MATHEMATICALL
Recreations
Or a Collection of
sundrie excellent
Problemes
out of ancient & moderne
Philosophers
Both vsefull and
Recreatiue
Printed for William Leake
and are to be solde at the
Crowne in fleet streete
betweene the two
Temple gates
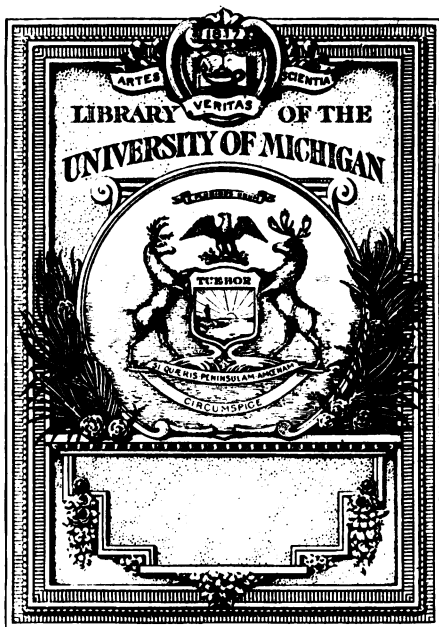
Mathematicall
RECREATIONS.
OR,

A Collection of many *Problemes*,
extracted out of the Ancient and Modern Philoso-
phers, as Secrets and Experiments in *Arithmetick*,
Geometry, *Cosmographie*, *Horologiographie*, *Astronomie*,
Navigation, *Musick*, *Opticks*, *Architecture*, *Staticks*,
Mechanicks, *Chemistry*, *water-works*, *Fire-*
works, &c. Not vulgarly mani-
fest till now.

Written first in *Greeke* and *Latin*, lately compi'ld
in *French*, by *Henry Van Etten*, and now in *English*,
with the *Examinations* and *Augmentations* of
divers *Modern Mathematicians*

Whereunto is added the *Description* and *Use* of
the *Generall Horologicall Ring*:

And

The *Double Horizontall Diall*.
Invented and written by

WILLIAM OUGHTRED.

TO

The thrice Noble and most generous Lo. the Lo.

Lambert Verreyken, Lo. of Hinden, Wolverthem, &c.

My honourable Lo.

Mongst the rare and curious Propositions which I have learned out of the studies of the *Mathematicks* in the famous Univerfity of *Pont a Mouſſon*, I have taken 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
A 4   teſtifie

testifie my affectionate desires to serve you, and to satisfie the curious, who delight themselves in these pleasant studies, knowing well that the *Nobilitie*, and *Gentrie* rather studie the *Mathematicall Arts*, to content and satisfie their affections, in the speculation of such admirable experiments as are extracted from them, than in hope of gaine to fill their *Purses.* All which studies, and others, with my whole indevours, I shall alwayes dedicate unto your Honour, with an ardent desire to be accounted ever,

Your most humble and
obedient Nephew
and Servant,

H. VAN ETTEN.

By vvay of advertifement.

Five or fix things I have thought worthy to declare before I paffe further.

Irſt, that I place not the ſpeculative demonſtrations with all theſe *Problems* , but content my ſelf to ſhew them as at the fingers end: which was my plot and intention, becauſe thoſe which underſtand 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 practice of theſe things, they ought to be concealed 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 unknowne :* which if it were diſcovered , halfe the pleaſure is loſt; therefore all the fineneſſe conſiſts in the

dexterity

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 him that shewes it: when the cause is not in the Mathematicall principles, but in him that failes 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 dependances 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 palate, the matter being not of one nature, nor of like subtiltie: But whosoever will have patience to read on, shall finde the end better than the beginning.

To

To the Reader.

IT hath been 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 foot 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 smalnesse of the subject: And have amongst most solid and artificiall conclusions, composed and produced sundry Inventions both Philosophicall and Mathematicall, 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 often-times yeelds praise to the industry of its author.   Hence for thy use (Courteous Reader) I have with

<div align="right">great</div>

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, Hypar-
chus, Euclides, Vitruvius, Diaphantus,
Pergæus, Archimedes, Papus Alexandri-
nus, Vitellius, Ptolomæus, Copernicus,
Proclus, Mauralicus, Cardanus, Valal-
pandus, Kepleirus, Gilbertus, Tychonius,
Dureirus, Josephus, Clavius, Galileus,
Maginus, Euphanus Tyberill, and
others) knowing Art imitating Nature
that glories alwayes in the variety of
things, which she produceth to satisfie the
minde of curious inquisitors. And though
perhaps these labours to some humourous per-
sons may seeme vaine, and ridiculous, for
such it was not undertaken: But for those
which intentively have desired and sought
after the knowledge of those 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 busi-
ed in vaine Pamphlets, Play-books, fruit-
lesse Legends, and prodigious Histories
that are invented out of fancie, which abuse
many Noble spirits, dull their wits, & alien-
ate

ate their thoughts from laudable and honourable Studies. In this Tractate thou maist therefore make choise of such Mathematicall Problemes and Conclusions as may delight thee, which kinde of learning doth excellently adorne a man, seeing the usefulnesse thereof, and the manly accomplishments it doth produce, is profitable and delightfull for all sorts of people, who may furnish and adorne themselves with abundance of matter in that kinde, to help them by way of use, and discourse. And to this we have also added our Pyrotechnie, knowing that Beasts have for their object only 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 an higher Contemplation, having so glittering a Canopie to behold, 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 spirit may easily digest them, and put them finely in order, though now in disorder.

A

A Table of the particular
heads of this Book, contracted according to the severall Arts specified in the Title-page.

Ex-

The Table.

F I N I S.

A Table of the Contents, and chiefe points con-
teined in this Book.

PROBLEM. II.

*

Prob.

The Contents.

The Contents.

2   *may*

The Contents.

The Contents.

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Certaine

The Contents.

Certaine fine Obſervations.

The Contents.

The Contents.

Prob.

FINIS.

Ad Authorem D. D. *Henricum*
Van Etenium, Alumnum Academiæ Ponta Mousson.

Rdua Walkeri sileant secreta profundi,
    Desinat occultam carpere Porta viam.
Itala Cardani mirata est Lampada docti
    Terra, Syracusium Græcia tota senem:
Orbi terrarum, Ptolemæi Clepsydra toti,
    Rara dioptra Procli, mira fuere duo. (num:
Anglia te foveat doctus Pont-Mousson alunt,
    Quidquid naturæ, qui legis, hortus habet.
Docta, coronet opus doctum, te sit tua docto
    Digna, Syracusii, arca, corona, viri.
Arca Syracusiis utinam sit plumbea servis,
    Aurea sed dominis, aurea tota suis.

MATHEMATICAL
RECREATION.

PROBLEM I.
To finde a number thought upon.

Id him that he 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 sum,
then ask how much it coms to,
for then if you take away half the number from
it which you willed him at first to add to it, there
shall remain 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

B   Take

Take away halfe the number added from
  it, *viz.* 4, the rest is $\Big\}$ 10

  The double of the number thought upon,
viz.   10

Another way to finde what Number was thought upon.

Bid him which thinketh double his Number,
  and unto that double adde 4, and bid him
multiply 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 setting a
Cypher at the end of the number) then ask 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 number thought upon 7 $\Big\rangle$
His double   14
To it add 4, makes   18
Which multiplyed by 5 makes
                              90
To which add 12 makes   102
This multiplyed by 10 $\Big\}$
  which is only by ad-
  ding a Cypher to it, $\Big\}$ 1020
  makes
From this subtract   320
Rest   700 $\Big\rangle$

For which 700
account onely
but the number
of the hundreds
viz. 7. so have
you the number
thought upon.

To finde numbers conceived upon, otherwise than the former.

Bld the party which thinks the number, that he triple his thought; and cause him to take the half of it: (if it be odde take the least half, and put one unto it:) then will him to triple the half, and take half of it as before: lastly, ask him how many nines there is in the last half, and for every nine, account four in your memory, for that shall shew the number thought upon, if both he 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 keep one in memory: if the first triple be even, and the second odde, for the one added unto the least halfe keepe two in memory: lastly, if at both times in tripling, the numbers be odde, for the two added unto the least halfes, keep three in memory, these cautions observed, and added unto as many fours as the party sayes there is nines contained in the last halfe, shall never fail 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 thereof **6** or **10**, one put to it makes **11**
The triple of the halfe   **18** or **33**
The halfe **9** or **16**, one put to it makes   **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 be not diſco-
vered, which to help, you may with dexterity
and induſtry make *Additions Subſtractions, Mul-
tiplications, Diviſions, &c.* and inſtead of asking
how many nines there is, you may ask how ma-
ny 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, *Book* of
the Elements of *Euclide* : upon which 2. *Book* &
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 party that thinks, that he break the
number thought upon into any two parts, and
unto the Squares of the parts, let him adde the
double product of the parts, then ask what it
amounteth unto, ſo the *root Quadrat* ſhall be the
number thought upon.

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

The

The square of 3 makes 9 ⎞
The square of 2 makes 4 ⎟ the sum of these three
The product of the ⎞ ⎟ nūbers 25, the *squa*
 parts. *viz.* 3 by 2 ⎜ ⎟ *Root* of which is 5, the
 makes 6, which 6 ⎟ 12 ⎟ *number* thought upon
 doubled makes ⎠ ⎠

Or more compendiously it may be delivered
   thus.

Break the number into two parts, and to the
product of the parts, adde the square of half the
difference of the parts, then the Root Quadrat
of the aggregate is halfe the number conceived.

* * *

EXAMINATION.

THe Problems *which concern* Arithme-
tick, *we examine not, for these are easie to
any one which hath read the grounds and prin-
ciples of* Arithmetick, *but we especially touch
upon that, which tends to the speculations of*
Physick, Geometry, *and* Optickes, *and
such others which are of more difficulty, and
more principally to be examined and conside-
red.*

                              B 3   PROB.

PROBLEM II.

How to reprefent to thofe which are in a
Cham er that which is without, or
all that which paffeth by.

THis is one of the fineſt experiments in the
Optiques, and it is done thus, chuſe a Cham-
ber or place which is towards the ſtreet, fre-
quented with people, or which is againſt ſome
fair flouriſhing object, that ſo it may be more
delightfull and pleaſant to the beholders, then
make the Room dark. by ſhutting out the light,
except a ſmall hole of ſix pence broad, this done
all the *Images* and ſpecies of the objects which
are without, will be ſeen within, and you ſhall
have pleaſure to ſee it, not only upon the wall,
but eſpecially upon a ſheet of white paper, or
some white cloth
hung neer the hole:
& if unto the hole
you place a round
glaſſe, that is, a
glaſſe wᶜʰ is thick-
er in the middle
than at the edge:
ſuch as is the com-
mon Burning Glaſſes, or ſuch which old peo-
ple uſe, for then the Images which before did
ſeeme dead, and of a darkiſh colour, will appear
and be ſeen upon the paper, or white cloth, ac-
cording

cording to their naturall colours, yea more live-
ly than their naturall, and the appearances wil
be so much the more beautifull and perfect, by
how much the hole is lesser, the day cleere, and
the sun shining.

It is pleasant to see the beautifull and goodly
representation of the heavens intermixed with
clouds in the Horizon, upon a woody scituation,
the motion of Birds iu 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 seen within even
to the life, but inversed: notwithstanding, this
beautifull paint will so naturally represent it self
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
inversed, is because
the species doe inter-
sect one another in
the hole, so that the
species of the feet as-
cend, and these of the
head descend.

But here note, that they may be represented
right two manner of wayes; first, with a con-
cave glasse: secondly, by help of another con-
vex glasse, disposed or placed between the pa-
per and the other Glasse: as may be seen here
by the figure.

Now

Now I will add here only by passing by, for such which affect Painting and portraiture, that this experiment may excellently help them in the lively painting of things perspectivewise, as *Topographicall cards, &c.* and for Philosophers, it is a fine secret to explain the Organ of the sight, for the hollow of the eye is taken as the close Chamber, the Ball of the Apple of the eye, for the hole of the Chamber, the Crystaline humor at the small of the Glasse, and the bottome of the eye, for the Wall or leafe of paper.

EXAMINATION.

THe species being pressed together or contracted doth not perform it upon a wall, for the species of any thing doth represent it selfe not only in one hole of a window, but in infinite holes, even unto the whole Sphere, *or at least unto a* Hemisphere *(intellectuall in a free medium) if the beams or reflections be not interposed, and 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 convexe, & by how much the parts of the* image *comes*
                                                            neer

neer to the Axis, for those that are neer are
better proportioned then these which are far-
ther off.

But to have them more lively and true, ac-
cording to the imaginary conicall section, let
the hole be no greater than a pins head made
upon a piese of thin brasse, or such like, which
hole represents the top of the Cone, and the
Base thereof the term of the species: this pra-
ctice is best when the sun 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 per-
fect inversed perspective, which drawn by
the Pensill of some artificiall Painter, turn
the paper upside down, 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 spe-
cies reflect upon a concave Glass, and let that
glas reflect upon a paper or some white thing.

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

S Caliger in his 331 exercise against *Cardan*, re-
lates that the *Mathematicians* of *Maximilian*
the

the Emperour did propose upon a day this *Que-stion*, and promised to give the resolution ; not-withstanding *caliger* delivered it not, and : con-ceive it to be thus. Take a Balance, and let the Fist, the Mallet, or Hatchet rest upon the scale, or upon the beam of the Balance, and put into the other Scale as much weight as may coun-terpoyse 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 waigh: for as *Aristotle* saith , *The motion that is made in striking adds great waight unto it , and so much the more, by how much it is quicker :* there-

fore in effect, if there were placed a thou-sand *mallets* , or a Thousand pounde waight upon a stone, nay , though it were exceedingly pressed down by way of a Vice, by Levers, or other Mechanick Engine, it would be nothing to the rigor and violence of a blow.
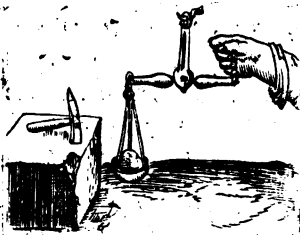
Is it not evident that the edge of a knife laid upon butter, and a hatchet upon a leafe of pa-per, without striking makes no impression , or at least enters not; but striking upon the wood a little, you may presently see what effect it hath, which is from the quicknesse of the motion, which breaks and enters without resistance, if it be extream quick, as experience shews us in the

blows

blows of Arrows, of Cannons, Thunder-boults and such like.

EXAMINATION.

THis Problem *was extracted from Sca-liger, who had it from* Aristotle , *but somwhat refractory compiled, & the strength of the effect he says depends only in the vio-lence of the motion, then would it follow that a little light* hammer *upon a piece of* wood *being quickly caused to smite , would give a greater blow, and do more hurt than a great sledge striking soft , this is absurd, and con-trary 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 quick-ness , the effect would be much different : there is then some thing 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 win-dow to a place neer at hand, is not so forceable as if it fell farther down; and when a bullet flying out of a* peece *and striking the mark neer at hand, will not make such an effect as striking the mark further off: but we suppose that* Scaliger *aud* Cardanus *who handles this subiect , would not be less troubled tore-solve this , than they have been in that.*

PROBLEM IV.

How to break a staffe which is laid upon two Glasses
full of water, without breaking the Glasses,
spilling the water, or upon two reeds or
straws without breaking
of them.

Frst, 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 di-
stant one from another by 2 or 3 foot, then
place the ends of the staffe upon the edges of
the two Glasses so that they be sharp, 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.
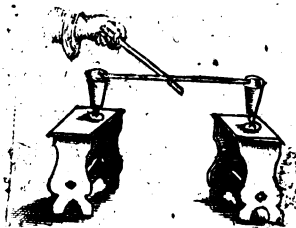
In like manner may
you doe upon two
Reeds, held with
your hands in the
aire without breaking them : thence Kitchin
boyes often break bones of mutton upon their
hand, or with a napkin without any hurt, in
only striking upon the middle of the bone with
a knife.

Now

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, forasmuch as in breaking it presseth not: as *Aristotle* in his *Mechanick 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 break, bow, or depart from his props , and that either directly or obliquely : But why by this violence, that one* Staffe *striking another, (which is supported by two* Glasses*) will be broken without offending the* Glasses*, is as great a difficulty to be resolved as the former.*

PROS.

PROBLEM V.

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

IT is usuall amongst great men to have faire
Geographicall Maps, 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 only
of their own Kingdoms form, scituation, lon-
gitude, latitude, &c. but of all other places in
the whole Universe, with their magnitudes, po-
sitions, Climats, and distances.

Now I esteem that it is not unworthy for the
meditations of a Prince, seeing it carries with it
many profitable and pleasant contentments : if
such a Card or Map by the advice and direction
of an able Mathematician were Geographically
described in a Garden plot form, or in some o-
ther convenient place, and instead of which ge-
nerall description might particularly and artifi-
cially be prefigured his whole Kingdoms and
Dominions, the Mountains and hils being raised
like small hillocks with turfs of earth, the val-
leys somwhat concave, which will be more a-
greeable and pleasing to the eye, than the de-
scription in plain Maps and Cards, within which
may be presented the Towns, Villages, Castles, or
other remarkable edifices in small green mossie
banks, or spring-work proportionall to the plat-
form,

form, the Forrests and Woods reprefented according to their form and capacity, with herbs and ftoubs, the great Rivers, Lakes, and Ponds to dilate themfelves according to their courfe from fome artificia'l Fountain made in the Garden to paffe through chanels; then may there be compofed walks of pleafure, afcents, places of repofe, adorned with all variety of delightfull herbs and flowers, both to pleafe the eye or other fenfes. A Garden thus accommodated fhall farre exceed that of my Lord of *Verulams* fpecified in his ffayes; that being only for delight and pleafure, this may have all the properties of that, and alfo for fingular ufe, by which a Prince may in little time perfonally vifit his whole Kingdom, and in fhort time know them diftinctly: and fo in like manner may any particular man Geographically prefigure his own poffeffion or heritage.

How three ftaves, knives, or like bodies, may be conceived to hang in the aire, without being fupported by any thing but by themfelves.

TAke the firft ftaffe A B, raife up in the aire the end B, and upon him crof-wife place the ftaffe C B, then laftly, in Triangle-wife place the third ftaffe E F in fuch manner that it may be under A B, and yet upon C D. I fay that thefe ftaves fo difpofed 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* break not, or sever themselves from the *triangular* forme: so that alwayes the Center of gravi-

tie be in the Center of the *Triangle*: for A B is supported by E F, and E F is held 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.
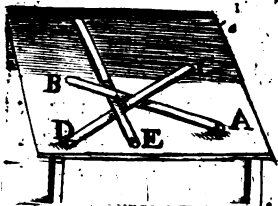
PROBLEM VII.

How to dispose as many men, or other things in such sort, that rejecting, or casting away the 6, 9, 10 part., unto a certain number, there shall remaine these which you would have.

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

to fave the reft : now it was agreed to be
done by lot, and therefore they confent to put
themfelves in rank , counting by nine and nine,
the ninth Perfon fhould alwayes be caft into
the Sea , untill there were halfe throwne over
board ; Now the Pilote being a Chriftian in-
deavoured to fave the Chriftians , how ought
he therefore to difpofe the Chriftians , that
the lot might fall alwayes upon the Turkes ,
and that none of the Chriftians be in the ninth
place ?

The refolution is ordinarily comprehended in
this verfe.

Populeam virgam mater regina ferebat.

For having refpect unto the vowels , making
a one , *e* two , *i* three , *o* foure, and *u* five : *o* the
firft vowell in the firft word fheweth that
there muft be placed 4. Chriftians ; the next
vowel *u*, fignifieth that next unto the 4. Chrifti-
ans muft be placed 5 Turkes , and fo to place
both Chriftians and Turkes according to the
quantity and value of the vowels in the words
of the verfe , untill they be all placed ; for then
counting from the firft Chriftian that was
placed , unto the ninth , the lot will fall upon
a Turk , and fo proceed. And here may be
further noted that this Probleme is not to be
limited, feeing it extends to any number and
order whatfoever , and may many wayes be
ufefull for Captaines , Magiftrates , or others
which have divers perfons to punifh, and would
chaftife chiefely the unrulieft of them, in taking
the 10, 20, or 100. perfon , &c. as we reade was

C   com-

commonly practised amongst the ancient Romans : herefore 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 be observed, take as many units as there are persons, and dispose them in order privately : as for example, let 24 men be 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 eight man should be alwayes punished. Take therefore first 24 units, or upon a piece of paper write down 24 cyphers, and account from the beginning to the eighth, which eighth mark, 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 be punished, and so of others.

It is supposed that *Josephus* the Author of the *Jewish History* escaped the danger of death by help of this Problem ; for a worthy Author of beliefe reports in his eighth chapter of the third Book of the destruction of *Jerusalem*, that the Town of *Jotapata* being taken by main force by *Vespatian*, *Josephus* being Governour of that Town, accompanyed with a Troop of forty Souldiers, hid themselves in a Cave, in which they resolved rather to famish than to fall into the hands of *Vespatian* : and with a bloudy resolution in that great distresse would have butchered one another for sustenance, had not *Josephus* perswaded them to die by lot and order, upon which it should fall : Now

see-

seeing that *Iosephus* did save himselfe by this
Art, it is thought that his industry was exercised
by the helpe of this Problem, so that of the
40 persons which he had, the third was alwayes
killed. Now by putting himselfe in the 16 or
31 place he was saved, and one with him which
he might kill, or easily perswade to yeild unto
the Romans.

PROBLEM. VIII.

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

LEt the three things be a *Ring*, a piece of *Gold*,
and a piece of *Silver*, or any other such like,
and let them be known privately to your self by
these three Vowels *a, e, i*, or let there be three
persons that have different names, as *Ambrose,
Edmond*, and *John*, which privately you may
note or account to your selfe once known by
the aforesaid Vowels, which signifie for the first
vowel 1, for the second vowell 2, for the third
vowell 3.

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

other a piece of Gold, and the third should
take a piece of Silver; it is easie to finde which
hath the Gold, the Silver, or the Ring, 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 down before
the parties, and as they sit or stand, give to
the first 1. Counter, which signifieth *a*, the first
vowell; to the second 2. Counters, which re-
present *e*, the second vowel; and to the third 3.
Counters, which stand for *i*, the third vowell:
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 he 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 mark what number
of Counters you had at the first, for there are
necessarily but 24. as was said before, the sur-
pluse you may privately reject. And then there
will be left either 1. 2. 3. 5. 6 or 7. and no other
number can remaine, which if there be, then
they have failed in taking according to the
directions delivered: but if either of these num-
bers do remaine, the resolution will be disco-
vered by one of these 6 words following, which
ought to be had in memory, *viz.*

Salve, certa, anima, femita, vita, quies.
    1.   2.   3.   5.   6.   7.

As

As ſuppoſe ɣ. did remaine, the word belong-
ing unto it is *ſemita* , the vowels in the firſt
two ſyllables are *e* and *i*,vvhich ſhevveth accord-
ing to the former directions , that to vvhom
you gave 2 Counters,he hath the Ring (ſeeing
it is the ſecond vovvell repreſented by tvvo as
before) and to vvhom you gave the 3.Counters,
he hath the Gold , for that *i* repreſents the
third vovvel, or 3. in the former direction,and
to vvhom you gave one Counter , he hath the
Silver,and ſo of the reſt: the variety of changes,
in vvhich exerciſe, is laid open in the Table fol-
lovving.

reſt	men	hid	reſt	men	hid
	1	a		1	
1	2	e	5	2	
	3	i		3	
	1	e		1	
2	2	a	6	2	
	3	i		3	
	1	a		1	
3	2	i	7	2	
	3	e		3	
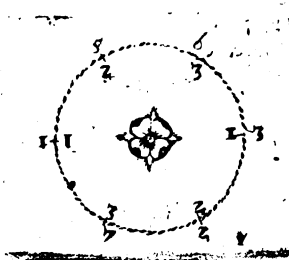
This feat may be done alſo without the for-
mer words by help of the Circle *A.* for ha-
ving divided the Circle into 6 parts , write 1.
within and 1. vvithout, 2.vvithin and 5. vvith-
out , &c. the firſt 1.2. 3. vvhich are vvithin
vvith the numbers over them, belongs to the
upper ſemicircle; the other numbers both
vvithin and vvithout , to the under ſemicircle;

C 3   novv

now if in the action there remaineth such a
number which may be found in the upper femi-
circle without, then that which is oppofite with-
in fhews the firft, the next is the fecond, &c. as
if 5 remains, it fhews to whom he gave 2, he
hath the *Ring* ; to whom you gave 2, he hath
the *Gold*, &c. But if the remainder be in the
under femicircle, that which is oppofite to it is
the firft; the next backwards towards the right
hand is the fecond ; as if 5 remains, to whom
you gave 1 he hath the *Ring*, he that had 3 he
had the *Gold*, &c.

