*, so the fire comming to the holes will fire the graine *Powder*, the which will cause the *Balls* to separate and fly here and there, sometimes two at a time, sometimes three, sometimes more, which will burne within the *water* with great astonishment and content to those which see it.

## Of Lances of fire.

**S**tanding *Lances of fire*, are made commonly with hollow wood, to containe sundry *Petards*, or *Rockets*, as the figure here sheweth, by which is easie to invent others according to ones fancy. These *Lances* have wooden handles, that so they may be fastned at some *Post*, so that they be not overthrowne in the flying out of the *Rockets* or *Petards*: there are lesser sorts of *Lances* whose cases are of three or foure fouldings of *Paper* of a foote long, and about the bignesse of ones finger, which are filled with a composition for *Lances*. But if these *Lances* be filled with a composition,

on, then (unto every 4. ounces of powder adde  
2. ounces of Salt Peeter, and unto that adde 1.  
ounce of Sulphur)

it will make a brick  
fire red before it be  
halfe spent, if the  
Lance be fiered and  
held to it: and if  
20. such Lances  
were placed about  
a great Rocket and  
shot to a house or ship, it would produce a  
mischievous effect.



*How to shoote a Rocket Horizontall, or  
otherwise.*

VNto the end of the Rocket place an Arrow  
which may not be too heavy, but in stead  
of the feathers let that bee of thinne white  
tinne plate, and  
place it upon a rest,  
as here you may see  
by the Figure, then  
give fire unto it,  
and you may see  
how serviceable it  
may bee. To the  
head of such Roc-  
kets may be placed Petards, Balls of fire, Gre-  
nardes, &c. and so may be applied to warlike  
affaires.

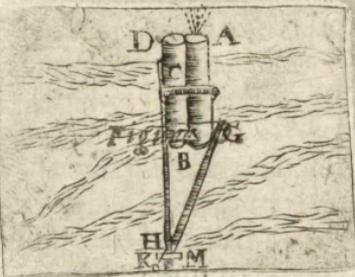


*How*

*How a Rocket burning in the water for a certain time, at last shall fly up in the Ayre with an exceeding quicknesse.*

**T**O doe this take two *Rockets* the one equall to the other, and joyne them one unto another in the middle at *C.* in such sort that the fire may easily passe from one to another: it being thus done, tye the two *Rockets* at a sticke in *D,* and let it be so long and great that it may make the *Rockets* in the *water* hang, or lye upright; then take a packe thread and tye it at *G.* and let it come double about the sticke *D M.*

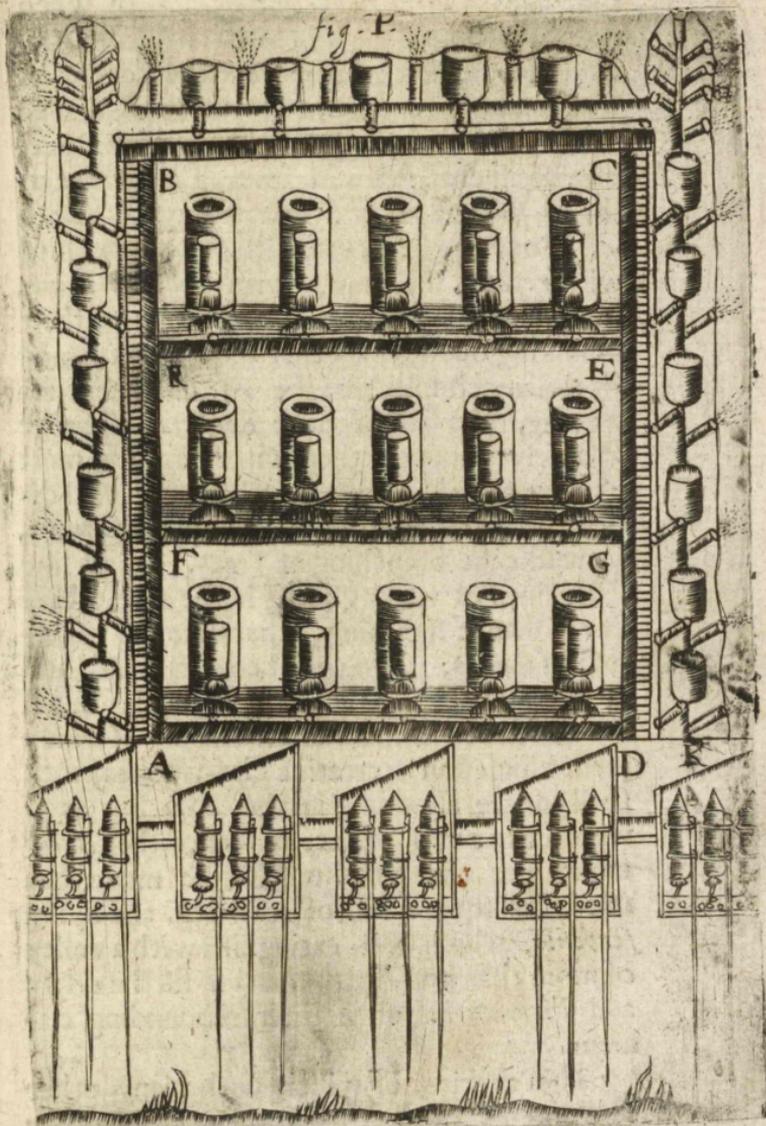
at *H.* and at that point hang a *Bullet* of some weight as *K.* for then giving fire at *A.* it will burne to *B.* by a small serpent filled there and tyed at the end, and covered