PROBLEM IX.

How to part a Veffel which is full of wine conteining
eight pints into two equall parts, by two other
veffels which conteine as much as the
greater veffell ; as the one
being 5 pints, and the
other 3 pints.

LEt the three veffels be reprefented by A B C,
A being full, the other two being empty ;
firft, poure out A into B until it be full, fo there
will be in B 5 pints, and in A but 3 pints : then
poure out of B into C untill it be full : fo in C
fhall be 2 pints, in B 2 pints, and in A 3 pints,
then poure the wine which is in C into A , fo in
A will be 6 pints, in B 2 pints, and in C nothing:
then poure out the wine which is in B into the
pot

pot C, so in C there is now 2 pints, in B nothing, and in A 6 pints,. Lastly, poure out of A into B untill it be full, so there will be now in A only 1 pint, in B 5 pints, and in C 2 pints. But it is now evident, that if from B you poure in into the pot C untill it be full, there wil remain in B 4 pints, and if that which is in C, *viz.* 3 pints be poured into the vessell A, which before had 1 pint, there

shall be in the vessel A, but halfe of its liquor that was in it at the first, *viz.* 4 pints as was required. Otherwise poure out of A into C untill it be full, which pour into B, then poure out of A into C again untill it be full, so there is now in A onely 2 pints, in B 3, and in C 3, then pour from C into B untill it be full, so in C there is now but 1 pint, 5 in B, and 2 in A : poure all that is in B into A, then poure the wine which is in C into B, so there is in C nothing, in B onely 1 pint, and in 7 A 7 pints : Lastly, out of A fill the pot C, so there will remain in A 4 pints, or be but halfe full : then if the liquor in C be poured into B, it will be the other half. In like manner might be taken the half of a vessell which conteins 12 pints, by having but the measures 5 and 7, or 5 and 8. Now such others might be proposed, but we omit many, in one and the same nature.

C 4   **PROB.**

PROBLEM. X.

To make a stick stand upon the tip of ones finger,
without falling.

FAsten the edges of tvvo knives or such like
of equall poise, at the end of the stick,
leaning out somevvhat from the stick, so that
they may counterpoise one another; the stick
being sharp at the end, and held upon the top
of the finger, vvill there rest vvithout support-
ing: if it fall, it must fall together, and that
perpendicular or plumb-
wise, or it must fall side-
wise or before one ano-
ther; in the first man-
ner it cannot: for the
Centre of gravitie is sup-
ported by the top of the
finger: and seeing that
each part by the knives is
counterpoised, it cannot
fall sidevvise, therefore
it can fall no vvise.
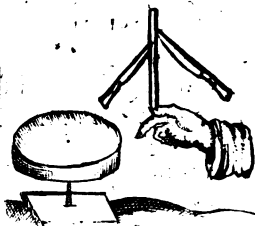
In like manner may great pieces of Timber,
as Joists, &c be supported, if unto one of the
ends be applied convenient proportionall coun-
terpoises, yea a Lance or Pike, may stand per-
pendicular in the Aire upon the top of ones
finger: or placed in the midst of a Court by
help of his Centre of gravitie.

EXAMI-

EXAMINATION.

THis Proposition seems doubtfull; for to imagine absolutely, that a Pike, or such like, armed with two Knives, or other things, shall stand upright in the Aire, and so remain without any other support, seeing that all the parts have an infinite difference of propensity to fall; and it is without question that a staff so accommodated upon his Centre of gravity, but that it may incline to some one part without some remedy be applied, and such as is here specified in the Probleme will not warrant the thing, nor keep it from falling; and if more Knives should be placed about it, it should cause it to fall more swiftly, forasmuch 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 always then the staffe, and so it will hang together as one body: and it will appear admirable if you place the Centre of gravity, neer the side of the top of the finger or point; for it will then hang Horizontall, and seem to hang onely by a touch, yet more strange, if you turn the point or top of the finger upside down.

P 2 Or

PROBLEM XI.

How a milſtone or other Ponderoſity, may be ſup-
ported by a ſmall needle, without break-
ing or any wiſe bowing the ſame.

LEt a needle be ſet perpendicular to the *Ho-*
rizon, and the center of gravitie of the ſtone
be placed on the top of the needle : it is evident
that the ſtone cannot fall, foraſmuch as it hangs
in *æquilibra*, or is counterpoyſed in all parts a-
like ; and moreover it cannot bow the needle
more on the one ſide then on the other, the nee-
dle will not therefore be either broken or bow-
ed ; 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 experi-

ments which are
made upon tren-
cher plates, or
ſuch like leſſer
thing doth make
it moſt credible
in greater bo-
dies.
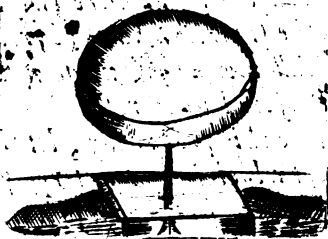
But here eſpe-
cially is to be noted, that the needle ought to
be uniforme in matter and figure, and that it be
erected perpendicular to the *Horizon*, and laſt-
ly, that the *Center* of *gravity* be exactly found.

PROB.

PROBLEM XII.

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

FIt the three *Knives* in form of a *Ballance*, and holding a *Needle* in your hand, and place the back of that Knife which lyes cross-wise to the other two, up on the point of the Needle: as the figure here sheweth you; for then in blowing softly upon them, they will easily turne and move upon the point of the Needle withou falling.
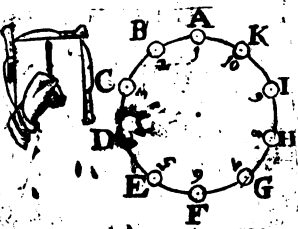
PROBLEM XIII.

To finde the weight of Smoak, which is exhaled of any combustible body whatsoever.

LEt it be supposed that a great heape of Fagots, or a load of straw weighing 500 pound should be fired, it is evident that this grosse substance will be all inverted into smoak and ashes: now it seems that the *smoak* weighs nothing ; seeing it is of a thin substance now dilated in the Aire, notwithstanding if it were gathered and reduced into the thickest that it was at first, it would be sensibly weighty : weigh therefore the ashes which admit 50 pound, now seeing that the

the reſt of the matter is not loſt , but is exhaled
into *ſmoake*, it muſt neceſſarily be , that the reſt
of the weight (to wit) 450 pound, muſt be the
weight of the *ſmoak* required.

EXAMINATION.

*N*ow although it be thus delivered , yet
here may be noted, that a ponderoſity in
his own medium is not weighty : for things
are ſaid to be weighty , when they are out of
their place, or medium, and the difference of
ſuch gravity , is according to the motion :
the ſmoak therefore certainly is light being
in its true medium (the aire,) if it ſhould
change his medium, then would we change
our diſcourſe.

PROBLEM XVI.
*Many things being diſpoſed circular, (or otherwiſe)
to finde which of them, any one thinks upon:*

SUppoſe that having ranked 10 things, as 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 : ask the party at what
                                                        letter

letter he would begin to account(for account he
muſt, otherwiſe it cannot be done) which ſup-
poſe . at E which is the 5 place , then add ſe-
cretly 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 he ſhal
account to himſelf 7,
at D account 8, at C
account 9,&c. So the
account of 15 wil ex-
actly fall upon G,
the thing or number
thought upon : and ſo
of others : but to con-
ceal it the more , you may will the party from
E to account 25,35, &c. and it will be the ſame.
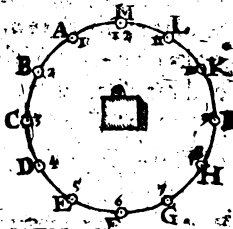
    There are ſome that uſe this play at Cards,
turned upſide downe , as the ten ſimple Cards,
with the King and Queen , the King ſtanding
for 12, and the Queene for 11, and ſo knowing
the ſituation of the Cards : and thinking a cer-
tain houre of the day : cauſe the party to ac-
count from what Card he pleaſeth : with this
Proviſo, that when you ſee where he 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.

                                PROB.

PROBLEM XV.

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

ALL the skill and subtilty of this, rests in the artificiall disposer of foure 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 hooks or hinges of the Posts, and by the other end may be made fast to the Gate, and so moving upon these hinges, the Gate will open upon one side with the aforesaid plates, or hooks of Iron : and by help of the other two plates, will open upon the other side.

PROBLEM XVI.

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

TAke a pale which hath a handle, and fill it full of water (or at pleasure:) then take a staffe or stick which may not rowle upon the Table as E C, and place the handle of the Pale upon the staffe; then place another staffe, or stick, under the staffe C E, which may reach from the bottom of the Pale unto the former staffe C E, perpendicular wise : which suppose F G, then shall the Pale of water hang without

fal-

falling, for if it fall it
muſt fall perpendicu-
larly, or plumbe wiſer,
and that cannot be
ſeeing the ſtaffe C E
ſupports it, it being
parallel to the Hori-
zon and ſuſteined by
the Table, and it is a
thing admirable that
if the ſtaffe C E were
alone from the table,
and that end of the ſtaffe which is upon the
Table were greater and heavier than the other:
it would be conſtrained to hang in the nature.
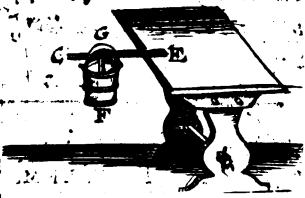
*Now without ſome experience of this
Probleme, a man would acknowledge
either a poſſibility or impoſſibity; there-
fore it is that very touchſtone of knowledge
in any thing, to diſcourſe firſt if a thing be
poſſible in nature, and then if it can be
brought to experience and under ſence with-
out ſeeing it done. At the firſt, this
propoſition ſeems to be abſurd, and impoſ-
ſible. Notwithſtanding, being ſupported
with*

*with two sticks, as the figure declareth,
it is made facile : for the Horizontall
line to the edge of the Table , is the
Centre of motion ; and passeth by the Centre
of gravity, which necessarily supporteth it.*

PROBLEM XVII.

Of a deceitfull Bowle to play withall.

MAke a hole in one side of the Bowle , and
cast molten 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 wil turn away side-wise : for
that on that part of the Bowle which is heavier
upon the one side then on the other , it never
will go truly right , if artificially it be not cor-
rected ; which will hazard the game to those
which know it not : but if it be known that the
leady side in rolling be always under or above,
it may go indifferently right ; if otherwise, the
weight will carry it always side-wise.

PROB.

PROBLEM. XVIII.

To part an Apple into 2.4 or 8. like parts, without breaking the Rinde.

PASse a needle and threed under the kinde of the Apple, and then round it with divers turnings, untill you come to the place where you began: then draw out the threed gently, and part the Apple into as many parts as you think convenient: and so the parts may be taken out between the parting of the Rind, and the rind remaining alwayes whole.

PROBLEM XIX.

To finde a number thought upon without asking of any question, certaine operations being done.

BId him adde to the number thought (as admit 15) halfe of it, if it may be, if not the greatest halfe that exceeds 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 be, 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 keep 3 in the memory, if at the second time it will not be

D   equally

equally halfed , 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. to
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 keep in your memory : then
will him to take the halfe againe if he can , if
not, take one from it, which reserve in your me-
mory , and so perpetually halveing untill 1. re-
maine : for then mark how many halfes
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 reser-
ved in memory , so there being 5 remaining in
this proposition , there were 2 halfings : 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 multiplyed by 4, makes 20.
from which subtract the first 3 and 2, because
the halfe could not be formerly added , leaves
15, the number thought upon.

Other Examples.

The number thought   12
The halfe of it   6
The summe   18
The halfe of it   9
The summe of it   27
The double of the number, 24
Which taken away, rests   3

The halfe of it   1
For which account   2
and 1 put to it because the   3
could not be halfed, makes   3
this multiplied by 4 makes 12

The number thought upon.

The number thought   79
The greatest halfe   40   3
The summe   119
The greatest halfe of which
   is   60   2
The summe of it is   179
The double of 79 is   158
Which taken from it, rests 21
The lesser half 10. wch halve:
The halfe of this is 5 which
   makes
The half of this is 2 wch is 10
The half of this is 1, with 10
   and 11 is 21.
this 21 which is the double
of the last halfe with the re-
mainder being multiplied by
4. makes 84, from which take
the aforesaid 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, and the
other square, Quadrangular, and
Triangular-wise, yet so that
the holes shall be ex-
actly filled.

THis Probleme is extracted from Geometri-
call observations, and seemes at the first

somewhat obſcure, yet that which may be extracted in this nature, will appeare more difficult and admirable. Now in all Geometricall practiſes, the leſſer or eaſier Problemes do alwayes make way to facilitate the greater: and the aforeſaid Probleme is thus reſolved. Take a Cone or round Pyramide, and make a Circular hole in ſome board, or other hard materiall, which may be equall to the baſes of the Cone, and alſo a Triangular hole, one of whoſe ſides may be equall to the Diameter 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 Pyramides conjoyned, then if a Circular hole be made, whoſe Diameter is equall to the Diameter of the Cones conjoyned, and a Quadrangular hole, whoſe ſloping ſides be equall to the length of each ſide of the Pyramide, and the breadth of the hol equal to the Diameter of the Circle, this conjoyned Pyramide ſhall exactly fill both the Circular hole, and alſo the Quadrangle hole.
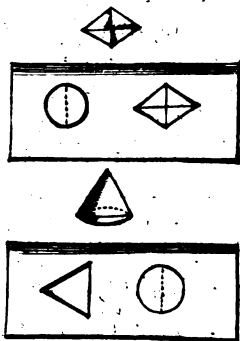
PROB.

Problem. 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 ovall forme?

THis Propofition feemes more fubtill then
the former, yet it may be practifed two
wayes: for the firft, take a Cylindricall body as
great or little as you pleafe: Now it is evident
that it will fill a Circular hole, which is made
equall to the bafis of it, if it be placed downe
right, and will alfo fill a long fquare; whofe
fides are equall unto the Diameter and length
of the Cylinder, and
acording to *Pergeus*,
Archimeder, &c. in
their Cylindricall de-
monftrations, a true
Ovall is made when
a Cylinder is cut
flopewife, therefore if
the ovall have breadth
equall unto the Dia-
meter of the Bafis of
the Cylinder, & any
length whatfoever:
the Cylinder being put into his owne Ovall
hole fhall alfo exactly fill it.
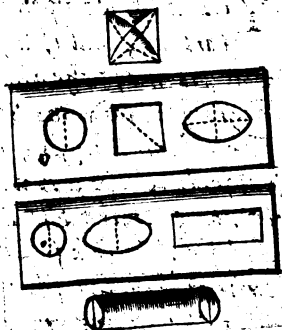
The fecond way is thus, make a Circular hole
in fome board, & alfo a fquare hole, the fide of
which Square may be equall to the Diameter
of

of the Circle: and laſtly, make a hole Oval-wiſe,
whoſe breadth may be equal unto the diagonall
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 O-
vall.

EXAMINATION.

You may note upon the laſt two Problemes
farther, that if a Cone be cut Ecliptick-
wiſe, it may paſſe through an Iſſocele Tri-
angle through many Scalen Triangles , and
through an Ellipſis ; and if there be a Cone
cut Scalen-wiſe, it will paſſe through all the
former, only for the Ellipſis place a Circle :
and further, if a ſolid colume be cut Eclip-
tick-wiſe it may fill a Circle, a Square , di-
vers Parallelogrammes, and divers Ellipſes,
which have different Diameters.

PROB.

Problem XXII.

To finde a number thought upon after another manner, then what is formerly delivered

Bid 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 & 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 he thought upon. In like manner do 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 multiplyed by 6, makes 60, and divided by 4, makes 15. in the same time admit you think upon 4, which multiplied by 4, makes 16, this divided by 2, makes 8, which

multiplied

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

Problem XXIII.

To finde out many numbers that sundry persons,
or one man hath thought upon.

IF the multitude of numbers thought upon be
odde, as three numbers, five numbers, seven,
&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, substract this from the former
22, then there will remaine the double of the
first

firſt number thought upon, *viz.* 4. which
known, the reſt is eaſily known : ſeeing you
know the ſumme of the firſi and ſecond ; but if
the multitude of numbers be even as theſe ſix
numbers, viz. 2,3,4,5,6,7, cauſe the partie to
declare the ſumme of each two , by antecedent
and conſequent , and alſo the ſumme of the ſe-
cond and laſt,which will be 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
pla ces together , that is 7,11,10, which makes
28,ſubſtract the one from the other, there ſhall
remaine the double of the ſecond number
thought upon, which known all the reſt are
knowne.

PROBLEM XXIV.

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 ?

THe anſwer is very facill , for to be ſo he
muſt be ſuppoſed to be in the centre of the
earth: for as the heaven is above on every ſide,
Cælum undique ſurſum, all that which looks to
the heavens being diſtant from the centre is up-
ward ; and it is in this ſenſe that *Maurolycus*
in his Coſmographie, & firſt dialogue,reported
of one that thought he was led by one of the
Muſes to hell, where he ſaw Lucifer ſitting
<div align="right">in</div>

in the middle of the World, and in the Centre
of the earth, as in a Throne: having his head
and feet upward.

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*

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

PROBLEM. XXVI.

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

THe opening of this is easie, forasmuch as
he that possesseth a Rod of ground posses-
seth

seth not only the exterior surface of the earth, but is master also of that which extends even to the Centre of the earth, and in this wise all heritages & possessions are as so many Pyramides, whose summets or points meet in the centre 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 go to the bottome of the heritage, which would reach to the centre of the earth; it would be 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 either true
North or true 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 he looketh South, because all the Meridians concurre in the Poles of the world, and if he be under the South-pole, he locks directly North by the same reason.

PROBLEM XXVIII.

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

Bid him to think upon a number, and will
him to multiply it by what number you
think convenient: and to the product bid him
adde what number you please, provided that se-
cretly you confider, that it may be divided by
that which multiplied, and then let him divide
the fum by the number which he first multi l i-
ed by, and fubftract from this Quotient the
number thought upon: In the fame time divide
apart the number which was added by that
which multiplied, fo then your Quotient fhall
be equall to his remainder, wherefore without
asking him any thing, you fhall tell him what
did remaine, which will feem ftrange to him
that knoweth not the caufe: for example, fup-
pofe he thought 7, which multiplied by 5 makes
35, to which adde 10, makes 45, which divided
by 5, yields 9, from which if you take away one
the number thought, (becaufe the Multiplier
divided by the Divifor gives the Quotient 1,)
the reft will be two, which will be alfo proved,
if 10 the number which was added, were divi-
ded by 5, *viz.* 2.

PROB.

PROBLEM XXIX.

Of the play with two severall things.

IT 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 be shewen in this en-
suing progression. In the meane time to pro-
duce alwayes some of them : suppose that a
man hold divers things in his hand, as Gold
and Silver, and in one hand he held the Gold,
and in the other hand he held the Silver : to
know subtilly, and by way of divination, or
artificially in which hand the Gold or Silver is;
attribute to the Gold, or suppose it have a cer-
taine price, and so likewise attribute to the Sil-
ver another price, conditionally that the one
be odd, and the other even : as for example, bid
him that the Gold be valued at 4 Crownes, or
Shillings, and the Silver at 3 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, &
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 Gold is in the right hand; if odde, the
Gold is in the left hand.

PROB.

PROBLEM. XXX.

Two numbers being proposed unto two severall par-
ties , to tell which of these numbers is taken
by each of them.

AS for example : admit you had proposed
unto two men whose names were *Peter* and
John, two numbers , or pieces of money , the
one even , and the other odde, as 10. and 9.
and let the one of them take one of the num-
bers, and the other partie take the other num-
ber , which they place privately to themselves :
how artificially , according to the congruity ,
and excellency of numbers , to finde which of
them did take 10. and which 9. without asking
any qustion : and this seems most subtill, yet de-
livered howsoever differing little from the for-
mer , 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 took, and do
you privately double also your greatest num-
ber ; then bid *John* to triple the number which
he hath , and do you the like upon your last
number : adde your two products together, &
mark 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
do, then immediately tell *Peter* he took 10. and
John 9. because the aggregate of the double of
4. and the triple of 3. makes odde , and such
                                              would

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 ta-
ken 10. and *Peter* 9. as suppose *Peter* had taken
10. the double is 20. and the triple of 9. the o-
ther umber 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. & the triple of
10. is 30. which set together makes 48. the
halfe of it may be taken: therefore in such case
Peter the took lesse number: and *John* the
greater, and this being don cleanly carries much
grace with it.

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:*

LEt the three points be *A. B. C.* put one
foot of the Compasse upon *A.* and describe
an Arch of a Circle at pleasure: and placed
at *B.* crosse that Arch in the two points *E.* and
F. and placed in *C.* crosse the Arch in *G.* and *H.*
then lay a ruler upon *G. H.* and draw a line, and
<div align="right">place</div>

place a Ruler upon *E.*
and *F.* cut the other
line in *K*, ſo *K*. is the
Centre of the Cir-
cumference of a Cir-
cle, which will paſſe
by the ſaid three
points *A. B. C.* or it
may be inverted, ha-
ving a Circle drawne;
to finde the Centre
of that Circle, make
3. points in the circumference, and then uſe the
ſame way: ſo ſhall you have the Centre, a thing
moſt faciſt to every practitioner in the prin-
ciples of Geometrie.
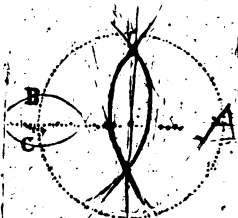
PROBLEM. XXXII.

How to change a Circle into a ſquare forme?

MAke a Circle upon paſt-board or other
materiall, as the Circle *A. C. D. E.* of
which *A.* is the Centre; then cut it into 4.quar-
ters, and diſpoſe them ſo, that *A.* at the centre
of the Circle may alwayes 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 be
noted that the square
is greater then the
Circle by the vacuity
in the middle, *viz.M.*

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 then another?

IT is not without cause that many admire how
this Proposition is to be resolved; yea in the
judgement of some it is thought impossible:
who consider not the industrie of an ingenious
Geometrician, 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 Centre of that Circle, a small pegge
of wood be placed, to be raised up and put
downe at pleasure by help of a small hole made
in the Centre, then with the same opening of
the Compasses, you may describe Circles Con-
centricall, that is, one greater or lesser than a-
nother; for the higher the Center is lifted up, the

lesser the Circle will be. Secondly, the compasse being at that extent upon a *Gibus* body, a Circle may be described, which will be lesse than the former, 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 demonstrated by the 20. Prop. of the first of *Euclids*, for the Diameter *E D*. is lesse than the line *A D*. *A E*. taken together, and the lines *A D*. *A E*. 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 was to be performed.
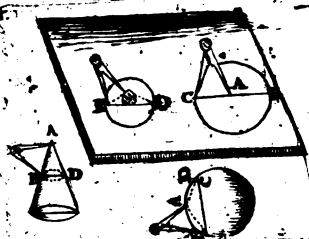
<div align="right">PROB.</div>

PROBLEM XXXIV.

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

LEt the firſt number be doubled, and unto it
adde 5. and multiply that ſumme by 5.
and unto it adde 10. and unto this product add
the next number thought upon ; multiply this
ſame againe by 10. and adde unto it the next
number , and ſo proceed : now if he declare the
laſt ſumme; marke. if he thought but upon one
figure , for then ſubtract only 35. from it, and
the firſt figure in the place of tennes is the
number thought upon : if he thought upon
two figures ; then ſubtract alſo the ſaid
35. from his laſt ſumme , and the two
figures which remaine are the number thought
upon: if he thought upon three figures , then
ſubtract 350. and then the firſt three 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.

Amongſt 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 works by Magick , or Witchcraft : But in effect it is nothing elſe but a nimble act of Arithmetick , 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 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 think 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 proceed, as in the 34 Problem : in cauſing him to double the firſt number : that is the number of per-
ſons

fons, which was 4. and it makes 8. to which add
5. makes 13. this multiplied by 5. makes 65. put
10. to it, makes 75. unto this put 2. for the num-
ber belonging to the left hand, and so it makes
77. which multiplied by 10. makes 770. to this
adde the number of the fingers upon which the
Ring is, *viz.* 5. makes 775. this multiplied by
10. makes 7750. to which adde the number for
the joynt upon which the Ring is, *viz.* the third
joynt, makes 7753. to which cause him to adde
14. or some other number, to conceale it the
better: and it makes 7767. which being de-
clared unto you, substract 3514. and there will
remaine 4.2.5.3. which figures in order declares
the whol mystery of that which is to be known:
4. signifieth the fourth person, 2. the left hand,
5. the fifth finger, and 3. the third joynt of that
finger.

Problem. XXXVI.
The Play of 34. or more Dice.

THat which is said of the two precedent
Problemes may be applied to this of Dice
(and many other particular things) to finde
what number appeareth upon each Dice being
cast by some one, for the points that are upon
any side of a Dice are alwayes lesse than 10 and
the points of each side of a Dice may be taken
for a number thought upon: therefore the Rule
will be as the former : As for example , one ha-

ving

ving thrown three Dice, and 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 multiply 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?

Take a Glasse neere full of water or other
liquor; and setting one hand upon the foot
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 privately
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 sen-
sibly appeare to tremble, with notable *rarefa-*
ction and *condensation*: thirdly, the water will
shake, seeme to boyle: fourthly, it will cast it
selfe out of the Glasse, and leap out by small
drops, with great astonishment to the standers
by; if they be ignorant of the cause of it, which
is

is onely in the Rarefaction of the parts of the Glaſſe, occaſioned by the motion and preſſure of the finger.

<hr/>

EXAMINATION.

THe cauſe of this, is not in the rarefaction of the parts of the Glaſſe, but it is rather in the quick locall motion of the finger, for reaſon ſheweth us that by how much a Body draweth nearer to a quality, the leſſe is it ſubject or capable of another which is contrary unto it? now condenſation, and rarefaction are contrary qualities, and in this Probleme there are three bodies conſidered, the Glaſſe, the Water, and the Aire, now it is evident that the Glaſſe being the moſt ſolid, and impenitrable Body, is leſſe ſubject and capable of rarefaction than the water, the water is leſſe ſubject than the Aire, and if there be any rarefaction, it is rather conſiderable in the Aire then in the Water, which is inſcribed by the Glaſſe, and above the Water, and rather in the Water then in the Glaſſe: the agitation, or the trembling of the parts of the Glaſſe to the ſenſe appeares 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 appeares not, but only the

upper contiguous parts of the Water: that at the bottome being lesse subiect 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 Aire be agitated, and so the water shall receive some apparant affection more or lesse from it, according to that motion: as we see from the quicknesse of winde upon the Sea, or calme thereof, that there is a greater or lesser agitation in the water; and for further examination, we leave it to the search of those which are curious.

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.

LEt 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 bottom 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

then poure in water or wine, and as long as it
mounts not above *E*, it is safe; but if you poure
in the water so that it mount above it, fare-
well all: for it will not cease untill it be all gone
out; the same may be
done in disposing any
crooked Pipe in a ves-
sell in the manner of a
Faucet or funnell, as in
the figure *H*, for fill it
under *H*, at pleasure,
and all will go well;
but if you fill it unto *H*.
you will see fine sport,
for then all the vessell
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 those which know the nature
of a Cock or Faucet; 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 run 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 then
the water, it will run out without ceasing: but
if the mouth of the Pipe be higher then the
water or levell with it, it will not runne, al-
though the Pipe which is without be many
times bigger than that which is in the water:
for it is the property of water to keep alwayes
exactly levell,
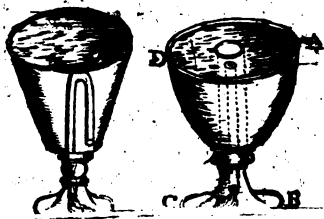
EXAM-

EXAMINATION.

Here is to be noted, that if the face of the water without be in one and the same plaine, with that which is within, though the outtermost Pipe be 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 then 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 only 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 ponderosity of the water within, is the cause of running in some respect.

PROBLEM. XXXIX.

Of a Glasse very pleasant.

SOmetimes there are Glasses which are made of a double fashion, as if one Glasse were within another, so that they seem but one, but there is a little space between them. Now poure Wine or other liquor between the two edges

edges by help of a Tunnell, into a little hole
left to this end, so vvill there appeare tvvo fine
delusions or fallacies; for though there be not
a drop of Wine vvithin the hollovv of the
Glaſſe, it vvill ſeem to thoſe vvhich behold it
that it is an ordinary Glaſſe full of Wine, and
that eſpecially to thoſe vvhich are ſide-vviſe of
it, and if any one move it, it vvill much confirme
it, becauſe of the motion of the Wine; but
that vvhich vvill give moſt delight, is that, if a-
ny one ſhall take the Glaſſe, and putting it to
his mouth ſhall think to drink the Wine, in-
ſtead of vvhich he ſhall ſup the Aire, and ſo
vvill cauſe laughter to thoſe that ſtand by, vvho
being deceived, vvill hold the Glaſs to the light,
& thereby conſidering that the raies or beames
of the light are not reflected to the eye, as they
vvould be if there vvere a liquid ſubſtance in the
Glaſſe, hence they have an aſſured proofe to
conclude, that the hollovv of the Glaſſe is
totally empty.

PROBLEM. XL.

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

Bid him that holds the money that he put
out of one hand into the other vvhat num-
ber you think 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 af-
sured that in the hand which was put the first
taking away : there will be found just the dou-
ble of the number taken away at the first.   Ex-
ample, admit there were in each hand 12 Shil-
lings 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 be 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.

Problem. XLI.

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

SVppose 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 mark how many
points a paire are upwards, which adde unto the
former summe : then put one of these Dice a-
way not changing the side , mark the points
which are under the other Dice , and adde it to
the

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 do appeare upward upon the three Dice, which adde privataly together, and unto it adde 2 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 he formerly made. As if he should throw three Dice, and there should appeare upward 5, 3, 2. the sum of them is 10. and setting one of them apart, (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 suppose there should appeare 4 and 1, this added unto 19 makes 24. and setting one of these two Dice apart 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 practife with 4, 5, 6, or many Dice or other bodies, observing only 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-

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

PROBLEM. XLII.

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

IT is said that an Emperour 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 think that in this Probleme one must be guided only 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 know not otherwise. A Mathematician accounts it an easie proposition, & will infallibly chuse the chest of Gold, and leave the chest of Lead, without either breaking, or opening any of the chests, and not go by chance and fortune : for if he may be permitted to weigh those chests first in the Aire, then in the water : it is a thing cleare by the

the proportion of
Mettalls, & accord-
ing to the princi-
ples of *Archimedes*,
that the Gold shal
be lesse weighty by
his eighteenth part,
& the Lead by his
11th part, where-
fore there may be
gathered in which
is the Gold, and in
which is the Lead.
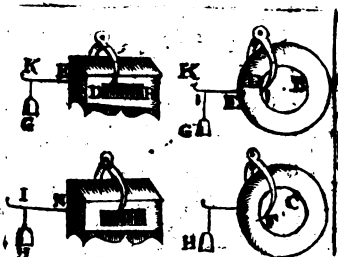
But because that this experiment in water
hath divers accidents, and therefore subject to
a caution ; and namely, because the matter of
the chest, mettall or other things may hinder.

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 equal quantity: and 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 two Globes or
Chests of wood or other matter alike, & equall
one to the other, in one of which in the middle
there is another Globe or body of lead weighing
12.l. (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 broad paire of Compasses, and clip one
of the Coffers or Globes somewhat from the
middle, as at *D.* then fix in the Chest or Globe
a small piece of Iron between the feet of the
Compasses, as *E K,* at the end of which hang
a vveight *G,* so that the other end may be coun-
terpoysed, and hang *in æquilibrio:* and do the
like to the other Chest or Globe. Novv if
that the other Chest or Globe being clipped in
like distance from the end, and hanging at the
other end the same weight *G.* there be found
no difference; then clip them nearer tovvards
the middle, that so the points of the Compasse
may be against some of the mettall vvhich is
inclosed; or just against the extremitie of the
Gold as in *D,* and suppose it hang thus in *æqui-*
libria; it is certaine that in the other Coffer is
the Lead; for the points of the Compasses be-
ing advanced as much as before, as at *F,* vvhich
takes up a part of the Lead, (because it occu-
pies a greater place than the Gold) therefore
that shall help the vveight *G.* to vveigh, and so
vvill not hang in *æquilibrio,* except *G.* be placed
neare to *F.* hence vve may conclude, that there
is the Lead; and in the other Chest or Globe,
there is the Gold.

EXAMINATION.

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

PROBLEM. XLIII.

Two Globes of diverse mettalls, (as one Gold, and the other Copper) yet of equall weight being put into a box, as B G, to finde in which end the Gold or Copper is.

THis is discovered by the changing of the places of the tvvo Bovvles or Globes, having the same counterpoyse *H* to be hung at the other side, as in *N.* and if the Gold vvhich is the lesser Globe, vvere before the nearest to the handle *D E*, having novv changed his place vvill be farthest from the handle *D E*, as in *K.*

F   theres

therefore the Centre of gravity of the two
Globes taken together, ſhall be farther ſeparate
from the middle of the
handle (under which
is the Centre of gra-
vity of the Box) than
it was before, and ſee-
ing that the handle is
alwayes in the middle
of the Box, the vveight
N. muſt be augment-
ed, to keep it in *equi-*
libris : and by this way one may knovv , that if
at the ſecond time , the counterpoiſe be too
light , it is a ſigne that the Gold is fartheſt off
the handle, as at the firſt triall it vvas neareſt.
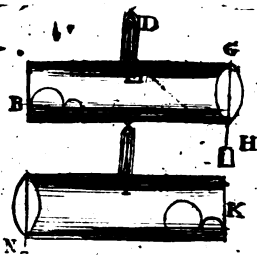
Problem. XLIIII.

How to repreſent diverſe ſorts of Raine-
bowes here below?

THe Rainbovve is a thing admirable in the
vvorld, vvhich raviſheth often the eyes and
ſpirits of men in conſideration of his rich inter-
mingled colours vvhich are ſeen under the
clouds, ſeeming as the gliſtering of the Starres,
precious ſtones , and ornaments of the moſt
beauteous flovvers : ſome part of it as the re-
ſplendent ſtars, or as a Roſe , or burning Cole
of fire . in it one may ſee Dyes of ſundry ſorts,
                                the

the Violet, the Blew, the Orange, the Saphir, the
Jacinct, and the Emerald colours, as a lively
plant placed in a green soile : and as a most rich
treasure of nature, it is a high work of the Sun
who casteth his raies or beames as a curious
Painter drawes strokes with his pensill, and
placeth his colours in an exquisite situation ;
and *Solomon* saith, *Eccles.* 43. it is a chiefe and
principall work of God. Notwithstanding there
is left to industrie how to represent it from a-
bove, here below, though not in perfection,
yet in part, with the same intermixture of co-
lours that is above.

Have you not seen 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 a-
tomes, upon which the beames of the Sunne re-
flecting, make a kinde of coloured Rainbowe:
or may we not see in houses or Gardens of plea-
sure artificiall fountaines, which poure forth
their droppie streames of water, that being be-
tween the Sunne and the fountaine, there will
be presented as a continuall Rainbowe ? But
not to go farther, I will shew you how you may
do it at your doore, by a fine and facill expe-
riment.

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

atomes

atomes vapours in the beames of the Sunne to
turne into a faire Rainebowe, but all the griefe
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 raies that
passe through strike upon a shadowed place,
you will have pleasure to see the fine forme of a
Rainebovve by this reflection. Or take a Trigo-
nall Glasse or Crystall Glasse of diverse An-
gles, and look through it, or let the beames of
the Sunne passe through it; or vvith a candle let
the appearances be received upon a shad-
ed place: you vvill have the same contentment.

PROBLEM XLV.

*How that if all the Powder in the world were in-
closed within a bowle of paper or glasse, and
being fired on all parts, it could not
break that bowle?*

IF the bowle and the powder be uniforme in
all his parts, then by that means the powder
would presse and move equally on each side,
in which there is no possibility whereby it
ought to begin by one side more than another.
Now it is impossible that the bowle should be
broken in all his parts: for they are infinite.
& Of like finenesse or subtiltie may it be that a
bowle of Iron falling from a high place upon a
plaine pavement of thin Glasse, it were impos-
sible

sible any wise to break it ; if the bowle were
perfectly round , and the Glasse flat and uni-
forme in all his parts . for the bowle would
touch the Glasse but in one point , which is in
the middle of infinite parts which are 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
bovvle falling upon such a glasse vvill not break
it . But this matter is meere Metaphysicall, and
all the vvorkmen in the vvorld cannot ever
vvith all their industrie make a bovvle perfect-
ly round, or a Glasse uniforme.

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 di-
divided by 7, the e will re-
maine nothing.

IN many Authors of Arithmetick this Pro-
bleme is thus proposed : A vvoman carrying
Egges to Market in a basket , met an unruly fel-
lovv who broke them who vvas by order made
to pay for them: and she being demanded what
number she had, she could not tell : but she re-
membred

E 3

membred that counting them by 2 & 2, there
remained 1. likewife by 3 and 3 by 4 and 4,
by 5 and 5, by 6 and 6; there ftill Iremained 1,
but when fhe counted them by 7 and 7, there
remained nothing : Now how may the number
of Egges be difcovered ?

Finde a number which may exactly be mea-
fured by 7, and being meafured by 2,3,4,5, and
6; there vvill ftill remaine a unite : multiply
thefe numbers together, makes 720, to which
adde 1; fo have you the number, *viz.* 721. in
like manner 301 vvill be meafured by 2,3,4,5,
6; fo that 1 remaines : but being meafured by 7,
nothing vvill remaine; to vvhich continually
adde 220, and you have other numbers vvhich
vvill do the fame : hence it is doubtfull vvhat
number fhe had, therefore not to faile, it muft
be knovvn vvhether they did exceed 400, 800,
&c. in vvhich it may be conjectured that it
could not exceed 4 or 5 hundred, feeing a man
or vvoman could not carry 7 or 8 hundred
Egges, therefore the number vvas the former
301. vvhich fhe had in her Basket : vvhich be-
ing counted by 2 and 2, there vvill remaine 1,
by 3 and 3, &c. but counted by 7 and 7, there
vvill remaine nothing.

PROB.

PROBLEM. XLVII.

One had a certaine number of crownes, and count-
ing 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 & 6,
there rested 5. but counting them by
7 and 7, there remained nothing:
how many crownes might
he have?

THis Queſtion hath ſome affinitie to the pre-
cedent, and the reſolution is almoſt in the
ſame manner : for here there muſt be found a
number, vvhich multiplied by 7, and then di-
vided by 2,3,4,5,6; there may alvvayes remaine
a number leſſe by 1 than the Diviſor: Novv the
firſt number vvhich arrives in this nature is 119,
unto vvhich if 420 be added, makes 539, vvhich
alſo vvill do the ſame : and ſo by adding 420,
you may have other numbers to reſolve this
propoſition.

PROBLEM. XLVIII.

How many ſorts of weights in the leaſt manner
muſt there be to weigh all ſorts of things
between 1 pound and 40 pound, and
ſo unto 121, & 364 pound.

TO vveigh things betvveen 1 and 40, take
numbers in triple proportion, ſo that their
F 4   ſumm

fumme be equall, or fomewhat greater than 40,
as are the numbers 1. 3. 9. 27. I fay that with 4
fuch weights, the firft being of 1 pound, the
fecond being 3 pound, the third being 9 pound,
and the fourth being 27: any weight between
1 and 40 pound may be weighed. As admit to
weigh 21 pound, put unto the thing that is to
be weighed the 9 pound weight, then in the o-
ther ballance put 27 pound and 3 pound, which
doth counterpoife 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 fo of others.

In the fame manner take thofe 5 weights, 1,
3, 9, 27, 81, you may weigh with them between
1 pound, and 121 pound: and taking thofe 6
weights, as 1, 3, 9, 27, 81, 243, you may weigh
even from 1 pound unto 364 pound: this de-
pends upon the property of continued propor-
tionals, the latter of which containing twice
all the former.

PROBLEM. XLIX.

Of a deceitfull ballance which being empty feemes
to be juft, becaufe it hangs in æquilibrio: net-
withftanding putting 12 pound in one
ballance, and 11 in the other, it
will remaine in æquilibrio.

A Riftotle maketh mention of this ballance
in his mechanick Queftions, and faith, that
the

the Merchants of purpose in his time used
them to deceive the world: the subtiltie or
craft of which is thus, that one arme of the
ballance is longer then another, by the same
proportion, that one weight is heavier then an-
other: 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 o-
ther side: condition-
ally that the short-
er end should be as
heavy as the longer,
a thing easie to be
done: then after-
wards put into the
ballance two unequall
weights in such pro-
portion 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
æquilibrio*, which will seem most sincere and
just; though it be most deceitfull, abominable,
and false.
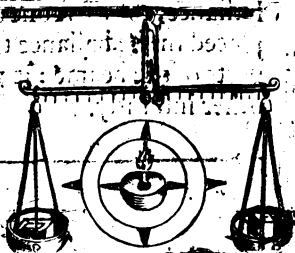
The reason of this is drawne from the expe-
riments of *Archimedes*, who shewes that two
unequall weights will counterpoyse one ano-
ther, when there is like proportion betweene
the parts of the beame (that the handle sepa-
rates)

rates) and the vveights themselves : for in one
and the same counterpoise, by hovv much it is
farther from the Centre of the handle, by so
much it seems 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 deceit , change the weight into the other
ballance, for as soone as the greater vveight is
placed in the ballance that hangs on the longer
parts of the beame : it vvill vveigh dovvne the
other instantly.

PROBLEM. L.

To heave or lift up a bottle with a straw.

Take a stravv that is not bruised, bovv it that
it make an Angle , and put it into the bottle
so that the greatest end be in the neck, then the
Reed being put in
the bovved part
vvil cast side-vvise,
and make an Angle
as in the figure
may be seen : then
may you take the
end vvhich is out
of the bottle in
your hand , and
heave up the bottle,
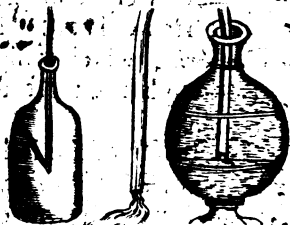
and

and it is so much surer, by how much the Angle
is acuter or sharper ; and the end which is bow-
ed approacheth to the other perpendicular
parts which come out of the bottle.

PROBLEM. LI.

How in the middle of a wood or desert, without the
sight of the Sunne, Starres, Shadow or Com-
passe, 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 help you in some mea-
sure to make it more manifest than any of the
former, from a tree thus : Cut a small tree off,
even to the ground, and mark the many circles
that are about the sap or pith of the tree, which
seem nearer together in some part than in o-
ther, which is by reason of the Suns motion a-
bout the tree : for that the humiditie of the
parts of the tree towards the South by the heat
of the Sun is rarified, and caused to extend :
and the Sun not giving such heat towards the
North-part of the tree, the sap is lesser rarefied,
but condensed ; by which the circles are nearer
together on the North-part, than on the South-
part : therefore if a line be drawne from the
widest

widest to the narrowest
part of the circles, it
shall shew the North
& South of the world.
Another   Experiment
may be thus : Take a
small needle, such as
women work with :
place it gently downe
flatwise upon still wa-
ter, and it will not sink,
(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 be great and will not swim,
thrust it through a small piece of Cork, or some
such like thing, and then it will do the same: for
such is the property of Iron when it is placed
in æquilibrio, it strives to finde out the Poles of
the world or points of North and South in a
manner as the *magnes* doth.
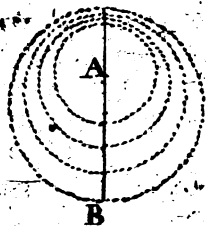
EXAMINATION.

H*Ere is observable, that the moisture which
    aideth to the growth of the tree , is dila-
ted and rarefied by the Meridionall heat, and
contracted by the Septentrionall cold : this
rarefaction works upon the part of the hu-
mour or moisture that is more thinne, which
doth easily dissipate and evaporate : which
                                        evapo-*

*euaporation carries a part of the salt with it,
and because that solidation or condensation,
so that there is left but a part of the nourish-
ment which the heat bakes up and consumes:
so contrarily on the other side the condensati-
on and restrictive quality of the moisture
causeth lesse euaporation and perdition : and
so consequently there remaines more nourish-
ment, which makes a greater increase on that
side than on the other side : for as trees have
their growth in winter, because of their pores
and these of the earth are shut up : so in the
spring when their pores are open, and when
the sappe and moisture is drawne by it, there
is not such cold on the North-side that it
may be condensed at once : But contrarily
to the side which is South, the heat may be
such, that in little time by continuance, this
moisture is dissipated greatly : and cold is
nothing but that which hardneth and con-
tracteth the moisture of the tree, and so con-
verteth it into wood.*

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, and 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.

Problem. LIII.

*How to make a confort of musick of many parts
with one voyce, or one instrument only?*

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 answer, he may be-
gin *sol*, and pronounce it in the same tune that
the Echo answereth, by which meanes you
have a fifth, agreeable confort of musick : then

in

in the same time that the Echo followeth, to sound the second note *sol*, he may sound forth another *sol* higher or lower to make an eight, the most perfect consort of musick, and so of others, if he will continue his voice 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 are many more parts in the musick of a Quire, then in effect truly there are because of the resounding and multiplying of the voic, and redoubling of the Quire.

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 are many fine wayes in Geometricall practices, to make an Ovall figure or one neare unto it, by severall centres: any of which I will not touch upon, but shew how it may be done promptly upon one centre 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 deep 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 Columne or Cylinder: if pa-

per

per 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 plaine thus. As let the
length of the Ovall be *H. K*, fasten 2 pinnes
or nailes neare the end of that line as *F.G*, and
take a threed which is double to the length of
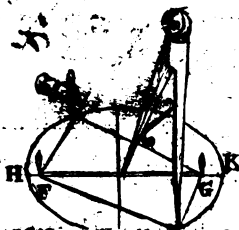
G.H, or *F. K*, then if
you take a Compasse
which may have one
foot lower than ano-
ther, with a spring be-
tween his legges: and
placing one foot of this
Compasse in the Cen-
tre of the Ovall, and guiding the threed by
the other foot of the Compasses, and so carry-
ing it about: the spring will help to describe and
draw the Ovall forme. But in stead of the
Compasses it may be done with ones hand only,
as in the figure may appeare.

PROBLEM. LV.

Of a purse difficult to be opened.

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

and

and *C D*, at the end of which are 2 rings, *B* &
D, and the string *C D* 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
C D, then over the purse, there is a piece of
Leather *E F G H*, which covers the opening of
the purse, and there is another piece of Leather
A E, which passeth
through many rings:
which hath a slit to-
wards the end *I*, so
great that the string
B C may slide into
it : Now all the cun-
ning or craft is how
to make fast or to o-
pen the purse, which
consists in making the string *B C* slide through
the side at *I*, therefore bring down *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 seem diffi-
cult 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 C*, by this way
the purse will be opened.
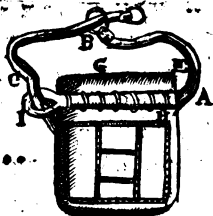
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PROBLEM. LVI.

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

IT is said that upon a time past, two Mathe-
maticians met, and they would make tryall
of their industry: the one made instantly a
Perfect circle without Compasses, and the other
immediately pointed out the Centre thereof
with the point of a needle; now which is the
chiefest action? it seems the first, for to draw
the most nobleft figure upon a plaine Table
without other help than the hand, and the
minde, is full of admiration; to finde the Cen-
tre is but to finde out only one point, but to
draw a round, there must be almoft infinite
points, equidistant from the Centre or middle;
that in conclusion it is both the Circle and the
Centre together. But contrarily it may feem that
to finde the Centre is more difficult, for what
attention, vivacitie, and fubtiltie muft there be
in the fpirit, in the eye, in the hand, which will
chufe the true point amongft a thoufand other
points? He that makes a circle keeps alwayes
the fame diftance, and is guided by a halfe di-
ftance to finifh the reft; but he that muft finde
the Centre, muft in the fame time take heed to
the parts about it, and choofe one only point
which is equall diftant from an infinite of other
                                        points

points which are in the circumference; which is very difficult. *Aristotle* confirmes this amongst his morals, and seems 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 Centre of the end of a right mediocritie of a vertuous action; for to do well it must touch the middle point which is but one, and there must be a true point which respects the end, and that's but one only. Now to judge which is the most difficult, as before is said, either to drawthe round or to finde the Centre, the round seems to be harder than to finde the Centre, because that in finding of it, it is done at once, and hath an equall distance from the whole; But, as before, to draw a round there is a visible point imagined, about which the circle is to be drawne. I esteeme that it is as difficult therefore, if not more, to make the circle without a Centre, as to finde the middle or Centre of that circle.