so that the *water* injure it not, which will fire the *Rocket B D,* and so mounting quicke out of the *water* by the loose tying at *C.* and the *Bullet* at the packe thread, will leave the other *Rocket* in the *water:* and so ascend like a *Rocket* in the *Ayre,* to the admiration of such as know not the secrecie.

Of the framing of the parts of a Fire-Worke  
together that the severall workes  
may fire one after another.

**C**Ause a frame to be made as *ABCD*. of  
two foot square every way, or thereabouts  
(according to the quantity of your severall  
workes) then may you at each angle have a  
great *Lance* of fire to stand, which may cast  
out *Pots* of fire as they consume: upon the  
ledges, *AB*. *BC*. and *CD*. may bee placed  
small *Lances* of fire about the number of 30. or  
60. some sidewise, & others upright, betweene  
these *Lances* may be placed *Pots* of fire sloping  
outwards, but made very fast, and covered ve-  
ry close, that they chance not to fire before they  
shou'd; then upon the ledges *RE*. *FG*. *HI*.  
and *AD*. may be placed your *foucifons*, and be-  
hind al the work may be set your *Boxes of Roc-*  
*kets*, in each of which you may place 6, 9, 12. or  
20. small *Rockets*: Now give fire at *A*. (by  
helpe of a peece of primer going from one  
*Lance* to another) all the *Lances* will instantly  
at once be lighted, and as soone as the *Lance*  
at *A* is consumed, it will fire the Channell  
which is made in the ledge of the frame which  
runnes under the *Pots* of fire, and as the fire  
goes along burning, the *Pots* will be cast forth,  
and so the ranke of *Pots* upon the sides of the  
frame *AB*. *BC*. and *CD*. being spent, the  
*foucifons* will begin to play being fiered also  
by a Channell which runnes under them, upon  
the



the ledges *AD, HI, FG,* and *RE*. then when the *Souciſons* are ſpent, upon the laſt ledge *RE*. there may be a ſecret *Channell* in the ledge *CD*, which may fire the *Box* of *Rockets* at *K.* & may fire all the reſt one after another, which *Boxes* may be all charged with ſeverall *Fre-Workes*: for the *Rockets* of the firſt *Box* may be loaden with *ſerpents*, the ſecond with *ſtarres*, the third with *reports*, the fourth with *Goulden raine*, and the fiſt with ſmall flying *Serpents*; theſe mounting one after another and flying too and fro will much inlighten the *Ayre* in their aſcending, but when theſe *Rockets* diſcharge themſelves above, then will there be a moſt pleaſant representation, for theſe fires will dilate themſelves in divers beautifull formes, ſome like the branching of *Trees*, others like fountaines of water gliding in the *ayre*, others like ſaſhes of lightning, others like the glittering of *ſtarres*, giving great contentment, and delight to thoſe which behold them; But if the worke be furniſhed alſo with *Balons* (which is the chiefeſt in recreative *Fire-workes*) then ſhall you ſee aſcending in the *Ayre* but as it were onely a quill of fire, but once the *Balon* taking fire, the *Ayre*, will ſeeme more than 100. foot ſquare full of crawling, and flying *ſerpents*, which will extinguiſh with a volley of more than 500. *reports*, and ſo fill the *Ayre* and *Firmament* with their rebounding clamour.