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

THis is to be exercised upon a full Pack 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 shew the
number of points that his three Cards which he
took at the first did conteine. As if the 3 Cards
were 7,10,and 4;now 7 wants of 15, 8. take 8
Cards therefore for your first Card : 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,& giving him the rest of the Cards ,
there will be 25; from which take 4, there re-
maines 21, the number of the three Cards ta-
ken, *viz.* 7, 10, and 4.

   Whosoever would practise this play with 4,
5,6,or more Cards , and that the whole num-
ber 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 pro-
duct adde the number of Cards taken, then sub-
tract this summe from the whole number of
Cards; the remainder is the number which
must be subtracted from the Cards , which re-
maines to make up the game : if there remaine
nothing after the Subtraction , then the num-
ber of Cards remaining doth justly shew the
number of points which were in the Cards cho-
sen. If the Subtraction cannot be made , then
subtract the number of Cards from that num-
ber , and the remainder added unto the Cards
that did remaine, the summe will be the num-
ber of points in the Cards taken, as if the Cards
were 7,10,5,8, and the terme given were 12;

<div align="right">**so**</div>

ſo the firſt wants 5, the ſecond wants 2, the third wants 7, and 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 be 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 be 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 privately multiply 15 by 5, makes 75, to which adde 5 makes 80, from this take 52 the number of Cards, reſt 28, to which add the remainder of Cards, make 34. the ſummewith 8, 6, 10, 3, 7.

Problem. LVII.

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

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

in

in which of the rankes his Card is, which heap
place in the middle of the other two heaps al-
wayes, and this do foure times at least, so in put-
ting the Cards altogether, look upon the Cards,
or let their back be towards you, and throw
out the eight Card, for that was the Card
thought upon without faile.

PROBLEM. LVIII.

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

ADmit there were 4 persons, then take 4
Cards, and shew them to the first, bid him
think one of them, and 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 do 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, and lastly, upon them these of the fourth
person, then shew unto each of these parties
each of these ranks, and aske him if his Card
be in it which he thought; for infallibly that
which the first partie thought upon will be in
the first rank, and at the bottome, the Card of
the second person will be in the second ranke,

the

the Card of the third thought upon will be in
the third rank, and the fourth mans Card will
be in the fourth rank; and so of others, if there
be more persons use the same method. This
may be practised by other things, ranking them
by certaine numbers: allotted to pieces of mo-
ney, or such like things.

PROBLEM. LIX.

*How to make an instrument to help hearing,
as* Galileus *made to help the sight?*

THink 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 trunks or pipes make
one heare well farre off, and experience
shewes us that in certaine places of the Or-
cades in a hollow vault, that a man speaking
but softly at one corner thereof, may be audi-
bly understood at the other end: notwithstand-
ing those which are between the parties can-
not heare him speak at all: And it is a generall
principle, that pipes do greatly help 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 issu-
ing out of a fountaine, shewes us that vvater be-
ing contracted into a pipe, causeth a violence in
its passage. The Glasses of *Galileus* 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 those which walk in the adjacent Gardens, which is by certaine vessels and pipes that answer from the Garden to the Hall. *Vitruvius* makes mention also of such vessels and pipes, to strengthen the voice and action of *Comedians*: and in these times amongst many noble personages, the new kinde of trunkes are used to help the hearing, being made of silver, copper, or other resounding materiall; in funnell-wise putting the widest end to him which speaketh, to the end to contract the voice, that so by the pipe applied to the eare it may be more uniform and lesse in danger to dissipate the voice, and so consequently more fortified.

PROBLEM. LX.

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

IT must be observed that the vessell in which the oile 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 ſolid matter : laſtly, this ſecond
circle) hath two pinnes, which may hang within
ſome box to containe the whole lamp, in ſuch
manner, that there be 6 pinnes in different po-
ſition : Now by the aid of theſe pegges or
pinnes, the lamp that is in the middle will be
alwayes well ſituated according to his Centre
of gravity, though it
be turned any way:
though if you endea-
vour to turne it up-
ſide downe, it will lie
levell: which is plea-
ſant and admirable
to behold to thoſe
which know not the
cauſe : And it is fa-
cil from his to make
a place to reſt quiet in, though there be great a-
gitation in the outvvard parts.

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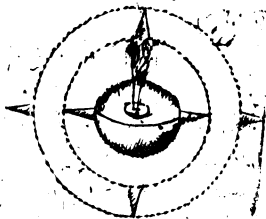
*Any one having thought a Card amongſt
many Cards, how artificially to
diſcover it out?*

TAke any number of Cards as 10, 12, &c. and
open ſome 4 or 5 to the parties ſight, and
bid him think one of them, but let him note
vvhether it be the firſt, ſecond, third, &c. then
vvith promptneſs learn vvhat number of Cards
you

you had in your hands, and take the other part
of the Cards, and place them 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 back-
wards 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 marke
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 mo-
ney as another, how could this be?

THE answer to the Probleme is easie, as sup-
pose 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 she 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
cheap.

$$A.20 \quad \frac{18}{3}$$
$$\frac{2}{18} \text{ and } 54 \text{ is } 56.$$

$$B.30 \quad \frac{13}{4}$$
$$\frac{17}{13} \text{ and } 39 \text{ is } 56.$$

$$C.40 \quad \frac{8}{7}$$
$$\frac{32}{8} \text{ and } 24 \text{ is } 56.$$

cheap, but would sell them for 3 pence the peece, which she 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 a 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 9th book of *Euclide.*

Thirdly,

Thirdly, the numbers 5 and 6 are called circular numbers, becaufe the circle turnes to the point from whence it begins : fo thefe numbers multiplied by themfelves, do end alwayes in 5 and 6; as 5 times 5 makes 25, that againe by 5 makes 125, fo 6 times 6 makes 36, and that by 6 makes 216, &c.

Fourthly, the number 6, is the firft which Arithmeticians call a perfect number, that is, whofe parts are equall unto it, fo 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 fo few of them, and how rare thefe numbers are, fo 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.

Fiftly, the number 9 amongft other priviledges carries with it an excellent property : for, take what number you will, either in groffe or in part, the nines of the whole or in its parts rejected, and taken fimply will be the fame, as 27 it makes 3 times 9, fo whether the nines be rejected of 27, or of the fumme of 2 and 7, it is all one, fo if the nines were taken avvay of 240, it is all one, if the nines were taken avvay of 2, 4, and 0; for there vvould remaine 6 in either ; and fo of others.

Sixtly

Sixtly, 11 being multiplied by 2, 4, 5, 6, 7, 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 unequall, notwithstanding the parts of the one number do alwayes equalize 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 book of *Euclide* was grounded, that the square of the *Hypothenusal* in any such Triangle, is equal to the square of the other two sides: that is 5, the *Hypothenusal* 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 quare of 8 and 6, *viz.* 10 times 10 makes 100, and 8 times 8 makes 64, and 6 times 6 is 36; which

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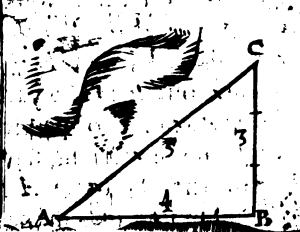
36 and 64, put together makes 100, as before:
and so may they be *Tripled, Quadrupled,&c.*

The use of these numbers 3,4,5, are mani-
fold, but it may be applied thus, for the help of
such which plot out Gardens, Houses, encamp
Horse or Foot , &c. Example , take 3 cords :
one of 5 yards, another of 4 yards, and another
of 3 yards , or the
double , triple, de-
cuple , &c. or all in
one line , and make
knots at the tearmes
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 plat , a square building
plat , 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 meet, 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
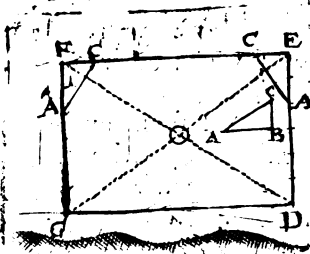
pegge; then at F, apply your Triangular cord, as you did at E, and so may you draw the line $F G$ as long as $E D$, *viz.* 60 yards. Lastly, it is easie to draw the line $G D$, and so the rectanguled figure or long square shall be plotted, whose breadth is 60 yards, & length 100 yards, as was required: 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 be amended.

If one be 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 $+.1$ being added to that even number makes a square number, and the even number taken from it leaves a square number.

If odde numbers be continually added from the unitie successively, there will be made all square numbers; and if cubick numbers be added successively from the unitie, there will be likewise made square numbers.

PROBLEM. LXIV.

Of an excellent lamp, which serves or furnisheth it selfe with oile, and burnes a long time.

I Speak not here of a common lamp which *Cardanus* writes upon in his book *de subtilisate*, for that's a little vessell in columne-wise, which

which is full of Oile , and becaufe there is but
one little hole at the bottome neare the weeke
or match; the oile runnes not , for feare that
there be emptineffe above : when the match is
kindled it begins to heat the lamp , and rare-
fying the oile it iffueth by this occafion : and
fo fends his more airie parts above to avoid va-
cuitie.

But that which I
here deliver , is more
ingenious, the princi-
pall peece of which is
a veffel, as C D. which
hath neare the bot-
tome a hole , and a
funnell or pipe C. &
then a bigger fun-
nell, which paffeth
through the middle
of the veffell, having an opening at D neare the
E top , and another at the bottome as at E, near
the veffell under it , fo that the pipe touch it
not : the veffell being thus made , fill it with
oyle, and opening the hole C. the oile running
out will ftop the hole at E, or throwing in oile
into the veffell underneath , untill E be ftop-
ped ; then the oile at C will not runne : becaufe
no aire can come into the pipe D E. Now as
the oile burneth and confumeth in the veffell
A B, the hole at E, will begin to be open, then
immediately will C begin to runne to fill up A
B. and E being ftopped with the oile, the oile
at C ceafeth to run.
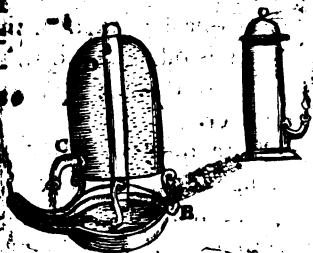
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It is certaine that such a lampe the *Athenians* used, which lasted a whole yeare without being touched: which was placed before the statue of *Minerva*, for they might put a certaine quantitie of oile in the lamp *C D*, and a match to burne without being consumed: such as the naturalists write of, by which the lamp will furnish it selfe, and so continue in burning: and here may be noted that the oile may be poured in, at the top of the vessell at a little hole, and then made fast againe that the aire get not in.

Problem. LXV.

Of the play at Keyles or nine Pinnes.

YOu will scarce beleeve 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 be demonstrated, that if the hand of him that playes were 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 strike it, that it should strike down the Keyles, and 5, and these might in their violence strike
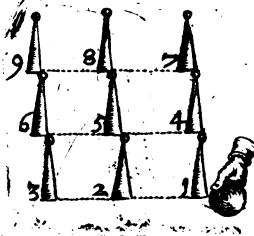
downe

downe the Keyles 3,
6, and 9, and the
bowle being in mo-
tion may ſtrike down
the Keyle 4, and 7;
which 4 Keyle may
ſtrike the Keyle 8, &
ſo all the 9 Keyles
may be ſtriken down
at once.

PROBLEM. LXIV.

Of Spectacles of pleaſure.

SImple Spectacles of blew, yellow, red or
green colour, are proper to recreate the ſight,
and will preſent the objects died in like colour
that the Glaſſes are, only thoſe of the greene
do ſomewhat degenerate; inſtead of ſhewing
a lively colour it will repreſent a pale dead co-
lour, 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.

EXAMINATION.

IT is certaine, that not onely Glaſſes dyed
green, but all other Glaſſes coloured, yield
the appearances of objects ſtrong or weak in
colour according to the quantity of the dye,
more or leſſe, as one being very yellow,
another

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 beams; for in the same Glasses those which are most dyed, give alwayes the objects more high coloured and obscure, and those which are lesse dyed give 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 divers Angles diamond-wise do make a marvellous 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 solely by the diversity of refractions, for as many plainces 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 avaricious persons that love Gold and silver, for one piece will seeme many, or one heap of money will seeme as a treasury: but all the mischiefe is, he will not have his end in the enjoying of it, for indeavouring to take

it, it will appeare but a deceitfull *Image*, or delu-
sion of nothing. Here may you note that if the finger
be directed by one and the same ray or beam, which
pointeth to one and the same object, then at the first
you may touch that visible object without being de-
ceived: otherwise you may faile often in touching
that which you see. Againe, there are *Spectacles*
made which do diminish the thing seen very much,
and bring it to a faire perspective forme, espe-
cially if one look upon a faire *Garden* plat, a greater
walk, a stately building, or great *Court*, the indu-
stry of an exquisite *Painter* cannot come neare to
expresse the lively forme of it as this *Glasse* will re-
present it; you will have pleasure to see it really ex-
perimented, and the cause of this is, that the Glasses
of these *Spectacles* are hollow and 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 seen 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 *Galileus* admirable *Glasse*,
for the common simple perspective *Glasses* give to
aged men but the eyes or sight of young men, but
this of *Galileus* gives a man an *Eagles* eye, or an
eye that pierceth the heavens: first it discovereth the
spottie and shadowed opacous bodies that are found
about the *Sunne*, which darkneth and diminisheth
the splender of that beautifull and shining *Lumina-*
ry: secondly, it shewes the new *Planets* that ac-
company

company Saturne and Jupiter: *thirdly* , *in*
Venus *is seen the new, full, and quartill in-*
crease ; as in the Moon by her separation
from the Sunne : fourthly *, the artificiall*
structure of this instrument helpeth us to see
an innumerable number of stars, which other-
wise are obscured, by reason of the naturall
weaknesse of our sight, yea the starres in via
lactea *are seen most apparautly; where there*
seem no starres to be, this Instrument makes
apparantly to be seen , and further delivers
them to the eye in their true and lively co-
lour, as they are in the heavens : in which
the splendor of some is as the Sunne in his
most glorious beauty. Thus Glasse hath also a
most excellent use in observing the body of
the Moone in time of Eclipses , for it aug-
ments 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
Moon, & when totally she is over shadowed :
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 therein
his performance, so on the earth it claimeth

pre-

preheminency, *for the objects which are far-
theft remote, and moft obfcure, are feen plain-
er than thofe which are neere at hand, fcorn-
ing as it were all fmall and triviall fervices,
as leaving them to an inferiour help : great
ufe may be made of this Glafs in difcovering
of Ships, Armies, &c. Now the apparell or
parts of this inftrument or Glaffe, is very
meane or fimple, which makes it the more ad-
mirable (feeing it performes fuch great fer-
vice) having but a convex Glaffe thickeft in
the middle, to unite and amaffe the rayes, and
mak the object the greater: to the augmenting
the vifuall Angle, as alfo a pipe or trunk to
amaffe the* Species, *and hinder the greatnefs
of the light which is about it : (to fee well,
the object muft be well inlightened, and
the eye in obfcurity,) then there is adjoyn-
ed unto it a Glaffe of a fhort fight to diftin-
guifh the rayes, which the other would make
more confufed if alone. As for the proportion
of thofe Glaffes to the Trunk, though there
be certaine rules to make them, yet it is often
by hazard that there is made an excellent one
there being fo many difficulties in the action,
therefore many ought to be tryed, feeing that
exact proportion, in Geometricall calculati-
on cannot ferve for diverfity of fights in the
obfervation.* PROB.

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

WHo would beleeve if he faw 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 black 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 vvere a
chaine without a line, without souldering toge-
ther , or without any other thing to support
them onely; but a most occult and hidden ver-
tue, yet most evident in this effect, which pene-
trateth infensibly from the first to the second,
from the second to the third, &c.

Is it not a wonder to see that a needle touch-
ed once will draw other needles; and so a naile,
the point of a knife , or other pieces of Iron?
Is it not a pleafure to fee how the *magnes* will
turne file duft , or move needles , or nailes be-
ing upon a Table, or upon a piece of paper ?for
as foone as the *magnes* turnes or moves over,
it moves alfo : who is it that would not be ra-
H 4   viſhed

vished as it were, to
see a hand of Iron
write upon a planke,
without seeing the
Magnes which cau-
seth that motion be-
hinde the planke, or
to make an image of
Iron to run up and
downe a Turret:now
infinite of such inven-
tions is proper to be
extracted from the
properties of the
magnes.

What is there in the world that is more ca-
pable to cast a deeper astonishment in our minds
than a great massie substance of Iron to hang
in the aire in the middest of a building without
any thing in the world touching it, only but
the aire? As some histories assure vs, that by the
aid of a *Magnes* or Adamant, placed at the roof
of one of the Turkish Synagogues in *Meca* : the
sepulchre of that infamous *Mah.met* rests sus-
pended in the aire ; and *Plinie* in his naturall
Historie writes that the Architect or *Democrates*
did begin to vault the Temple of *Arsinoe* in *A-
lexandria* , with store of *magnes* to produce the
like deceit, to hang the sepulchre of that God-
desse likewise in the aire.

I should passe the bounds of my counter-
poise, if I should divulge all the secrets of this
stone,

ftone, and fhould expofe my felfe to the laugh-
ter of the world: if I fhould brag to fhew others
the caufe how this appeareth, than in its owne
naturall fympathy, for why is it that a *magnes*
with one end will caft the Iron away, & attract
it with the other? from whence commeth it that
all the *magnes* is not proper to give a true touch
to the needle, but only in the two Poles of the
ftone: which is known by hanging the ftone by
a threed in the aire untill it be quiet, or placed
upon a peece of Cork in a difh of water, or upon
fome thinne board, for the Pole of the ftone
will then turne towards the Poles of the world,
and point out the North and South, and fo
fhew by which of thefe ends the needle is to be
touched?

From whence comes it that there is a varia-
tion in the needle, and pointeth not out truly
the North and South of the world, but only in
fome place of the earth?

How is it that the needle made with pegges
and inclofed within two Glaffes, fheweth the
height of the Pole, being elevated as many de-
grees as the Pole is above the Horizon?

What's the caufe that fire and Garlick takes
away the propertie of the *magnes*? There are
many great hidden myfteries in this ftone, which
have troubled the heads of the moft learned in
all ages; and to this time the world remaines ig-
norant of declaring the true caufe thereof.

Some fay, that by help of the *Magnes* per-
fons which are abfent may know each others
minde,

minde, as if one being here at *London*, and a-
nother at *Prague* 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 which is at *Prague* shall move, this that
is at *London* shall also; provided that the parties
have like secret notes or alphabets, and the ob-
servation 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 moving of the other parties
needle shall open his intention.

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

EXAMINATION.

THe *experimentall difference of rejecti-*
on, and attraction proceeds not from the
different nature of Stones, but from the qua-
lity of the Iron, and the vertue of the stone
consisteth only, and especially in his poles,
which being hanged 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

turning *North* and *South*, as the magnes
hath:notwithstanding theend of the Iron Rod
touched, hath acontrary 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 this may easily be experi-
mented upon two needles touched with one or
different stones, though they have one
and the same position; for as you come unto
them apply one end of the magnes neare unto
them, 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 between 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 naile of ones
finger or such like,) and marke which way
the end of the needle that was touched turn-
eth: if to the *South*, then the point that
touched

touched it was the South-Pole, &c. and it is most certain 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 Æolipiles or bowels to blow the fire.

THese are concave vessels of Brass or Copper or other material, 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 be hot there is no effect seen; but assoone as the heat doth penetrate it, the water begins to rarefie, & issueth forth with a hidious and marvelous force; it is pleasure to see how it blowes the fire with great noise.
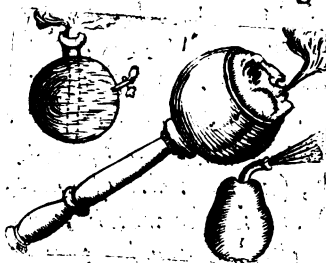
Vitruvius in his first book of *Architecture*, *Cap.* 8: approves from these Engines, that winde is no other thing than a quantity of vapours and exhalations agitated with the aire by rarefaction and condensation, and we may draw a consequence from it, to shew that a little water

ter

ter may ingender a very great quantitie of vapours and aire : for a Glaſſe of water throwne into an *Æolipile* will keep blowing neare a vvhole houre, ſending forth his vapours a thouſand times greater than it is extended.

Novv touching the forme of theſe veſſels, they are not made of one like faſhion : ſome makes them like a bovvle, ſome like a head painted repreſenting the vvinde, ſome make them like a Peare : as though one vvould put it to roſt at the fire, vvhen one vvould have it to blovv, for the taile of it is hollovv, in forme of a funnell, having at the top a very little hole no greater than the head of a piñne.

Some do accuſtome to put vvithin the *Æolipile* a crooked funnell of many foldings, to the end that the vvinde that impetuouſly rolles, to and fro vvithin, may imitate the noiſe of thunder. Others content themſelves vvith a ſimple funnell placed right upvvard, ſomevvhat vvider at the top than elſevvhere like a Cone, vvhoſe baſis is the mouth of the funnell : and there may be placed a bovvle of Iron or Braſſe, vvhich by the vapours that are caſt out vvill cauſe it to leap up, and dance over the mouth of the *Æolipile*.

Laſtly, ſome apply near to the hole ſmal Windmils, or ſuch like, vvhich eaſily turne by reaſon of the vapours; or by help of tvvo or more bovved funnels, a bowle may be made to turne: theſe *Æolipiles* are of excellent uſe for the melting of mettalls and ſuch like.

<div align="right">Novv</div>

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

Heat the *Æolipiles* being empty, and the aire which is within it will become extreamely rarefied ; then being thus hot throw it into water, and the aire will begin to be 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 *Æolipile*.

Problem. LXIX.

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

THis 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, yellow, green, or such like : such as is not thick. This being done the use may be thus.

First, I say, that as the aire inclosed in the *Thermometer* is rarefied 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

ball

ball of the *Thermometer* : the Glaſſe being ſo
thinne, and the aire ſo capable of rarefaction,
that at the very inſtant you may ſee the water
deſcend: and your hand being taken away, it
will ſoftly aſcend to his formes place againe.
This is yet more ſenſible when one heats the
ball at the top 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 heat-
ed in the *Thermome-*
ter, doth rarefie 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 heat
and cold, which are in the aire each houre of
the day; foraſmuch as the exterior aire is either
hot or cold, the aire which is incloſed in the
Thermometer doth likewiſe either rarefie.or con-
denſe, and therefore the water aſcends or de-
ſcends; ſo you ſhall ſee that the water in the
morning is mounted high, afterward by little
and little it will deſcend towards noone or mid-
day; and towards evening it will againe aſcend:
ſo in winter it will mount ſo high, that all the
Cylinder of the *Thermometer* will be full, but
in
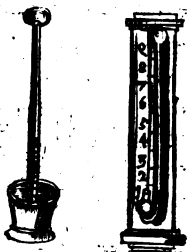
in Summer, it will defcend fo low that fcarce
there will be percea ved in it any water at all.

Thofe 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 *Philofophers*,
or into 4 degrees according to the Phyficians,
dividing each of thefe 8 into 8 others: to have
in all 64 divifions, & by this vvay they may not
only diftinguifh upon vvhat degree the vvater
afcendeth in the morning, at midday, & at any
other houre: but alfo one may knovv hovv much
one day is hotter or colder than another : by
marking hovv many degrees the vvater afcend-
eth or defcendeth, one may compare the hot-
teft and coldeft dayes in a vvhole year together
vvith thefe of another year : againe one may
knovv hovv much hotter one roome is than an-
other' ; by vvhich alfo one might keep a cham-
ber, a furnace, a ftove, &c. alvvayes in an equalitie
of heat, by making the vvater of the *Thermo-
meter* reft alvvayes upon one & the fame degree :
in brief, one may judge in fome meafure the
burning of Fevers, and neare unto what exten-
fion the aire canbe rarefied by the greateft heat.

Many make ufe of thefe glaffes to judge of
the yveather: for it is obferved that if the vvater
fall in 3 or 4 hours a degree or thereabout, that
raine infueth; and the vvater vvill ftand at that
ftay, untill the vveather change : marke the wa-
ter at your going to bed, for if in the morning
it hath defcended raine followeth, but if it be

<div align="right">mounted</div>

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

Problem. LXX.

Of the proportion of humane bodies of sta-
tues, of Coloſſus or huge images,
and of monſtrous Giants.

PYthagoras had reaſon to ſay that man is the
measure of all things.

Firſt, becauſe he is the moſt perfect amongſt
all bodily creatures, & according to the *Max-*
ime of Philoſophers, that which is moſt perfect
and the firſt in rank, meaſureth all the reſt.

Secondly, becauſe in effect the ordinary mea-
ſure of a foot, the inch, the cubit, the pace, have
taken their names and greatneſſe from humane
bodies.

Thirdly, becauſe the *ſymmetrie* and concord-
ancie 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 pieces 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 breadth 50
Cubits, in height or depth 30 cubits, ſo that the
length containes the breadth 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 *Solomon* (that chieftaine of works) was modulated all of good *Architecture*, and curiously to be observed in many pieces to keep the same proportion as the body to his parts: so that by the greatnesse of the work 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 foot; the top, and roofe as the head; the rest as the body: those which have beene somewhat more curious, have noted that as in humane 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 equality in the same *Architecture*.

In like manner, some have been 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 channells of columnes, to the fouldings of womens Robes, &c.

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

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

and all the best *Architectes.*, treate of the proportion of man; amongst others *Albert Durens* hath made a whole book of the measures of mans body, from the foot to the head, let them read it who wil, they may have a prefect knowledge thereof: 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. *Andrews* Crosse, placing one foot 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 neck, make 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 extremity of the longest finger.

Fiftly, the thicknesse of the body taken from the belly to the back; the one or the other is the tenth part of the whole body, or as some will have it, the ninth part, little lesse.

Sixtly, the height of the brow, the length of

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the nofe, the fpace between the nofe and the chinne, the lengt h of the eares, the greatneffe of the thumbe, are perfectly equall one to the other.

What would you fay to make an admirable report of the other parts , if I fhould reckon them in their leaft ? but in that I defire to be excufed, and will rather extract fome conclufion upon that which is delivered.

In the firftplace, knowing the proportion of a man, it is eafie to Painters, Image-makers, &c. perfectly co proportionate their work ; and by the fame is made moft evident, that which is related of the images and ftatues of Greece, that upon a day diverfe workmen having enterprifed to make the face of a man, being fevered one from another in fundry places, all the parts being made and put together, the face was found in a moft lively and true proportion.

Secondly, it is a thing moft cleare, that by the help of proportion, the body of *Hercules* was meafured by the knowledge of his foot onely , a Lion by his claw, the Giant by his thumb, and a man by any part of his body.   For fo it was that *Pythagoras* having meafured the length of *Hercules* foot , by the fteps which were left upon the ground, found out all his height: and fo it was that *Phidias* having oneiy the claw of a Lion, did figure and draw out all the beaft according to his true type or forme, fo the exquifite Painter *Timantes*, having painted a *Pygmey* or Dwarfe, which he meafured with a fadome made with the inch of a Giant , it was fufficient

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ent to know the greatneſſe of that Giant-

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

Of Statues , of Coloſſus , or huge images.

VItruvius relates in his ſecond book, that the eArchitect *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 piece of work 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 reteine the Citizens of that place, *Alexander* was wiſe not to entertaine the deſigne.

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

For the Statue, it could not be higher than the Mountaine it ſelfe, and the Mountaine was about a mile in height plumb or perpendicular;

therefore the hand of this Statue ought to be
the 10th part of his height, which would be
500 foot; and so the breadth of his hand would
be 250 foot, the length now multiplyed by the
breadth, makes an hundred twenty five thousand
square feet, for the quantitie of his hand to
make the towne in, to lodge the said 10 thou-
sand men, allowing to each man neere about
12 foot of square ground : now judge the ca-
pacitie of the other parts of this *Collossus* by
that which is already delivered.

Secondly, *Plinie* in his 34 book of his natural
History, speakes of the famous *Colossus* that
was at *Rhodes*, between whose legges a Shippe
might passe with his sailes open or displayed,
the Statue being of 70 cubits high : and other
Histories report that the *Sarasens* having bro-
ken it, did load 900 Camels with the mettal
of it, now what might be the greatnesse and
weight of this Statue?

For answer, it is usually allowed for a Ca-
mels burthen 1200 pound weight, therefore
all the *Collossus* did weigh 1080000 pound
weight, which is ten hundred and fourescore
thousand pound vveight.

Novv 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
foot and a halfe, and seeing that the Nose, the
brovv, and the thumbe, are the third part of the
face, his Nose vvas 2 foot and a halfe long, and
so much also vvas his thumbe in length : novv
the thicknesse being alvvayes the third part of
the

the length, it should seem that his thumb was a foot thick 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 be painted in the same height. Now would you know the greatnesse of the members of this *Colossus*, the breadth would be 20 foot, his face 12 foote, his thumb and his nose 4 foot, 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 speak therefore a word touching the Giants, and then passe away to the matter.

Of monstrous Giants.

Y Ou 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 ago there have been men of a most prodigious greatnesse; for the holy vvritings vvitnesse this themselves in *Deut, Chap.* 3. that there vvas a certaine Giant called *Og*, of the Town of *Rabath*, vvho had a bed of Iron, the length thereof vvas 9 cubits, and in breadth 4 cubits.

So in the first of *Kings Chap.* 17. there is mention made of *Goliah*, vvhose height vvas a

I 4   palme

palme and 6 cubits, that is more then 9 foot,
he was armed from the head to the foot, and
his Curiat onely with the Iron of his lance,
weighed five thousand and six hundred shekels,
which in our common weight, is more than
233 pound, of 12 ounces to the pound: Now
it is certaine, that the rest of his armes taking
his Target, Helmet, Bracelets, and other Ar-
mour together, did weigh at the least 5 hun-
dred pound, a thing prodigious; seeing that
the strongest man that now is, can hardly beare
1200 pound, yet this Giant carries this as a ve-
sture without paine.

Solinus reporteth in his 5 *Chap.* of his Histo-
rie, that during the Grecians warre after a great
overflowing of the Rivers, there was found up-
on the sands the carcase of a man, whose
length was 33 Cubits, (that is 49 foot and a
halfe) therefore according to the proportion
delivered, his face should be 5 foot in length,
a thing prodigious and monstrous.

Plinie in his 7. book and 16 *Chap.* saith, that
in the Isle of *Crete* or *Candia*, a mountaine be-
ing cloven by an Earth-quake; there was a bo-
dy standing upright, which had 46 Cubits of
height: some beleeve that it was the body of
Orion or *Othus*, (but I think rather it was some
Ghost or some delusion) whose hand should
have beene 7 foot, 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 *Tingy* a Morative Towne, where

it

it is thought that the Giant *Antheus* was buried, *Sertorius* could not beleeve that which was reported of his prodigious greatnesse, caused his sepulchre to be opened, and found that his body did containe 60 Cubits in length, then by proportion he should be 10 Cubits or 15 foot in breadth; 9 foot for the length of his face, 3 foot for his thumb, which is neare the capacitie of the *Colossus* at *Rhodes.*

But behold here a fine fable of *Symphoris Campesius*, in his book intituled *Hortus Gallicus*, who sayes that in the Kingdome of *Sicilie*, at the foot of a mountaine neare *Trepane*, in opening the foundation of a house, they found a Cave in which was laid a Giant, which held in stead of a staffe a great post like the mast of a Ship: 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 corn, and by proportion it should seeme that his length was 200 cubits, or 300 foot: if he had said that he had been 300 cubits in length, then he might have made us beleeve that *Noahs* Ark was but great enough for his sepulchre.

Who can believe that any man ever had 20 cubits, or 30 foot in length for his face, and a nose of 10 foot long? but it is very certaine that there have been men of very great stature, as the holy Scriptures before witnesse, and many Authours worthy of beliefe relate: *Josephus Acosta* in his first book of the Indian History, *Chap.* 19. a late writer, reporteth, that

at

at *Peru* was found the bones of a Giant, which
was 3 times greater than these of ours are, that
is 18 foot, for it is usually attributed to the
tallest ordinary man in these our times but 6
foot of length; and Histories are full of the
description of other Giants of 9, 10, and 12
foot of height, and it hath been seen in our
times some which have had such heights as
these.

PROBLEM. LXXI.

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

THe Mathematickes often findeth place in
sundry Games to aid and assist the Game-
sters, though not unknowne unto them, hence
by Mathematicall principles, the games at Ten-
nis may be assisted, for 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 suffi-
ciently deliver the motion of a Ball or Bowle by
Geometrical lines and angles.

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

give a great advan-
tage to thoſe which
would make uſe of
them in ſuch gam-
ings

And the firſt max-
ime is thus: When a
Bowle toucheth ano-
ther Bowle, or when
a trapſtick ſtriketh
the Ball, the moving
of the Ball is made in
a right line, which
is drawne from the Centre of the Bowle by the
point of contingencie.
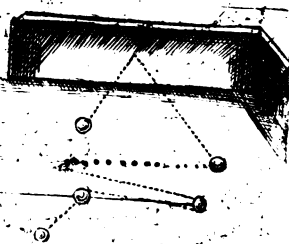
Secondly, in all kinde of ſuch motion; when
a Ball or Bowle rebounds, be it either againſt
wood, a wall, upon a Drumme, a pavement, or
upon a Racket; the incident Angle is alwayes
equall to the Angle of reflection.

Now following theſe *maximes*, it is eaſie to
canclude, firſt, in what part of the wood or
wall, one may make the Bowle or Ball go 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 go and meet with the third, keep-
ing the reflection or Angle of incidence equal.

Thirly, how one may touch a Bowle to ſend
it to what part one pleaſeth: ſuch and many
other practices may be done. At the exerciſes at
Keyls there muſt be taken heed that the motion
ſlack or diminiſh by little and little, and
<div align="right">may</div>

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, otherwise one may be frustrated
in that respect.

PROBLEM. LXXII.

Of the Game of square formes.

NVmbers have an admirable secrecie, di-
versly applied, as before in part is shewed,
and here I will say something by way of transf-
mutation 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 were appointed 9 men to
defend each front thereof, some at the gates, &
the other at each corner or Angle, so that each
Angle served to assist two faces of the square,
if need required: Now this square passage be-
ing thus manned to have each side 9, it hap-
ned that 4 Souldiers comming by, desired of the
Governour of the passage, that they might be
entertained into service, who told them he
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 ea-
sily place themselves amongst the rest, and yet
keep

keep ſtill the order
of 9, for each face of
the ſquare to defend
the Angles & Gates,
to which the Gover-
nours agreed, and
theſe Souldiers being
there ſome few weeks
liked not their ſervice

3 3 3	2 5 2	4 1 4
3 **A** 3	5 **B** 5	1 **C** 1
3 3 3	2 5 2	4 1 4
0 3 0	1 2 1	2 1 2
3 **O** 3	2 **G** 2	1 **H** 1
0 3 0	1 2 1	2 1 2
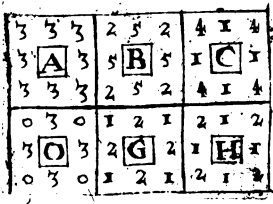
but indeavoured to remove themſelves, and ſo
laboured with ſome of the the reſt; that each
of theſe foure Souldiers took away his cumrade
with him, and ſo departed; yet left to defend
each ſide of the paſſage, and how may this be?

It's anſwered thus, in the firſt forme the men
were as the figure *A*, then each of theſe 4
Souldiers placed themſelves at each Gate, and
removing one man from each Angle to each
Gate, then would they be alſo 9 in each ſide
according to the figure *B*. Laſtly, theſe 4 Soul-
diers at the Gates take away each one his Cum-
rade, and placing two of theſe men which are
at each Gate to each Angle, there will be ſtill 9
for each ſide of the ſquare, according to the fi-
gure *C*. In like manner if there were 12 men,
how might they be placed about a ſquare that
the firſt ſide ſhall have 3 every way, then diſ-
ordered, ſo that they might be 4 every way; and
laſtly, being tranſported might make 5 every
way, & this is according to the figures, *F. G. H*

PROB.

Problem. LXXIII.

How to make the string of a Viole sensibly shake ;
without any one touching it?

THis is a miracle in musick , yet easie to be
experimented. Take a Viole or other Instru-
ment, and choose two strings , so that there be
one between them ; make these two strings, a-
gree in one and the same tune : then move the
Viole-bowe 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 touch-
ing it; and it is more admirable that the string
which is between 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 stop-
ping 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? & whence is it that the Viole-bowe mo-
ved upon the first string , doth instantly in the
same time move the third string,and not the
second? if the cause be not either in the first or
second? I leave to others to descant on.

EX-

EXAMINATION.

IN 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 extention upon one and the
same Cord in capacitie : then what might be
produced upon different Cords of length and
bignessto make them accord in a unisone or
octavo, or some consort intermediate : 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 admi-
rable Phænomeny. *Now this will sensibly
appeare when the Cords are of equall length
and greatnesse, and set to an unisone ; but
when the Cords differ from their equalitie,
it will be lesse sensible : hence in one and the
same Instrument, Cords at a unisone shall ex-
cite or shake more than that which is at an
octavo, and more than those which are of an
intermediate proportionall consort : as for
the other consorts they are not exempted,
though the effect be not so sensible, yet more
in one than in another : and the experiment
will seem more admirable in taking 2 Lutes,
Viols, &c. & in setting 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 o-
ther : and not onely so but also a harmony.

Problem. LXXIII.

Of a vessell which containes three severall kindes of
liquor, all put in at one bung-hole, and drawn
out at one tap severally without
mixture.

THe vessell is thus made ; it must be divided
into three Cells for to conteine the three li-
quors, which admit to be Sack, Claret, and
White-wine: Now in the bung-hole there is an
Engine with three pipes, each extending to his
proper Cell, 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 tvvo pipes
are stopped; then vvhen it is full, turne the fun-
nel, and then the former hole vvill be stopped,
and another open, to cast in other vvine vvith-
out mixing it vvith the other.

Novv to dravv out also vvithout mixture, at
the bottome of the vessell there must be placed
a pipe or broach, vvhich may have three pipes ;
and a cock piersed vvith three holes so artifici-
ally done, that turning the cock, the whole
vvhich anfvvereth to such of the pipes that is
placed at the bottom, may issue forth such vvine
as belongeth to that pipe, & turning the Cock
to another pipe, the former hole vvil be stopped;
<div align="right">and</div>

and so there will issue
forth another kinde
of wine without any
mixtures ; but the
Cocke may be so or-
dered that there may
come out by it two
wines together, or all
three kindes at once:
but it seems best
when that in one vessell and at one Cocke, a
man may draw severall kindes of wine, and
which he pleaseth to drink.
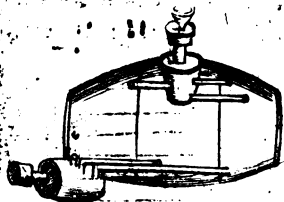
PROBLEM. LXXV.
Of burning-Glasses.

IN this insuing discourse I will shew the in-
vention of *Prometheus*, how to steale fire from
Heaven, and bring it down 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-brands to wake them
burne, melt Lead, Tinne, Gold, and Silver, in
a little time: with as great ease as though it had
been put into a Cruzet over a great fire.

Have you not read of *Archimedes* of *Syracu-
sa*, who when he could not come to the Ships
of *Ma cellus* which besieged that place, to hin-
der and impeach their aproach, he flung huge
stones by his Ingines to sink them into the Sea,
and transformed himselfe into *Jupiter*, thunder-
ing downe from the highest Towers of the

K   Town

Town, his thunder-bolts of lightning into the
Ships causing a terrible burning, in des-
pite of Neptune and
his watery region: *Zo-
ndrus* witnesseth that
Proclus a brave Ma-
thematician, burned
in the same manner
the Ships of *Vitali-
an*, which were come
to besiege *Constanti-
nople*; and daily experience may let you see
great effects of burning: for a Bowle of Cry-
stall 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 chil-
dren use with a Glasse to burne Flies which are
against the walles, and their fellowes cloaths.
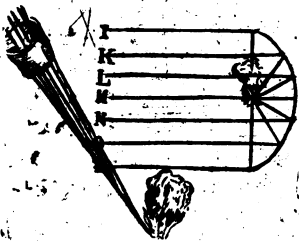
But this is nothing to the burning of those
Glasses which are hollow, namely those which
are of steele well polished, according to a pa-
rabolicall or ovall section. A sphericall Glasse,
or that which is according to the segment of a
Sphere, burnes very effectually about the fourth
part of the Diameter; notwithstanding the Pa-
rabolic and Ecliptick sections have a great ef-
fect : by which Glasses there are also diverse fi-
gures represented forth to the eye.

The cause of this burning is the uniting of
the beames of the Sunne, which heat migh-
tily in the point of concourse or inflammation,
which

which is either by tranſmiſſion or reflection.
Now it is pleaſant to behold when one breath-
eth in the point of concourſe ; or throweth
ſmall duſt there, or ſprinkles vapours of hot wa-
ter in that place ;' by which the Pyramidall
point, or point of inflammation is knowne. Now
ſome Authors promiſe to make Glaſſes which
ſhall burne a great diſtance off , but yet not
ſeen vulgarly produced, of which, if they were
made, the Parabolie makes the greateſt effect,
and is generally held to be 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 ſhadow, or neare ſuch a place where the
Sunne ſhines not , which is by help of a flat
Glaſſe, by which may be made a pertuſſion of
the beames of the Sun into the concave Glaſſe,
adding unto it that it ſerves to good uſe to put
fire to a Mine, provided that the combuſtible
matter be well applyed before the concave
Glaſſe ; in which he ſaies true : but becauſe all
the effect of the practice depends upon the
placing of the Glaſſe and the Powder which be
ſpeaks 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 Sun ſhining, it
ſhall take fire and burne : Now it is certaine

that the point of inflammation or burning, is
changed as the Sun chargeth place; and no
more nor lesse, than the shadow turnes about
the style 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 top
of the style is, and the Powder or other combu-
stible matter under the Meridian; or houre of
12, 1, 2, 3, &c. or any other houre, and under
the Suns arch for that day: now the Sunne
comming to the houre of 12, to 1, 2, ·, &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.

IT is certaine in the first part of this Pro-
bleme that Conicall, concave and sphericall
Glasses, of what matter soever, being placed
to receive the beames of the Sun will excite
heat, and that heat is so much the greater, by
how much it is neere the point of concourse or
inflammation. But that Archimedes or Proclus
did fire or burne Shipps with such Glasses,
the ancient Histories are silent, yea the selves
say nothing: besides the great difficultie
that doth oppose it in remotenesse, and the
matter that the effect is to work upon: Now

by

by a common Glasse we fire things neare at
hand, from which it seems very facil to
such which are lesse read, to do it at a farre
greater distance, and so by relation some de-
liver 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 admirable effects which are in Burning-
glasses, but to shew the variety of Antiquity,
and truth of History : and as touching to
burne at a great distance, as is said of some,
it is absolutely impossible, and that the Pa-
rabolicall and Ovall Glasses were of Ar-
chimedes and Proclus invention is much
uncertaine : for besides the construction of
such Glasses, they are more difficult than the
obtuse concave ones are ; and further, they
cast not a great heat but neere at hand, for if
it be cast farre off, the effect is little, and the
heat weake, or otherwise such Glasses must
be greatly extended to contract many beames
to amasse a sufficient quantity of beames in
Parabolicall and Conicall Glasses, the point
of inflammation ought to concur in a point,
which is very difficult to be done in a due pro-
portion. Moreover if the place be farre re-
mote, 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 diminished, by reason of the weaknesse of the Sunne-beames.

And here may be noted in the last part of this Probleme, that by reason of obstacles if one plaine Glasse be not sufficient, a second Glasse may be applyed to help it: that so if by one simple refraction it cannot be done, yet by a double reflection the Sun-beames may be cast into the said Caverne or Mine, and though the reflected beams in this case be weak, yet upon a fit cumbustible matter it will not faile to do 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 Greek Epigrams , but proposing the Question immediately will give the answer also , without staying to shew the manner how they are answered ; in this I will not be tied to the Greek tearms , which I account not proper to this place , neither to my purpose: let those read that will *Diophanta Schenbelius* 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 carried

a

a Barrell full of Wine : now the lasie Asse felt
her selfe over-loaden, complained and bowed
under her burthen; which thr Mule seeing said
unto her being angry , (for it was in the time
when beasts spake) Thou great Asse, wherefore
complainest thou ? if I had but onely one mea-
sure of that which thou carriest , I should be
loaden 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 apiece.

Of the number of Souldiers that fought before old Troy.

HOmer 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 eve-
ry fire, or in every Kitchin there were 50 broa-
ches turning to roast a great quantitie of flesh,
and each broach had meat enough to satisfie
900 men : now judge how many men there
might be. Answer, 315000. that is, three hun-
dred and fifteen thousand men, which is cleare
by multiplying 7 by 50 , and the product by
900 makes the said 315000.

Of

Of the number of Crownes that two men had.

John and *Peter* had certaine number of crowns: John 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 *John*, If you give me 10 of your crownes I shall have 5 times as much as you have: how much had each of them? Answere, *John* 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 those of *Johns*, then should *John* have 25 crownes and 5 sevenths of a crowne, which is triple to that of *Peters*, viz. 8, and 4 sevenths: and *John* 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 *John* 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.

Abou

SOme one asked a Mathemacian what a clocke it was ; who anſwered that the reſt of the day is ſoure thirds of that which is paſt : now judge what a clock it is. Anſwer, if the day were according to the Jewes and ancient Romanes , which made it alwayes to be 12 houres , it was then the 5 houre, and one ſeventh of an houce , ſo there remained of the whole day 6⅗ that is, 6 houres, and 6 ſevenths of an hour. Now if you take the ⅓ of 5 ⅐ it is,¹² or 1 and ⅚.7,which multipled by 4 makes 6 and ⅚, which is the remainder of the day, as before: but if the day had been 24 houres , then the houre had been 10 of the clock,and two ſeventhes of an houre , which is found out by dividing 12, or 24 by ⅐.

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

Of Pythagoras his Schollers.

PYthagoras being asked what number of Schollers he had , anſvvered , that halfe of them ſtudied *Mathematickes* , the fourth part Phyſick , the ſeventh part Rethorick , and beſides he had 3 vvomen : novv judge you ſaith he, hovv many Schollers I have. Anſvver, he had in all 28, the halfe of vvhich is 14 , the qnarter

of

of which is 7,   rt of which is
which 14, 7, and   d the other
3 to make up the 28,   men.

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, met
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 & the
Muses had one as many as the other: The que-
stion is how many Apples each Grace had, and
how many they gave to each Muse? To an-
svver the qeustion, joyne the number of Graces
and Muses together vvhich makes 12, and so
many Apples had each Grace: Novv 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 di-
stribution 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 Crovvnes a-
mongst his tvvo children; the one being
legitimate, and the other a Bastard, conditio-
nally

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 $\frac{7}{9}$, and
the Bastard 422 crownes and $\frac{2}{9}$; now the fifth
part of 577 and 7 ninthes is 1 5, and $\frac{5}{9}$, and the
fourth part of 422 and $\frac{2}{9}$ is 105 and $\frac{5}{9}$, which is
lesse then 115 $\frac{5}{9}$ by 10, according to the Will
of the *Testator.*

Of the Cups of Croesus.

CRoesus gave to the Temple of the Gods six
Cups of Gold, which weighed together 600
Drammes, but each cup was heavier one than
another by one Dram: how much did each of
them therefore weigh? Answer, the first weigh-
ed 102 Drammes and a halfe; the second 101
Drammes and a halfe, the third 100 Drammes
and $\frac{1}{2}$, the fourth 99 a & halfe, the fifth 98 & a
halfe; and the sixt Cup weighed 97 Drammes
and a halfe, which together makes 600 Drams
as before.

Of Cupids Apples.