The making of which with many other rare and excellent *Fireworkes*, and other practiſes,

practises, not onely for recreation, but also for service: you may finde in a booke intituled *Artificiall Fire-workes*, made by Mr. *Malthas* (a master of his knowledge) and are to be sold by *Rich. Hawkins* at his shop in *Chancery lane*, neare *Sarjants Inne*.

*Conclusion.*

In this Booke we have nothing omitted what was materiall in the originall, but have abundantly augmented it in sundry experiments: And though the examinations are not so full, and manifold, yet (by way of brevitie) we have expressed fully their substance, to avoyd prolixitie, and so past by things reiterated.

*FINIS.*



Ad Authorem D. D. *Henricum*  
*Van Etenium*, Alumnum Academiæ  
Ponta Mousson.

**A** *Rdua Walkeri sileant secreta profundi,*  
*Desinat occultam carpere Porta viam:*  
*Itala Cardani mirata est Lampada docti*  
*Terra, Syracusium Græcia tota senem:*  
*Orbi terrarum, Ptolemæi Clepsyratoti,*  
*Rara dioptra Procli, mira fuere duo.*  
*Anglia te foveat doctus Pont-Mousson alumni:*  
*Quidquid naturæ, qui legis, hortus habet.*  
*Docta, cæquet opus doctum, te sit tua docto*  
*Digna, Syracusij, arca, corona, viri.*  
*Arca Syracusijs utinam sit plumbea servis,*  
*Aurea sed dominis, aurea tota suis.*

A Table of the particurall  
heads of this Booke, contracted  
according to the severall Arts spe-  
cified in the Title page.

*Experiments of Arithmetick.*

PAGE 1, 2, 3, 16, 19, 22, 28, 33, 39, 40, 44,  
45, 51, 52, 53, 59, 60, 69, 71, 77, 83, 85, 86,  
89, 90, 91, 124, 134, 135, 136, 137, 138, 139,  
140, 178, 179, 181, 182, 183, 184, 185, 188, 208,  
210, 213.

*Experiments in Geometrie.*

Pag. 12, 15, 24, 26, 27, 30, 35, 37, 41, 42, 47,  
48, 49, 62, 65, 72, 79, 82, 113, 117, 118, 119,  
214, 215, 217, 218, 234, 235, 236, 239, 240.

*Experiments in Cosmographic.*

Pag. 14, 43, 75, 106, 107, 219, 220, 225, 227,  
228, 229, 230, 232. *works*

*Experiments in Horologographie.*

Pag. 137, 166, 167, 168, 169, 171, 234. *Dialing*

*Experiments in Astronomie.*

Pag. 220, 221, 222, 223, 224.

*Experiments in Navigation.*

Pag. 105, 233, 234, 237, 238. *Sea*

*Experiments in Musicke.*

Pag. 78, 87, 126.

*Experiments in Opticks.*

Pag. 6, 66, 98, 99, 100, 102, 129, 131, 141,  
142, 143, 144, 146, 149, 151, 152, 153, 155,  
156, 157, 158, 160, 161, 162, 163, 164, 165.

*Experiments in Artichitecture.*

*Artes*

Pag. 16, 242, 243.

*Experiments in Staticke.*

Pag. 27, 30, 32, 71, 199, 200, 201, 203, 204,  
205, 207.

*Experiments in Machanicks:*

Pag. 56, 58, 68, 88, 95, 108, 110, 128, 173,  
174, 176, 246, 248, 258, 259.

*Experiments in Chimestrie.*

Pag. 198, 255, 256, 257, 260, 262, 263, 264.

*Experiments in Waterworkes.*

Pag. 190, 191, 192, 193, 194, 196, 247, 249,  
250, 252, 253.

*Experiments in Fireworkes.*

From page, 265. to the end.

*FINIS.*

*Recensui hunc librum cui titulus est  
Mathematicall Recreations, qui  
quidem liber continet centum, & vigin-  
ti folia, in quibus omnibus nihil reperio,  
quod non cum utilitate Publica impris-  
matur, modo intra septem menses  
proximè sequentes typis mandetur.*

Ex ædibus Londinen-  
sibus. Jul. 23. 1632.