CUpid complained to his mother that the
Muses had taken away his Apples, *Clio,* said
he, took from me the fifth part, *Euterp* the
twelfth part, *Thalia* the eighth part, *Melpomene*
the twentieth part, *Erates* the seventh part,
Terpsichore the fourth part, *Polyhymnia* took a-
way 30, *Vrania* 120, and *Calliope* 300. So
there

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

There are an infinite of ſuch like queſtions a-
mongſt the Greek Epigrams : but it would be un-
pleaſant 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 ſixth part of his
life in childe-hood, the fourth part in his
youth, the third part in Manhood, and 18
yeares beſides in old age : what might his Age
be ? the anſwer is, 72 yeares : which and all o-
thers is thus reſolved : multiply $\frac{1}{6} \frac{1}{4}$ and $\frac{1}{3}$ toge-
ther, 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 Foun-
taine with this Epigramme.

Out 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 will be filled in 3
dayes : if it paſſe out of my feet the Ciſtern will
be 4 dayes a filling; but if I let the water paſſe
out of my mouth, I can fill the Ciſtern then in 6

<div align="right">houres.</div>

houres: in vvhat time should I fill it, if I poure forth the vvater at all the passages at once?

The Greeks (the greatest talkers in the world) varioussly apply this question to divers statues, and pipes of Fountaines : and the solution is by the Rule of 3, by a generall Rule, or by *Algebra.* They have also in their *Anthologie* 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 vvhich reflect : therefore I vvill novv produce some experiments upon them, not that I vvill dive into their depth (that vvere to lay open a mysterious thing) but that vvhich may delight and recreate the spirits: Let us suppose therefore these principles, upon vvhich is built the demonstration of the appparances which are made in all sort of Glasses.

First, that the rayes or beames, vvhich reflect upon a Glasse, make the Angle of incident equall to the Angle of Reflection, by the first Theo. of the *Catoptick* of *Euc.*

Secondly, that in all plain Glasses, the Images are seen in the perpendicular line to the Glasse,

as

as far within the glass as the object is without it.

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

And here you are to understand, that there is not meant only those 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, Mettal, or such like. Now take a Glasse in your hand and make experiment upon that which followeth.

Experiment upon flat and plaine Glasses.

First, a man cannot see any thing in these Glasses, if he be not directly and in a perpendicular line before it, neither can he 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 down flat: and to see that on the right hand, you must be on the left hand, &c.

Secondly, an image cannot be seen in a Glass 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 Horizontal Plaine, you shall see nothing of that which is upon the Table.   Thirdly.

Thirdly, in a plaine Glasse all that is seene appeares or seemes to sink 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, inverted or upside downe; and a Glasse placed upright, the right hand of the Image seems to be the left, and the left seems to be the right. Fifthly, will you see in a Chamber that which is done in the street, without being seen: then a Glasse must be disposed, that the line upon which the Images come on the Glasse, make the Angle of incidence equall to that Angle of reflexion.

Sixtly, an height (as suppose $D E$.) may be measured by a plaine Glasse, as let the Glasse be G placed downe upon the ground, and let the eye be at C. so farre removed from the Glasse, that the eye at C. may see the toppe of the Tower E in the Angle or edge of the Glass at A, but in the line of reflexion $C A$, then measure the distance between your foot B, and the point A, & also the distance betweene the Glasse A, and the foot of the Tower D, viz. $A D$. Now as often as $A B$ is found in $A D$, so often doth the height of ther Tower
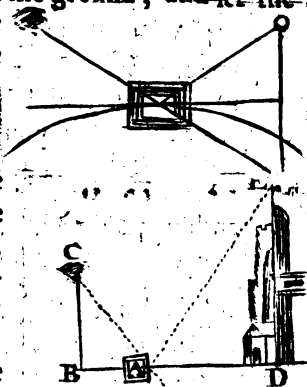
Tower *E D* contain the diſtance from your eye
to the foot, *viz.* *C B* for the Triangles *A,B,C,*
and *A,D,E*, are equal Triangles: therefore as
B A. to *A D,* ſo *C B,* to *E D,* or alternately
as *B A.* to *B C,* ſo *A D.* to *D E.*

Seventhly, preſent a Candle upon a plaine
Glaſſe, and look flaunting upon it, ſo that the
Candle and the Glaſſe be neere in a right line,
you ſhall ſee 3,4,5,&c. images, from one and
the ſame Candle.

Eightly, take tvvo plaine Glaſſes, and hold
them one againſt the other, you ſhall alternately
ſee them oftentimes one vvithin the other, yea
vvithin themſelves, againe and againe.

Ninthly, if you hold a plaine Glaſſe behinde
your head, and another before your face, you
may ſee the hinder part of your head, in that
Glaſſe vvhich you hold before your face.

Tenthly, you may have a fine experiment if
you place tvvo Glaſſes together, that they
make an acute angle, and ſo the leſſer the angle
is, the more apparances you ſhall ſee, the one di-
rect, the other inverſed, the one approaching,
and the other retiring.

Eleventhly, it is a vvonder & aſtoniſhment to
ſome, to ſee vvithin a Glaſſe an Image vvithout
knovving from vvhence it came, and it may be
done many vvayes: as place a Glaſs higher than
the eye of the beholder, and right againſt it is
ſome Image; ſo it reſteth not upon the behol-
der, but doth caſt the Image upvvards.   Then
place another object, ſo that it reflect, or caſt
the

the Image downeward to the eye of the specta-
tor, without perceiving it being hid behinde
something, for then the Glasse will represent a
quite contrary thing, either that which is
before the Glasse, or that which is about it, to
wit, the other hidden object.

Twelfthly, if there be ingraved behinde the
backside of a Glasse, or drawne any Image up-
on it, it will appeare before as an Image, with-
out any appearance: or portraicture to be per-
ceived.

EXAMINATION.

*T His 12 Article of ingraving an Image behinde
the Glasse, will be of no great consequence, be-
cause the lineaments will seem so obscure, but if there
were painted some Image, and then that covered ac-
cording to the usuall covering of Glasses behinde,
and so made up like an ordinary looking-Glasse ha-
ving an Image in the middle, in this respect it would
be sufficiently pleasant: and that which would ad-
mire the ignorant, and able to exercise the most
subtillest, and that principally if the Glasse be in
an obscure place, and the light which is given to it
be somewhat farre off.*

PLace a Glasse neare the floor of a Chamber,
& make a hole through the place under the
Glasse, so that those which are below may not
perceive it, and dispose a bright Image under

L   the

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 adjoyning, and so make it to be
seen upon the side of the Wall.

14 In these Channel-Images which shew one
side a deaths head, & 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 it in 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 read it in the Glasse, and yet out of
the Glasse there is nothing to be known, which
will thus happen, if the writing be writ back-
ward: but that which is more strange, to shew
a kinde of writing to a plaine Glasse, it shall ap-
pear another kinde of writing both against sense
and forme, as if there were presented to the
Glasse WEL, it would shew it MET; 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 inversed
that are perpendicular to the Glas, if the Glas
and the object be upright, then that on the right
hand, is turned to the left, as in the latter.

And here I cease to speak further of these
plaine Glasses, either of the Admirable multi-
plications, or appearances, which is made in a
great number of them; for to content the sight
in

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

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 hovv much more the Images are separated from the Glasse , by so much the more they diminish in Magnitude.

Secondly , they that shew the Images plaiting , 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 ravisheth 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 sphericity of these small Glasses: for present the Glasse to the lower end of a Gallarie, or at the Corner of a great Court full of Prople ; or towards a great street, Church, fortification, an Army of men, to a whole Cittie ; all the faire Architecture, and appearances will

L 2   be

be seene contracted within the circuit of the
Glasse with such varietie of Colours, and di-
stinctions 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 va-
riable, according to the distance of the Object
from the Glasse.

Exptriments upon hollow, or Concave
sphericall Glasses.

I Have heretofore spoken how they may
burne, being made of Glasse, or Metall, it re-
maines 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 for it must
in proportion as a segment of some be made
circle or orbe.

EXAMINATION.

I N this we may observe that a section of 2. 3. or 4.
Inches in diameter, may be segments of spheres
of 2. 3. or 4. foot nay of so many fadome, for it is
certaine that amongst those which comprehend a
great portion of a lesser sphere, and those which
comprehend a little segment of a great spheere, (whe-
ther they be equall or not in section, there will hap-
pen an evident difference in one and the same expe-
riment,

riment, in the number, situation, quantitie, and figure of the Images of one or many different objects, and in burning there is a great difference.

MAginus, in a little Tractate that he had upon these Glasses, witnesseth of himselfe that he hath caused many to be polished for sundry great Lords of *Italy*, and *Germanie*, which were segments of Globes of 2. 3. and 4. foot diameter; 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 Town, the contentment herein would beare with the cost.

EXAMINATION.

TOuching Maginus *he hath nothing ayded us to the knowledge of the truth by his extract out of* Vitellius, *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.*

FIrst therefore in concave Glasses, the Images are seene sometimes upon the surface of the Glasses, sometimes as though they were within it and behinde it, deeply sunk into it, sometimes they are seene before, and without the Glasse, sometimes between the object and the

Glasse;

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 concourse of the beames, and change of the place of the Images in the line of reflection.
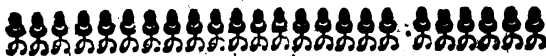
EXAMINATION.

THE relation of these appearances passe current amongst most men, but because the curious may not receive prejudice in their experiments, something ought to be said thereof to give it a more lively touch: in the true causes of these appearances, 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 seen in the Glasse: those that are more learned in Opticall knowledge affirme the contrary, and nature it selfe gives it a certaine place according to its position, being alwayes seen in the line of reflection, which Alhazen, Vitellius, 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 appearances, seeing they leave unto posterities many falsities in their writings, and those that followed them

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 seem
to come to the eye: and if the eye be without the
point of concourse, 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 concourse it goes back againe: these ap-
pearances thus approaching do not a little asto-
nish those which are ignorant of the cause: they
are inversed, if the eye be without the point of con-
course untill the object be within, but contrarily if
the eye be between the point of concourse and the
Glasse, then the Images are direct: and if the
eye or the object be in the point of concourse, the
Glasse will be enlightened, and the Images confu-
sed, and if there were but a spark of fire in the said
point of concourse, all the Glasse would seeme a
burning fire-brand, and we dare say it would oc-
curre without chance, and in the night be the most
certaine and subtislest light that can be, if a candle
were placed there. And whosoever shall enter into
the search of the truth of new experiments in this
subject, without doubt he will confirme what we
here speak of: & will finde new lights with a con-
veniable position to the Glasse, he will have reflecti-
on of quantities, of truth, and fine secrets in nature,
yet not known, which he may easily comprehend

is

if he have but an indifferent fight, and may assure
himselfe that the Images cannot exceed the fight,
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 reflection of
any object, and moved in the same line: the obect is
seene in one and the same place immutable; or if the
Image and the eye move in their owne lines, the re-
presentation in the Glasse seemes to invest it selfe
continually with a different figure.

NOw the image comming thus to the eye,
those which know not the secret, draw
their sword when theysee 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 I-
mage of his hand or his face out of the Glasse,
which comes out the farther, by how much the
Glasse is great and the Centre remote.

EXAMINATION.

NOw that a Pistoll being presented to a Glasse be-
hinde a man, should come out of the Glasse, and
make him afraid that stands before, seeming to shoot
at him, this cannot be : for no object whatsoever
presented

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 needs not feare that
which is said to be behinde his back, 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 Centre is farre remote, of a sword, stick, or
such like be presented to the Glasse, it shall totally be
seen to come forth of the Glasse, and all the hand that
holds it. And here generally note, that if an Image
be seen to issue out of the Glasse to come towards the
face of any one that stands by, the object shall be
likewise seen to thrust towards that face in the Glass
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 man-
ner ones hand being presented to the Glosse, as it is
thrust towards the Centre, so the representation of
it comes towards it, and so the hands will seeme to
be united, or to touch one another.

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

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

EXAMINATION.

Touching a Glasse tyed at a seeling or plan-
ching, that one may see a man hang by the
feet in the aire and so many Glasses, many men
may be seen: without caution this is very absurd, the
for if the Glasse or Glasses be not so great that
Centre of the spheare upon which it was made, ex-
tend not neere to the head of him that is under it, it
will not pleasantly appeare, and though the Glasse
should be of that capacity that the Centre did ex-
tend so farre. yet will not the Images be seene to
them which are from the Glasse but only to those
which are under it, or neere unto it: and to them it
will notably appeare, and it would be most admi-
rable to have a Gallerie vaulted over with such
Glasses which would wonderfully astonish any one
that enters into it: for all the things in the Gallery
would be seen to hang in the aire and you could not
walk without incountering airie apparitions.

SEcondly, in flat or plaine Glasses the Image
is seen equall to his object, and to repre-
sent a whole man, there ought to be a Glasse as
great as the Image is: In convex Glasses the I-
mages are seen alwaies lesse, in concave Glasses
they

they may be feen greater or leffer, but not truly proportionable, by reafon the diverfe reflexions which contracts or inlargeth the Species: when the eye is between the Centre and the furface of the Glaffe; the Image appeares fometimes very great and deformed, and thofe which have but the appearance of the beginning of a beard on their chinne, may cheare up themfelves to fee they have a great beard; thofe that feeme to be faire will thruft away the Glaffe with defpight, becaufe it will transforme their beauty: thofe that put their hand to the Glaffe vvill feeme to have the hand of a Giant, and if one puts his finger to the Glaffe it vvill be feen as a great *Pyramide* of flefh, inverfed againft his finger.

Thirdly, it is a thing admirable that the eye being approached to the point of concourfe of the Glaffe, there vvill be feen nothing but an intermixture or confufion: but retiring back a little from that point, (becaufe the rayes do there meet,) he fhall fee his Image inverfed, having his head belovy and his feet above.

Fourthly, the divers appearances caufed by the motion of objects, either retiring or approaching: whether they turne to the right hand or to the left hand, whether the Glaffe be hung againft a wall, or whether it be placed upon a Pavement, as alfo what may be reprefented by the mutuall afpect of concave Glaffes with plaine and convex Glaffes: but I will with filence paffe them over, only fay fomething of two rare experiments more as followeth.

The

The firſt is to repreſent by help of the Sun, ſuch letters as one would upon the front of a houſe: ſo that one may read them : *Maginus* doth deliver the way thus. Write the Letters, ſaith he, ſufficieutly bigge, but inverſed upon the ſurface of the Glaſſe, with ſome kinde of colour, or theſe letters may be written with wax, (the eaſier to be taken out againe :) for then placing the Glaſſe to the Sunne, the letters which are written there will be 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 help 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 Diameter : for by this meanes the light of the Candle will be reverberated into the Glaſſe, and vvill be caſt back againe very farre by parrallel lines, making ſo great a light that one may clearly ſee that vvhich is done farre off, yea in the camp of an Enemie : and thoſe which ſhall ſee the Glaſſe a farre off, will think they ſee a Silver Baſin inlightened, or a fire more reſplendent then the Torch. It is this way that there are made certaine Lanthorns which dazell the eyes of thoſe which come againſt them; yet it ſerves ſingular well to enlighten thoſe which carry them, accommodating a Candle with a little hollow Glaſſe, ſo that it may ſucceſſively be applyed to the point of inflammation.

In

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 suspition.

EXAMINATION.

THis will be scarce sensible upon a wall remote from the Glasse, and but indifferently seen 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 concourse 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 be placed, the light will be reflected by parallel lines, as a columne 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.

Lastly, those which feare to hurt their sight by the approach of Lampes or Candles, may by this artifice place at some corher of a Chamber, a Lamp 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* be somewhat raised to make the
light to streeke upon the Table with sharp
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 be more pleasant to the sight of
him that useth it.

Of other Glasses of pleasure.

First, the *Columnary* and *Pyramidall Glasses*
that are contained under right lines, do
represent the *Images* as plaine *Glasses* do ; and
if they be bowing, then they represent the *I-
mage*, as the concave and convex *Glasses* doe.

Secondly, those *Glasses* which are plaine, but
have ascents of Angels in the middle, will
shew one to have foure Eyes, two Mouthes,
two Noses, &c.

EXAMINATION.

These experiments will be found different ac-
cording to the diverse meeting of the Glasses,
which commonly are made scuing-wise at the end,
by which there will be two divers superficies in the
Glasse, making the exteriour Angle somewhat
raised, at the interiour onely one superficies, which
                                                    may

may be covered according to ordinary Glaſſes to
cauſe a refl xion, and ſo it will be but one Glaſſe,
which by refr action according to the different thick-
neſſe of the Glaſſe, and different *Angles* of the ſcu-
ing forme, do 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 in-
teriour ſolid *Angle*, according to the difference of
it, (as if it be more ſharp) there will be repreſented
two diſtinct double *Images*, that is, two entire vi-
ſages 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 ſu-
perficies will be turned into one, and the duplicity
of *Images* will alſo vaniſh and appeare but one one-
ly: and this is eaſily experimented with two little
Glaſſes of ſteel, or ſuch like ſo united, that they
make divers *Angles* and incliſnations.

THirdly, there are *Glaſſes* which make men
ſeeme pale, red, and coloured in diverſe man-
ners, which is cauſed by the dye of the *Glaſſe*,
or the diverſe refraction of the *Species*: and
thoſe which are made of *Silver, Latine, Steele,
&c.* do give the *Images* a diverſe colour alſo.

<div align="right">In</div>

In which one may fee that the appearances by fome are made fairer, younger or older than they are; and contrarily others will make them foule and deformed: and give them a contrary vifage : for if a Glaffe be cut as it may be, or if many pieces of Glaffe be placed together to make a conveniable 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 fhould be too long if I fhould fay all that which might be faid upon the property of Glaffes. I will therefore conclude this difcourfe of the properties of thefe Glaffes with thefe foure re-creative Problemes following.

PROBLEM. LXXVIII.

How to fhew to one that is fufpitious, what is done in another Chamber or Roome: notwithftanding the interpofition of the wall.

FOr the performance of this, there muft be placed three Glaffes in the two Chambers, of which one of them fhall be tyed to the planching or feeling, that it may be common to communicate the Species to each Glaffe by reflexion; there being left fome hole at the top of the Wall againft the Glaffe to this end : the two other Glaffes muft be placed againft the two Walls at right Angles, as the figure here fheweth at *B.* and *C.*

Then

Then the fight at *E* by the line of incidence
F E, shall fall upon the Glaſſe *B A*, and reflect
upon the ſuperficies of the Glaſſe *B C*, 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 *Catheti*:
which Image ſhall
come to the eye of
the ſuſpicious, *viz.* at
L. by help of the third Glaſſe, upon which is
made the ſecond reflexion, and ſo brings unto
the eye the object, though a wall be between
it.
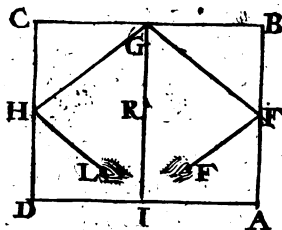
<center>*Corolarie.* 1.</center>

BY this invention of reflections the beſie-
gers of a Towne may be ſeene upon the
Rampart: notwithſtanding the Parapet, which
the beſieged may do by placing a Glaſſe in the
hollow of the Ditch, and placing another up-
on the toppe of the wall, ſo that the line of in-
cidence comming to the bottom of the Ditch,
make an Angle equall to the Angle of reflexi-
on, then by this ſituation and reflexion, the
Image of the beſiegement will be ſeen to him
is upon the Rampart.

<center>M</center>   *Coro-*

Corolarie 2.

BY which also may be inferred, that the same reflexions may be seen 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 Jmage will be seen easily.

Corolarie 3.

FArther, 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 Geometricall assistant, that the incident points may meet in the middle of the Glasses: but here all the defect will be, that the Jmages passing by so many reflexions, will be very weak and scarce observable.

PROBLEM LXXIX.

How with a Musket to strike a mark, not looking towards it, as exact as one aiming at it.

AS let the eye be at O, and the mark C, place a plaine Glasse perpendicular as A B. so the marke C shall be seen in *Catheti C A, viz.*

in

in *D*, and the line of
reflexion is *D*, now
let the Musket *F E*,
upon a rest, be mo-
ved to and fro untill
it be seen in the line,
O D, which admit to
be *HG*, so giving fire
to the Musket, it
shall undoubtedly strike the mark.
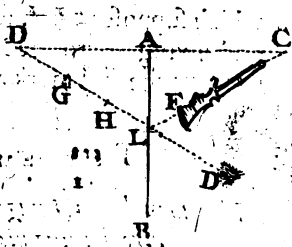
Corolaries.

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

AS let the eye be at *M*, the mark *C*; and the
wall which keeps it from being seene, ad-
mit to be *Q R*, then
set up a plaine Glass
as *A B*, and let the
Musket by *G H*, pla-
ced upon his rest *P
O*. Now because the
marke *C* is seen at
D, move the Musket
to and fro, untill it
doth agree with the
line of reflection *MB*,

M 2   which

which suppose at *L I*, so shall it be truly placed, and giving fire to the Musket, it shall not faile to strike the said mark at *C·*

PROBLEM. LXXX.

How to make an Image to be seen hanging in the aire, having his head downeward.

TAke two Glasses, and place them at right Angles one unto the other, as admit *A B*, and *C B*, of which admit *C B, Horizontall*, and let the eye be at *H*, and the object or image to be *D E*: so *D* will be reflected at *F*, so to *N*, so to *H E*: then at *G*, so to *M* and then to *H*, and by a double reflection *E D* will seeme in *Q R*, the highest point *D* in *R*, and the point *E* in *Q* inversed as was said, taking *D* for the head, and *E* for the feet; so it will be a man inversed, which will seem to be flying in the aire, if the Jmage 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 seen by that motion:

PROB.

PROBLEM. LXXXI.

How to make a company of representative Souldiers
seeme to be a Regiment, or how sam in
number may be multiplyed to
seem to be many in number.

TO make the experiment upon men, there
must be prepared two great Glasses ; but in
stead of it we will suppose two lesser , as *G H.*
and *F I,* one placed right against another per-
pendicular to the *Horizon* , upon a plaine levell
Table : betvveene
vvhich Glasses let
there be ranged in
Battalia-vvise upon
the same Table a
number of small men
according   to the
square *G,H,I,F,* or
in any other forme
or, posture : then may
yon evidently see hovv the said battel vvill be
multiplyed and seem farre bigger in the appear-
ance than it is in effect.
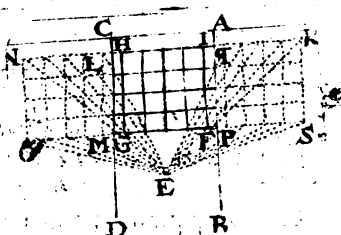
Corolarie.

BY this invention you may make a little
Cabinet of foure foot long , and tvvo foot
large, (more or lesse) vvhich being filled vvith

M 3   Rocks

Rockes or such like things, or there being put
into it Silver, Gold, Stones of luster, Jewels,
&c. and the walls of the said Cabinet being all
covered, or hung with plaine glasse ; these vi-
sibles will appeare manifoldly increased, by rea-
son of the multiplicitie of reflexions, and at the
opening of the said Cabinet, having set some-
thing which might hide them from being seen,
those that look into it will be astonished to see
so few in number which before seemed to be so
many.

PROBLEM. LXXXII.

Of fine and pleasant Dyals.

COuld you choose a more ridiculous one
than the natural *Dyall* written amongst the
Greek Epigrams, upon which some sound Poet
made verses ; shewing that a man carrieth a-
bout him alwayes a *Dyall* in his face by meanes
of the Nose and Teeth ? and is not this a jolly
Dyall ? for he need not but open the mouth, the
lines shall be all the teeth, and the nose shall
serve for the style.

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 repre-
sented with little bushie hearbes, as of Hysope
or

or such which is proper to be cut in the borders; and at the top of the style to have a Fanne to shew which way the winde b'oweth? this is very pleasant and useful.

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 vvithout any other *Dyall*, to see onely by the hand what of the clock it is? vvhich gives it very neare; and may be practised by the left hand, in this manner.

Take a stravv or like thing of the length of the *Index* or the second finger, hold this straw very right betvveen the thumb and the forefinger, then stretch forth the hand and turne your back, and the palm of your hand tovvards the Sunne; so that the shadovv of the muscle vvhich is under the Thumb, touch the line of life, vvhich is betvveen the middle of the tvvo other great lines, vvhich is seen in the palme of the hand, this done, the end of the shadovv vvill shevv vvhat of the clock it is: for at the end of the first 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 after-noone, 10 & 2 at the second joynt, 11 and 1 at the third joynt, and midday in the line follovving, vvhich comes from the end of the *Index*.

Of

Of a Dyall which was about an Obeliske at Rome.

WAs not this a pretty fetch upon a pavement, to choose an *Obeliske* for a *Dyall*, having 106 foot in height, without removing the Basis of it? *Plinie* assures us in his 26 book 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 were enchaced markes of Copper upon the Pavement, and placed also an Apple of Gold upon the toppe of the said *Obeliske*, to know the houre and the course of the Sunne, with the increase and decreale of dayes by the same shadow: and in the same manner do some by the shadow of their head or other style, make the like experiments in Astronomie.
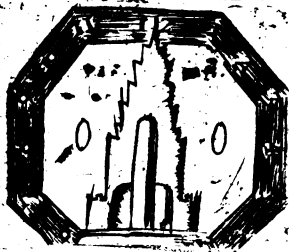
Of Dyals with Glasses.

PTolomie writes, as *Cardanus* reports, that long ago there were Glasses which served for *Dyals*, and presented the face of the beholder

holder as many times as the houre ought to
be, twice if it were 2 of the clock, 9 if it were 9,
&c: But this was thought to be done by the
help of water, and not by Glasses, which did
leake by little and little out of the vessell, dis-
covering anon one Glasse, then anon two Glas-
ses, 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 Style.

WHat will you say of the invention of Ma-
thematicians, which finde out daily so
many fine and curious novelties? they have
now a way to make *Dyals* upon the wainscot
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
style which reflecteth the light, with the same
condition that the shadow of the style sheweth
the houre: and it is easie to make experiment
upon a common *Dyall*, changing only the dis-
position of the *Dyall*, and tying to the end of
the style a piece 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 clock it is, which is reflected by
a little hole in the Window upon the wall or
seeling of the Chamber.

EXA-

EXAMINATION.

IN this there are 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 be cast upon a plain opposite: and in the other it is a hole in the window, or such like, by which may passe the beames of the Sun, which represent the extreamity of the style, & the Glasse representeth the plaine of the Dyall, upon which the beames being in manner of shadowes reflect cast upon a plaine opposite: and it is needfull that in this secand may 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 style or a pearle at the extreamitie 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.

<div align="right">But</div>

But that which is most noble, is to draw houre-lines upon the outside of the Glasse of a window, and placing a style thereto upon the outside; the shadow of the style will be seen within, and so you have the hour, more certaine without any difficulty.

Of Dyals with water.

SVch kinde of Dyals were made in ancient times, and also these of sand: before they had skill to make Sun-dyals or Dyals 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 piece of light board in the vessell to swimme upon the top of the water, carrying a little statue, which with a small stick did point out the houre upon a columne or wall, figured with houre-notes, as the vessell was figured within.

Vitruvius writes of another manner of water-Dyal more difficult;
and *Baptista à Porta*
amongst his naturall
secrets, delivers this
invention following.
Take a vessel full of
water like a caldron,
& another vessell of
glasse like unto a
Bell, (with which
some accustome to cover *Melons*:) and let this
Vessell
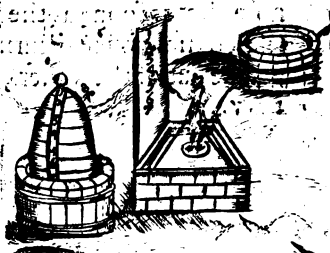
veſſell of Glaſſe be almoſt as great as the Cal-
dron, having a ſmall hole at the bottome, then
when it is placed upon the vvater, it vvill ſink
by little and little : by this one may marke the
houres on the ſurface of the Glaſſe to ſerve an-
other time. But if at the beginning one had
drawn the water vvithin the ſame veſſell of
Glaſſe in ſucking by the little hole , the vvater
vvould not fall out, but as faſt as the aire vvould
ſucceed it , entering ſlovvſy at the little hole: for
contrarily the houres may be diſtinguiſhed
by diminution of water, or by augmentation.

Novv it ſeemes a ſafer vvay that the vvater
paſſe out by drop and drop , and drop into a
Cylindricall Glaſſe by help of a Pipe : for ha-
ving marked the exterior part of the Cylinder
in the houre notes , the vvater it ſelfe vvhich
falls vvithin it , vvill ſhevv vvhat of the clock it
is, farre better than the running of ſand, for by
this may you have the parts of the houres moſt
accurate, vvhich commonly by ſand is not had:
and to vvhich may be added the houres of o-
ther Countreys vvith greater eaſe.   And here
note, that as ſoone as the vvater 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 a-
nevv.

P R O B.

PROBLEM. LXXXIII.

*Of Cannons or great Artillery. Souldiers, and o-
thers would willingly see this Probleme, which
contaynes three or foure subtile questions:
The first is, how to charge a Cannon
without powder?*

THis may be done vvith aire and vvater, only
having throvvn cold vvater into the Can-
non, vvhich might be squirted forceably in by
the closure of the mouth of the Piece, that so
by this pressure the aire might more condense;
then having a round piece of vvood very just,
and oiled vvell for the better to slide, and thrust
the Bullet vvhen it shall be time : This piece
of vvood may be held fast vvith some Pole, for
feare it be not thrust out before his time : then
let fire be made about the *Trunion* or hinder
part of the Piece to heat the aire and vvater,
and then vvhen one vvould shoot it, let the
pole be quickly loosened, for then the aire
searching a greater place, and having vvay novv
offered, vvill thrust out the vvood and the bullet
very quick : the experi mentvvhich vve have
in long trunkes shooting out pellats vvith aire
only, shevveth the verity of this Probleme.

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

THe resolution of this Question depends upon the goodnesse of the Piece & charge thereof, seeing in each there is great difference. It is reported that *Ticho Brahe*, and the *Lands-grave* 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 Germane mile, which distance proportionated to an houres time, makes 120 Italian miles.
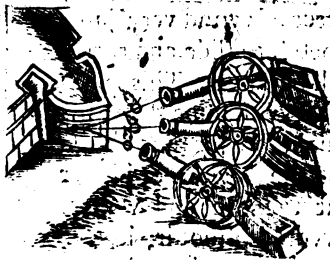
3. In the third question it may be asked, how it comes to passe, that a Cannon shooting up-wards, the Bullet flies with more vio-lence than being shot point-blanke, or shooting downeward?

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 perpendicular upon a wall, are more violent than those which strike byas-wise or glaunsing-ly.   But

But confidering the ftrength of the blow on-
ly , the Queftion is moft true , and often ex-
perimented to be found true: a Piece mounted
at the beft of the Randon, which is neare halfe
of the right , conveyes her Bullet with a farre
greater violence then that which is fhot at
point blanke, or mounted parallel to the Hori-
zon. The common reafon is , that fhooting
high, the fire carries the bowle a longer time in
the aire , and the aire moves more facill up-
wards, than dovvnevvards, becaufe that the airy
circles that the motion of the bullet makes, are
foonest broken. Hovvfoever this be the gene-
rall tenet, it is curious to finde out the inequality
of moving of the aire ; vvhether the Bullet fly
upvvard, dovvnevvard, or right forvvard, to
produce a fenfible difference of motion, & fome
think that the Cannon being mounted , the
Bullet preffing the povvder maketh a greater
refiftance, and fo caufeth all the Povvder to be
inflamed before the Bullet is throvvne out,
vvhich makes it to be more violent than other-
vvife it vvould be. When the Cannon is other-
vvife difpofed , the contrary arives , the fire
leaves the Bullet , and the Bullet rolling from
the Povvder refifts leffe : and it is ufually feene,
that fhooting out of a Musket charged onely
vvith Povvder , to fhoot to a marke of Paper
placed Point blanke, that there are feene, many
fmall holes in the paper , vvhich cannot be o-
ther than the graines of Powder which did not
take fire : but this latter accident may happen
                                                    from

from the over-charging of the Piece, or the length of it, or windy, or dampeneſſe of the Powder.

From which ſome may think, that a Cannon pointed right to the *Zenith,* ſhould ſhoot with greater violence, then in any other mount or forme whatſoever: and by ſome it hath beene imagined, that a Bullet ſhot in this faſhion hath been conſumed, melted, and loſt in the Aire, by reaſon of the violence of the blow, and the activity of the fire, and that ſundry experiments have been made in this nature, and the Bullet never found. But it is hard to believe this aſſertion: it may rather be ſuppoſed that the Bullet falling farre from the Piece 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 be moſt true, that the longer the Piece is, the more violent it ſhoots: and to ſpeak generally, that which is direction by a Trunke, Pipe, or other concavitie, 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. & the reaſon ſeems to hold in Cannons, becauſe in thoſe that are long, the fire is retained a longer time in the concavitie of the Piece, and ſo

<div align="right">throwes</div>

throwes out the Bullet with more violence; and experience lets us fee that taking Cannons of the fame boare, but of diverfitie of length from 8 foot to 12, that the Cannon of 9 foot long hath more force than that of 8 foot long, and 10 more than that of 9, and fo unto 12 foote of length. Now the ufuall Cannon carries 600 Paces, fome more, fome leffe, yea fome but 200 Paces from the Piece, and may fhoot into foft earth 15 or 17 foot, into fand or earth which is loofe, 22 or 24 foot, and in firme ground, about 10 or 12 foot, &c.

It hath been feen lately in Germany, where there were made Pieces from 8 foot long to 17 foot of like boare, that fhooting out of any piece which was longer than 12 foot; the force was diminifhed, and the more in length the Piece increafeth, the leffe his force was: therefore the length ought to be in a meane meafure, and it is often feene, the greater the Cannon is, by fo much the fervice is greater: but to have it too long or too fhort, is not convenient, but a meane proportion of length to be taken, otherwife the flame of the fire will be over-preffed with Aire: whic hinders the motion in refpect of fubftance, and diftance of getting out.

N   PRO*b*
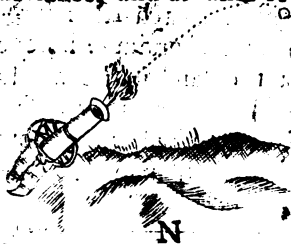
Problem. LXXXIIII.

*Of prodigious progreſſion and multiplication,
of Creatures, Plants, Fruits, Numbers,
Gold, Silver, &c. when they are
alwayes augmented by cer-
taine proportion.*

HEre we ſhall ſhew things no leſſe admira-
ble, as recreative, and yet ſo certaine and
eaſie to be demonſtrated, that there needs not
but Multiplication only, to try each particular:
and firſt,

Of graines of Muſtard-ſeed.

FIrſt, therefore it is certaine that the increaſe
of one graine of Muſtard-ſeed for 20 yeares
ſpace, cannot be contained within the viſible
world, nay if it were a hundred times greater
than it is: and holding nothing beſides from
the Centre of the earth even unto the firma-
ment, but only ſmall grains of Muſtard-ſeed:
Now becauſe this ſeems but words, it muſt be
proved by Art, as may be 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 yeares, every ſeed to bring
forth yearely a thouſand graines, now multiply-
ing alwayes by a thouſand, in leſſe then 17 years
you

you shall have so many graines which will sur-
passe the sands, which are able to fill the whole
firmament: for following the supposition of
Archimedes, and the most probable opinion of
the greatness of the firmament which *Ticho Bra-
be* 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 yeares 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 yeare, all the
graines of Mustard-seed which shall successive-
ly spring from one graine onely, cannot be con-
tained within the limits of the whole firma-
ment ; what should it be then, if it should be
multiplied againe by a thousand for the 18
yeare : and that againe by a thousand for every
yeares increase untill you come to the 20 yeare,
it's 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 bring onely
but the increase of one graine in 20 yeares.

Of Pigges.

SEcondly, is it not a strange proposition, to
say that the great Turke with all his Reve-
nues, is not able to maintaine for one yeares
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

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 be at the least so many crownes
to maintaine them, one a year, *viz.* 33 millions,
which exceeds the Turkes revenue by much.

Of graines of Corne,

THirdly, it will make one astonished to think
that a graine of Corne, with his increase
successively for the space of 12 yeares will pro-
duce in grains 244140625,00000 00000000,
which is able to load almost al the creatures
in the World.

To open which, 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 sowen the next yeare,
every one to produce 50, and so consequently
the whole and increase to be sowen every yeare,
until 12 yeares be expired, there will be of in-
crease the aforesaid prodigious summe of
graines, *viz.* 244140625000000000000, which
will make a cubical heap of 6258522 graines
every way, which is more than a cubicall body
of 31 miles every way: for allowing 40 graines

12

in length to each foot; the Cube would be
156463 foot every way: from which it is evi-
dent 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 be sufficient roome to con-
taine the aforesaid quantitie of Corne: and sup-
pose a bushel of Corne were equal unto two
Cubicke feet, which might containe twenty
hundred thousand graines, then would there
be 122070462500000. bushells, and allowing
30 bushels to a Tunne, it would be able to load
8138030833 vessels, which is more than
eight thousand one hundred and thirty eight
millions, ship loadings of 500 Tunne to each
ship a: quantity so great that the Sea is scarce
able to beare, or the universal world able to
finde vessels to carry it. And if this Corne should
be valued at halfe a crown the bushel, it would
amount unto 152588078125000 pounds sterling,
which I think 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 grain of Corne; and to continue it
in sowing, the increase only for 12 yeares to
have so great a profit?

Of the increase of Sheep.

FOurthly, those that have great flocks of
Sheep may be quickly rich, if they would
preserve their Sheep without killing or selling
of them: so that every Sheep produce one each

yeare, for at the end of 16 yeares, 100 Sheepe
will multiply and increase unto 6553600, which
is above 6 millions, 5 hundred 53 thousand
Sheep : now supposing them worth but a crown
apiece, it would amount unto 1638400 pounds
sterling, vvhich is above 1 million 6 hundred
38 thousand pounds, a faire increase of one
Sheep : and a large portion for a Childe if it
should be allotted.

Of the increase of Codfish, Carpes, &c.

FIfthly, if there be any creatures in the vvorld
that do abound vvith increase or fertilitie,
it may be rightly attributed to fish ; for they in
their kindes produce such a great multitude of
Eggs, and brings forth so many little ones, that
if a great part vvere not destroyed continually,
vvithin a ittle vvhile they vvould fill all the
Sea, Ponds, and Rivers in the vvorld ; and it is
easie to sheyv hovv it vvould 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.

SIxthly, there are some that cannot conceive
how it can be that from eight persons (which
were

were faved after the deluge or *Noahs* flood)
fhould fpring fuch a world of people to begin
a Monarchie under *Nimrod* , being but 200
yeares after the flood , and that amongft them
fhould be raifed an army of two hundred thou-
fand fighting men : But it is eafiy proved if
vve take but one of the Children of *Noah,* and
fuppofe that a nevv generation of people begun
at every 30 yeares, and that it be continued to
the feventh generation vvhich is 200 yeares ;
for then of oneonly family there vvould be pro-
duced one hundred and eleven thoufand foules,
three hundred and five to begin the vvorld :
though in that time men lived longer,and vvere
more capable of multiplication and increafe ;
vvhich number fpringing onely from a fimp'e
produ&ion of one yearly,vvould be farre great-
er , if one man fhould have many vvives,vvhich
in ancient times they had : from vvhich it is al-
fo that the Children of *Ifrael,* vvho came into
Egypt but onely 70 foules, yet after 210 yeares
captivity,theycame forth vvith their hoftes,that
there vvere told fix hundred thoufand fighting
men, befides old people,women a nd children;
and he that fhall feparate but one of the fami-
lies of *Iofeph* , it would be fufficient to make up
that number: how much more fhould it be then
if we fhould adjoyne many families together ?

Of the increafe of numbers.

SEventhly, what fumme of money fhall the
City of *London* be worth, if it fhould be fold,
and the money be paid in a yeare after this

manner

manner : the firſt week to pay a pinne, the ſe-
cond week 2 pinnes, the third week 4 pinnes,
the fourth week 8 pinnes , the fifth week 16
pinnes . and ſo doubling untill the 52 weeks, or
the yeare be expired.

Here one would think that the value of the
pinnes would amount but to a ſmall matter, in
compariſon of the Treaſures , or riches of the
whole City : yet it is moſt probable that the
number of pinnes would amount unto the ſum
of 4519599628681215, and if we ſhould al-
low unto a quarter a hundred thouſand pinnes,
the whole would contain ninetie eight millions,
foure hundred thouſand Tunne : which is able
to load 49930 Shippes of a thouſand Tunne a-
piece : and if we ſhould allow a thouſaud pins
for a penny , the ſumme of money would a-
mount unto above eighteen thouſand , eight
hundred and thirty millions of pounds ſterling,
an high price to ſell a Citie at , yet certain , at-
cording 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,
10995116277776 , which in pounds is 458129
8444, that is foure thouſand five hundred and
foureſcore millions of pounds and more.

Of

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

Eightly, admit there were an hundred Apples, Stones, or such like things that were plac'd 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 fetching one by one? this would require near halfe a day to do it, for there would be made ten thousand and ninety two paces before he should gather them all up.

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

Ninethly, is it not an admirable thing to consider 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 Arithmetick, do present unto them a world of confusion and difficultie.

As in the first place, it is often debated amongst our common Ringers, what number of Changes there might be made in 5,6,7,8, or more Bells : who spend much time to answer their owne doubts, entring often into a Labyrinth in the search thereof : or if there were 10 voyces, how many severall notes might there be ?

be? Thefe are propofitions of fuch facility, that a childe which can but multiply one number by another, may eafily refolve it, which is but only to multiply every number from the unite fucceffively in each others product, unto the terme affigned : fo the 6 number that is againft 6 in the Table, is 720, and fo many Changes may be made upon 6 *Bells*, upon 5 there are 120, &c.

In like manner againft 10 in the Table is 3628800, that is, three millions, fix hundred twenty eight thoufand, eight hundred : which fhews that 10 voices may have fo many conforts, each man keeping his owne note, but only altering his place ; and fo of ftringed Inftruments, and the *Gamat* may be varied according to which, anfwerable to the number againft *X*, viz. 1124001075070399680000 notes, from which may be drawne this, or the like propofition. Suppofe that 7 Schollers were taken out of a free Schoole to be fent to an *Univerfitie*, there to be entertained in fome *Colledge* at commons for a certaine fumme of money, fo that each of them have two meales daily, and no longer to continue there, then that fitting all together upon one bench or forme at every meale, there might be a divers tranfmutation of place; of account in fome one of them, in comparifon of another, and never the whole company to be twice alike in fituation : how long may the Steward entertaine them ? (who being not fkilled in this fetch may anfwere unadvifedly.) It is moft certaine that there will be

<div align="right">five</div>

five thousand and forty several Positions or changings in the seatings, which maks 14 years time wanting 10 weeks and 3 dayes. Hence from this mutability of transmutation, it is no marvell that by 24 letters there ariseth and is made such variety of languages in the world, & such infinite number of words in each language ; seeing the diversity of syllables produceth that effect , and also by the interchanging & placing of letters amongst the vowels, & amongst

1	a	1
2	b	2
6	c	3
24	d	4
120	e	5
720	f	6
5040	g	7
40320	h	8
362880	i	9
36288c0	k	10
39916800	l	11
479001600	m	12
6227c2c800	n	13
87178291200	o	14
1307674368000	p	15
2c922789888000	q	16
355687537996000	r	17
6402375683928000	s	18
121645137994632cc0	t	19
2432902759892640c0c0	u	20
51090957957745440cc00	w	21
1124c01c75c7c39968c00c	x	22
25852c2472661919264c00c0	y	23
62c448592438860623360c0cc	z	24

themselves maketh these syllables : vvhich Alphabet of 24 letters may be varied so many times , *viz.* 620448593438860623360c00 vvhich is six hundred tvventy thousand , foure hundred forty eight millions of millions of millions five hundred ninety three thousand, foure hundred thirty eight milions of milions,& more.

Novv allovving that a man may reade or speak one hundred thousand vvords in an houre vvhich is tvvice more vvords than there are con-

tained

teined in the Pfalmes of *David*, (a taske too
great for any man to do in fo fhort a time)
and if there were foure thoufand fix hundred
and fifty thoufand millions of men, they could
not fpeak thefe words (according to the
hourely proportion aforefaid)in threefcore and
ten thoufand yeares ; which variation & tranf-
mutation of letters, if they fhould be written
in bookes, allowing to each leaf 28000 words,
(which is as many as poffibly could- be infert-
ed,) and to each book a reame or 20 quire of
the largeft and thinneft printing paper, fo that
each book being about 15 inches long, 12 broad,
and 6 thick : the books that would be made
of the tranfmutation of the 24 letters aforefaid,
would be at leaft 38778037089928788: and
if a Library of a mile fquare every way, of 50
foot high, were made to containe 250 Galle-
ries of 20 foot broad apiece, it would con-
taine foure hundred millions of the faid books:
fo there muft be to containe the reft no leffe
than 9694509z fuch Libraries ; and if the books
were extended over the furface of the Globe of
the Earth, it would be a decuple covering unto
it a thing feeming moft incredible that 24 let-
ters in their tranfmutation fhould produce fuch
a prodigious number, yet moft certaine and in-
fallible in computation.

Of a Servant hired upon certaine conditions.

A Servant faid unto his Mafter, that he
would dvvell vvith 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 years
time; how think you of this bargaine? for if
he had but a quarter of an inch of ground for
each graine, and each graine to bring forth
yearely of increase 40 graines, the whole sum
would amount unto, at the terme aforesaid,
655360000000 graines: and seeing that three
thousand and six hundred millions of inches
do but make one mile square in the superficies,
it shall be able to receive foureteene thousand
and foure hundred millions of graines, which is
1440000000000. thus dividing the aforesaid
65536000000, the Quotient will be 455,
and so many square miles of land must there be
to sowe the increase of one graine of Corne for
8 yeares, which makes at the least foure hun-
dred 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 be continued for 8 yeares;
a pretty pay for a Masters Servant 8 yeares ser-
vice.

PROBLEM. LXXXV.

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

1. *First how to make water at the foot of a mount-
aine to ascend to the top of it , and so to de-
scend on the other side?*

TO do this there must be 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 then the Foun-
taine, as at *C*. then make a hole in the Pipe at
the top of the Moun-
taine , as at *B*, and
stop the end of the
Pipe at *A* and *C*;and
fill this Pipe at *B*
with water: & close
it very carefully a-
gaine at *B*, that no
aire get in: then un-
stop the end at *A*, &
at *C* ; then will the
water perpetually runne up the hill , and de-
scend on the other side, which is an invention
of great consequence to furnish Villages that
want water.
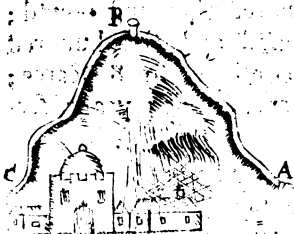
2. *Secondly,*

2. *Secondly , how to know what wine or other liquer*
there is in a veſſell without opening the bung-
hole , and without making any other hole,
thanthat by which it runnes
out at the top?

IN this problem there is nothing but to take
a bowed pipe of Glaſſe , and put it into the
faucets hole, and ſtopping it cloſe about : for
then you ſhall ſee the wine or liquor to aſcend
in this Pipe, untill it be juſt even with the liquor
in the veſſel; by which a man may fill the veſ-
ſel , or put more into it : and ſo if need were ,
one may empty one veſſel 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 foot of a
Mountaine ,· than ſtanding upon
the top of it ?

THis is a thing moſt certaine , becauſe that
water and all other liquor diſpoſeth it ſelfe
ſphericaliy about the Centre of the earth ; and
by how much the veſſel is nearer the Centre,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 Centre of the earth,
the ſurface of the water makes a greater ſphere,
and therefore leſſe *gibbous*, or ſwelling over the
veſſel.

veſſell : from whence it is evident that a veſſell
near the Centre 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 be-
ing placed on the top of the Mountaine.   Firſt,
therefore one may conclude , that one and the
ſame veſſel will al-
wayes hold more : by
how much it is nearer
the Centre of the
earth. Secondly, if a
veſſell be very neare
the Centre of the
earth, there will be
more water above
the brims of it , than
there is within the
veſſel.   Thirdly , a
veſſel full of water
comming to the Centre wil ſpherically increaſe,
and by little and little leave the veſſel ; and
paſſing the Centre, the veſſel will be all emp-
tied. Fourthly, one cannot carry a Paile of wa-
ter from a low place to a higher , but it will
more and more run out and over , becauſe that
in aſcending it lies more levell, but deſcending
it ſwels and becomes more *gibbous*.