*Guil. Bray,*  
Episcopo Londi-  
nensi Capellanus  
Domesticus.

Two apertures & work at out  
of hand & keep & 7 joining  
at both ends & - work must  
be wide / will & take  
howls & - other & may 7 bind  
- work Take 100 yards of small  
work for & 2 round

---

How to work & stop 1 - work  
must be done & 7 fingers  
or for more below work  
& make & hang & = & both  
of like kind & 7 must be  
about the work



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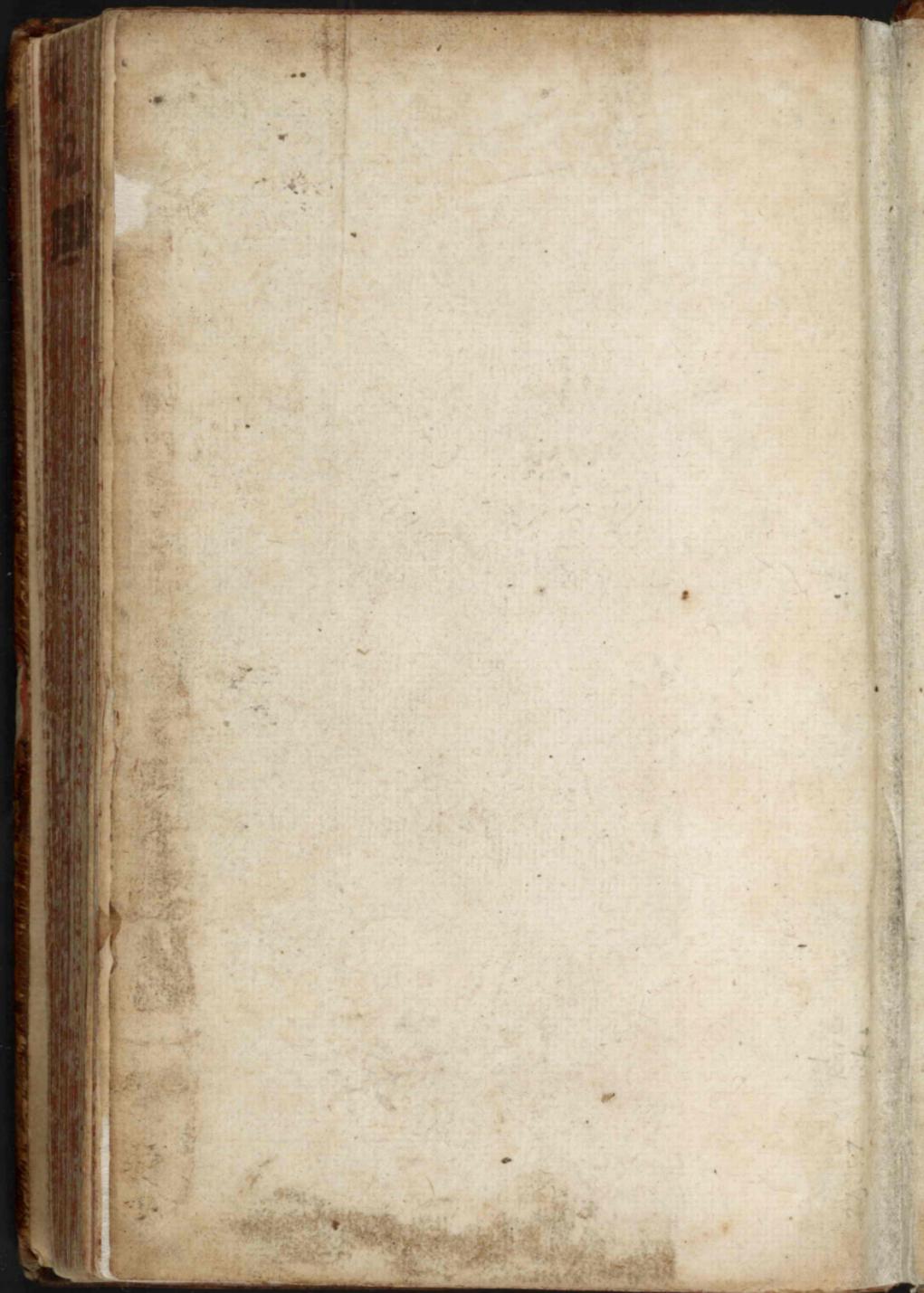
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