4. *Fourthly, to conduct water from the top 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
                                                    Moun-

Mountaine there are Inhabitants which want water: now to make a bridge from one Mountaine 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 top of the Mountaine be placed a Pipe, to descend into the valley, and ascend to the other Mountaine, 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 Cock.*

LEt there be a vessell as *A B*, made close in all his parts, in the middle of which let *C D* be a Pipe open at *D* neare the bottome, and then with a Squirt squirt in the water at *C*, stopped above by the cock or faucet *C*, vvith as great violence as possible you can; and turne the cock immediatly.

Novv there being an indifferent quantity of vvater and aire in the vessel, the vvater keeps it selfe in the bottome, and the aire vvhich vvas greatly pressed, seeks for more place, that
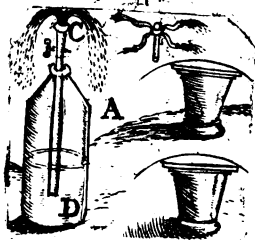
turning

turning the Cock the water issueth forth at the
Pipe, and flyes very high, and that especially if
the vessell be 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 quick, pleasurable to
behold.

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

THis is nothing else but a Cylinder, about
the which is a Pipe in form of a screw, and
when one turnes it, the water descends alwayes
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 En-
giner admirable in all Mathematicall Arts in-
vented this Instrument to wash King *Hieros*
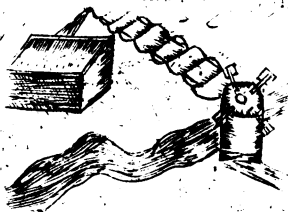
great vessells, as some
Authors saye, also
to water the fields
of Egypt, as *Diodo-
rus* witnesseth : and
Cardanus reporteth
that a Citizen of
Milan having made
the like Engine,
thinking himselfe to be the first inventer, con-
ceived such exceeding joy, that he became mad,
foll. 2.

Againe a thing may ascend by descending;

if

if a spiral line be made having many circulations
or revolutions ; the last being alwayes les-
ser than the first, yet higher than the Plaine sup-
posed - it is most certaine that then putting a
ball into it, and turning the spirall line so , that
the first circulation may be perpendicular , or
touch alwayes the supposed Plain: 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 re-
volution 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 ex-
periment may be more usefull , naturally made
with a thred of Iron, or Latine turned or bow-
ed Helically about a Cylinder , with some di-
stinction of distances between the *Helices* , for
then having drawn out the Cylinder, or having
hung or tyed some weight at it in such sort, that
the water may easily drop if one lift up the said
thred: these *Helices* or revolutions, notwithstan-
ding 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 be alike , and of equallity a-
mongst themselves, and the whirling or turn-
ing motion be quicke, the sight will be so de-
ceived, that producing the action it will seeme
to the ignorant no lesse than a Miracle.

O 2   7. *Seventh*

7. Seuenthly, of another fine Fountaine of pleasure.

THis is an Engine that hath two wheeles
with Cogges, or teeth as *A B*, which are
placed within an *Ovall C D*, 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
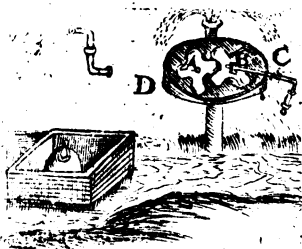
with a handle to
each wheele, so that
they may be turned,
and *A* being turned,
that turneth the o-
ther wheele that is
opposite: by which
motion the aire that
is in *E*, & the water
that is carried by the
hollow of the wheeles of each side, by continu-
all motion, is constrained to mount and flie out
by the funnell *F*: now to make the water runne
what way one would have it, there may be ap-
plied upon the top of the Pipe *F*, two other
moveable Pipes inserted one within another;
as the figure sheweth. But here note, that there
may acrue some inconveniency in this Machine
seeing that by quick turning the Cogges

or teeth of the wheeles running one againſt an-
other , may neare break them, and ſo give
way to the aire to enter in , which being vio-
lently incloſed vvill eſcape to occupie the place
of the vvater , vvhoſe vveight makes it ſo quick:
hovvſoever, if this Machine be curiouſly made
as an able vvorkeman may eaſily do , it is a
moſt ſovereigne Engine,to caſt vvater 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, vvhich may point
tovvards the place being ſet at the top thereof,
and ſo having great diſcretion in turning the
Axis of the vvheele , it may vvork exceeding
vvell,and continue long.

8. *Eightly, of a fine watering pot, for gardens.*

THis may be made in forme of a Bottle ac-
cording to the laſt figure or ſuch like, ha-
ving at the bottome many ſmall holes , and at
the neck of it another hole ſomevvhat greater
than thoſe at the bottome , vvhich hole at the
top you muſt unſtop vvhen you vvould fill this
vvatering pot, for then it is nothing but putting
the lovver end into a paile of vvater , for ſo it
vvill fill it ſelfe by degrees : and being full, put
your thumb on the hole at the neck to ſtop it,
for then may you carry it from place to place,
and it vvill not ſenſibly runne out , ſome-
thing it vvill,and all in time (if it vvere never ſo
cloſe ſtopped) contrary to the ancient tenet in
Philoſophy, that aire will not penetrate.

9. *Ninthly,*

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, stop the other end which is without and then pull out the Cane or Pipe, so will it be ful of wine, then opening a little the top above, you may fill a Glasse or other Pot with it, for as the Wine issueth out, the aire commeth into the Cane or Pipe to supply vacuity.
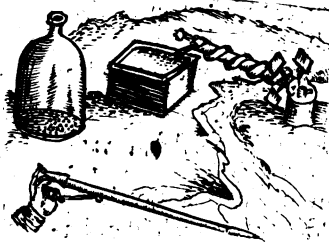
10. *Tenthly, how to measure irregular bodies by help of water?*

SOme throw in the body or magnitude into a vessell, and keep that which floweth out over, saying it is alwayes equal to the thing cast into the water: but it is more neater this way to poure into a vessell such a quantity of water,

hich

which may be thought sufficient to cover the body or magnitude, and make a marke how high the water is in the vessell, then poure out all this water into another vessell, and let the body or magnitude be placed into the first vessel; then poure in water from the second vessell, until it ascend unto the former marke made in the first vessell, so the vvater vvhich remaines 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 pores are more truly measured this way, than others are.

11. *To finde the weight of water.*

SEeing that $\frac{174}{1000}$ part of an ounce weight, makes a cubicall inch of water: and every pound weight *Haverdepoize* makes 27 cubicall inches, and $\frac{9}{8}$ *fere*, and that 7 Gallons and a halfe wine measure makes a foot cubicall, it is easie by inversion, that knowing the quantity of a vessel in *Gallons*, to finde his content in cubicall feet or weight: and that late famous *Geometrician* Master *Brigs* found a cubical foot of vvater to vveigh neare 62 pound vveight *Haverdepoize.* But the late learned *Simon Stevin* found a cubicall foot of vvater to vveigh 65 pound, vvhich difference may arise from the inequalitie of vvater; for some vvaters are more ponderous than others, and some difference

may be from the weight of a pound, and the
measure of a foot : thus the weight and quan-
titie of a solid foot settled, it is easie for Arith-
meticians to give the contents of vessells or bo-
dies which containe liquids.

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

THis 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 ves-
sell : we see that a barrel of wine or water cast
into the water, will not sink to the bottome,
but swim easily, and if a ship had not Iron
and other ponderosities in it, it might swim full
of water without sinking : in the same manner
if the vessell were loaden with lead, so much
should the watter weigh : hence it is that Mar-
riners call Shippes of 50 thousand Tunnes, be-
cause they may containe one or two thousand
Tunne, and so consequently carry as much.

13. *How comes it that a Shippe having safely sayl-*
ed in the vast Ocean, and being come
into the Port or harbour, without any
tempest will sink down right?

THe cause of this is that a vessel 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, Wels, or Fountains;
there-

therefore the loading of a veſſell which is ac-
counted ſufficient in the Sea, becomes too great
in the harbour or ſweet water. Now ſome
think 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 Ship be 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 fa-
thom deep of water, and if the vvater be no
thicker than a leafe of paper, and weigheth but
an ounce under a heavy body, it vvill ſupport it,
as vvell as if the vvater under it vveighed ten
thouſand pound vveight: hence it is if there be
a veſſell capable of a little more than a thouſand
pound vveight of vvater, you may put into this
veſſell a piece of vvood, vvhich ſhall vveigh a
thouſand pound vveight; (but lighter in his
kinde than the like of magnitude of vvater:) for
then pouring in but a quart of vvater or a very
little quantitie of vvater, the vvood vvill ſvvim
on the top of it, (provided that the vvood touch
not the ſides of the veſſell:) vvhich is a fine ex-
periment, and ſeems admirable in the perform-
ance.

14. *How a groſſe body of mettle may ſwimme upon the water?*

THis is done by extending the mettle into a
thin Plate, to make it hollovv in forme of
a veſſel; ſo that the greatneſſe of the veſſell
which the aire vvith it containeth, be equal to
<div align="right">the</div>

the magnitude of the vvater, vvhich vveighes as
much as it, for all bodies may svvim vvithout
sinking, if they occupie the place of vvater equal
in vveight unto them; as if it vveighed 12 pound
it must have the piace of 12 pound of vvater:
hence it is that vve see floating upon the vvater
great vessells of copper or Brasse, vvhen they
are hollow in forme of a Caldron. And how
can it be otherwise conceived of Islands in the
Sea that svvim and float? is it not that they are
hollow and some part like unto a Boat; or that
their earth is very light and spongeous, or ha-
ving many concavities in the body of it, or much
wood within it?

And it would be a pretty proposition to
shew how much every kinde of metall should
be inlarged, to make it swim upon the water:
which doth depend upon the proportion that
is between the vveight of the vvater and each
metall. Novv the proportion that is betvveene
metalls and water of equall magnitude, accord-
ing to some Authors, is as followeth.

	Gold.	187½
A magnitude of 10 pound	Lead.	116¼
weight of water will require	Silver.	104
for the like magnitude of	Copper.	91
	Iron.	81
	Tinne.	75

From which is inferred, that to make a piece
of Copper of o pound weight to swimme, it
must be so made hollow, that it may hold 90
times that weight of water and somewhat
more, that is to say, 91 pound: seeing that Cop-

per and water of like magnitudes in their pon-
derofities, are as before, as o to 911.

15. *How to weigh the lightnesse 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 light-
nesse as may counter-ballance and keep 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 do this; take a
Cubicall hollow vessell, or that which is *Cylin-
dricall*, which may swimme on the water, and
as it sinketh by placing of weights upon it,
marke hovv much, for then if you vvould ex-
amine the vveight of any body, you have no-
thing to do but to put it into this vessell, and
marke hovv deep it sinkes, for so many pound
it vveighes as the vveights put in do make it
so to sinke.
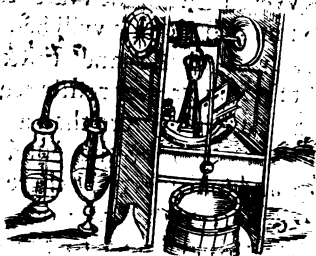
16. *Being given a body, to marke it about, and shew how much of it will sink in the water, or swim above the water.*

THis is done by knovving the vveight of the body vvhich is given, and the quantity of vvater, vvhich vveighes as much as that body; for then certainly it vvill sink so deep, untill it occupieth the place of that quantitie of vvater.

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

TAke a Ballance, & vveigh (as for example) 9 pound of Gold, Silver, Lead, or Stone in the aire, so it hang *in æquilibrio;* then comming to the vvater, take the same quantity of Gold Silver, Lead, or Stone, and let it softly dovvne into it, and you shall see that you shall need a lesse counterpoise in the other Ballance to counter-ballance it : vvherefore all solids or bodies vveigh lesse in the vvater than in the aire, and so much the lesse it vvill be, by hovv much the vvater is grosse and thick, becauſe the vveight findes a greater resistance, and therefore the vvater supports more than aire; and further, becauſe the vvater by the ponderositie is displeaſed, and so strives to be there againe, pressing to it, by reaſon of the other vvaters that are about it, according to the proportion of

his

his weight. *Archimedes* demonftrateth, that all bodies weigh leffe 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 fhall weigh a pound leffe than in the aire.

Now by knowing the proportion of water and mettles, it is found that Gold lofeth in the water the 19 part of his weight, Copper the 9 part, Quickfilver 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 abfolute weight, Gold in refpect 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 Quickfilver 15 times, Lead 11 and $\frac{3}{4}$, Silver 10 and $\frac{3}{4}$, Copper 9 and $\frac{3}{40}$, Iron 8 and $\frac{1}{2}$, and Tinne 8 and $\frac{1}{7}$. Contrarily in refpect of greatneffe, if the water be as heavy as the Gold, then is the water almoft 19 times greater than the magnitude of the Gold, and fo may you judge of the reft.

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

This is eafie to be refolved by confidering different mettles, which though they

<div align="right">weigh</div>

vveigh equall in the aire, yet in the vvater there
vvill be an apparant difference; as suppose so
that in the scale of each Ballance be placed 18
pound vveight of severall metalls, the one
Gold, and the other Copper, vvhich being *in
aqmilibrio* in the aire, placed in the vvater, vvill
not hang so, becauſe that the Gold loſeth
neare the 18 part of his vveight, vvhich is about
2 pound, and the Copper loſeth but his 9 part,
vvhich is 2 pound; vvherefore the Gold in the
vvater vveigheth but 17 pound, and the Copper
16 pound, vvhich is a difference moſt ſenſible
to confirme that point.

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

PHyſicians have an eſpeciall reſpect unto
this, judging that vvater vvhich is lighteſt
is moſt healthfull and medicinall for the body,
& Sea-men knovv that the heavieſt vvaters do
beare moſt, and it is knovvne vvhich vvater is
heavieſt thus. Take a piece of wax, and faſten
Lead unto it, or some ſuch like thing that it may
but preciſely ſwimme, for then it is equal to the
like magnitude of water, then put it into ano-
ther veſſ̣ll which hath contrary water, and if it
ſinke, then is that water lighter than the other:
but if it ſinke not ſo deep, then it argueth the
water to be heavier or more groſſer than the
firſt water, or one may take a piece of vvood,
and marke the quantitie of ſinking of it into
ſeverall waters, by vvhich you may judge
vvhich

which is lighteſt or heavieſt, for in that which
it ſtrikes 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?

THis propoſition ſeems very impoſsible,
   yet water incloſed in a veſſell, being con-
ſtrained to dilate it ſelfe, doth weigh ſo much
as though there were in the concavitie of it a
ſolid body of water.

There are many wayes to experiment this
propoſition, but to verifie it, it may be ſuffici-
ent to produce two excellent ones onely : which
had they not been really acted, little credit
might have been 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, and 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 inviron 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 vvay is yet more admirable : take
a common Ballance that is capable to receive
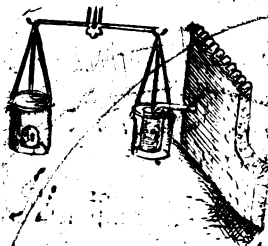
10 or 20 pound of water, then put into it a magnitude which may take up the place of 9 or 19 pound of water, which must be hung at some Iron or beame which is placed in a wall ; so that it hang quiet : (now it is not materiall whether the magnitude be hollow or massie) so that it touch not the Ballance in which it is put , for then having put the Lead or weight into the other Ballance, poure 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 Arithmetick, and first of the number of sands.

IT may be said incontinent , that to undertake this were impossible , either to number the Sands of *Lybia* , or the Sands of the Sea ; and it was this that the Poets sung, and that which the vulgar beleeves ; nay , that which long a-go certaine Philosophers to *Gelon* King of *Sici-*

by

ly reported, that the graines of fand vvere in-
humerable : But I anfvvere vvith *Archimedes* ,
that not only one may number thofe vvhich are
at the border and about the Sea ; but thofe
vvhich are able to fill the vvhole vvorld,if there
vvere nothing elfe but fand ; and the graines of
fands admitted to be fo fmall,that 10 may make
but one graine of *Poppy*: for at the end of the
account there need not to exprelfe them , but
this number 30840979456, and 35 Ciphers at
the end of it. *Clavius* and *Archimedes* make it
fomevvhat more ; becaufe they make a greater
firmament than *Ticho Brabe* doth ; and if they
augment the Vniverfe, it is eafie for us to aug-
ment the number , and declare alfuredly how
many graines of fand there are requifite to fill
another vvorld , in comparifon that our vifible
vvorld vvere but as one graine of fand , an a-
tome or a point; for there is nothing to do but
to multiply the number by it felfe , vvhich vvill
amount to ninety places, vvhereof tvventie are
thefe, 9514379813491095936 , and 70 Ci-
phers at the end of it : vvhich amounts to a
moft prodigious number,and is eafily fupputa-
ted:for fuppofing that a graine of Poppy doth
containe 10 graines of fand, there is nothing
but to compare that little bovvle of a graine of
Poppy , vvith a bovvle of an inch or of a foot,
& that to be compared vvith that of the earth,
and then that of the earth vvith that o the
firmament; and fo of the reft.

<center>P</center>

2. Divers

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

THis was a notable invention of *Archimedes*, related by *Uitrivius* in his Architecture, where he reporteth that the Gold-smith which King *Hiero* imployed for the making of the Golden 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 work proposed it to *Archimedes*, if by Art he could discover without breaking of the Crowne, if there had been made mixture of any other metall with the Gold. The way which he found out was by bathing himselfe; for as he entred into the vessell of water, (in which he bathed himselfe) so the water ascended or flew out over it, and as he pulled out his body the water descended : from which he gathered that if a Bowle of pure Gold, Silver, or other metall were cast into a vessell of water, the water proportionally according to the thing cast in would ascend ; and so by way of Arithmetick the question lay open to be 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 took two Masses, the one of pure Gold, and the other of pure Silver; each equall to the weight of the Crowne, and therefore unequall in magnitude or greatnesse; and

and then knowing the severall quantities of wa-
ter which was answerable to the Crown, and
the severall Masses, he subtilly collected, that
if the Crowne occupied more place within the
water than the Masse of Gold did: it appeared
that there was Silver or other metall melted
with it. Now by the rule of position, suppose
that each of the three Masses weighed 18 pound
apiece, 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 Crown 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 then the Masse of Gold, which
weighed 18 pound, and the Crowne which
weighed also 18 pound, being put into a
vessell full of water, threw out more water than
the Masse of Gold by a quarter of a pound, (be-
cause of mixt metall which was in it :) there-
fore 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 ex-
cesse shall be answerable to 9 pound of Silver,
and so much was mixed in the Crowne.

Some judge the way to be 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 vve
vvill suppose that Gold and Copper is mixed
together, it vvill vveigh lesse then 17 pound,

yet

yet more than 16 pound, and that according to the proportion mixed : let it then be supposed that it vveighed in the vvater 16 pound and 3 quarters, then might one say by proportion, if the difference of one pound of losse, (vvhich is betvveen 16 and 17) be ansvverable to 18 pound, to vvhat shall one quarter of difference be ansvverable to , vvhich is betvveen 17 and 16 ¾, and it vvil be 4 pound and a halfe; and so much Copper vvas mixed vvith the Gold.

Many men have delivered sundry vvayes to resolve this proposition since *Archimedes* invention, and it vvere tedious to relate the diversities.

Baptista Benedictus amongst his Arithmeticall 7 *heoremes*, delivers his vvay thus: if a Masse of Gold of equall bignesse to the Crovvne did vveigh 20 pound, and another of Silver at a capacity or bignesse at pleasure , as suppose did vveigh 12 pound, the Crovvne or the mixt body would vveigh more than the Silver , and lesser than the Gold, suppose it vveighed 16 pound vvhich is 4 pound lesse than the Gold by 8 pound, then may one say , if 8 pound of difference come from 12 pound of Silver , from vvhence comes 4 pound vvhich vvill be 6 pound and so much Silver vvas mixed in it, &c.

3. Three men bought a quantitie of wine, each paid.
alike, and each was to have alike ; it happened at
the last partition that there were 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 follow-
eth, 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, and as
many empty ones, and one which is halfe full;
so he shall have 7 vessells and 3 Barrels, 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 ge-
nerally 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 divid-
ing 21 by 3 there comes 7 for the Quotient,
which may be parted in these three parts, 2, 2, 2,
or 3, 3, 1, each of which being lesse than ha fe
of 7.

4. There

4. *There is a Ladder which stands upright against
a wall of 10 foot high, the foot of it is pulled
out 6 foot from the wall upon the pave-
ment: how much hath the top of
the Ladder descended?*

THe ansvver is, 2 foot: for by *Pythagoras*
rule the square of *D B*, the *Hypothenusal* is
equall to the square
of *D A* 6, & *A B* 10.
Novv if *D A* be 6
foot, and *A B* 10
foot, the squares are
36 and 100, vvhich
36 taken from 100
rests 64, vyhose
Roote-quadrate is 8
so the foot of the
Ladder being novv at *D*, the toppe vvill be at
C, 2 foot lovver than it vvas vvhen it vvas
at *B*.

PROBLEM. LXXXVII.

Witty suits or debates between Caius *and* Sempro-
nius, *upon the forme of figures, which Geo-
metricians call Isoperimeter, or
equall in circuit or compasse.*

MArvell not at it if I make the Mathema-
ticks take place at the Barre, and if I set
forth

forth here *Bartoleus*, who witnesseth of him-
selfe, that being then an ancient Doctor in the
Law, he himselfe took upon him to learne the
elements and principles of *Geometry*, by which
he might set forth certaine Lawes touching the
divisions of Fields, Waters, Islands, and other
incident places: now this shall be to shew in
passing by, that these
sciences are profi-
table and behovefull
for Judges, Coun-
sellors, or such, to ex-
plaine many things
which fall out in
Lawes, to avoid am-
biguities, contentions,
and suits often.
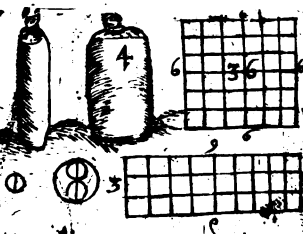
1. *Incident.*

Caius had a field which was directly square,
having 24 measures in Circuit, that was 6
on each side: *Sempronius* desiring to fit himselfe,
prayed *Caius* to change with him for a field
which should be equivalent unto his, and the
bargaine being concluded, he gave him for
counterchange a piece 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 breadth for each shorter
side: Now *Caius* which was not the most sub-

tilleft

tilleſt nor wiſeſt in the world accepted his bar-
gaine at the firſt, but afterwards having con-
ferred with a Land-meaſurer and Mathematici-
an, found that he was over-reached in his bar-
gaine, and that his field contained 36 ſquare
meaſures, and the other field had but 27 mea-
ſures, (a thing eaſie to be knowne by multiply-
ing the length by the breadth:) *Sempronius* con-
teſted with him in ſuite of Law, and argued
that figures which have equall *Perimeter* or *cir-
cuit*, are equall amongſt themſelves: my field,
ſaith he, hath equall circuit with yours, there-
fore it is equall unto it in quantitie. Now this
was ſufficient to delude a Judge which was ig-
norant in Geometricall proportions, but a Ma-
thematician will eaſily declare the deceit, being
aſſured that figures which are *Iſoperemiter*, or
equall in circuit, have not alwayes equall capa-
citie or quantitie: ſeeing that with the ſame cir-
cuit, there may be infinite figures made which
ſhall be more and more capable, by how much
they have more Angles, equall ſides, and ap-
proach nearer unto a circle, (which is the moſt
capableſt figure of all,) becauſe that all his parts
are extended one from anothes, and from the
middle or Centre as much as may be: ſo we
ſee by an infallible rule of experience, that a
ſquare is more capable of quantitie than a Tri-
angle 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

otherwise there might be that a regular Tri-
angle, having 24 meafures in circuit might
have more capacitie than a rectangled *Parallelo-
gram*, which had alfo 24 meafures of circuit, as
if it were 11 in length, and 1 inbreadth,
the circuit is ftill 24, yet the quantitie is but 11.
and if it had 6 every way, it gives the fame *Pe-
rimeter, viz.* 24. but a quantitie of 36 as before.

2. *Incident.*

SEmpronius having borrowed of *Caius* a fack
of Corne, which was 6 foot high and 2 foot
broad, and when there was queftion made to
repay it, *Sempronius* gave *Caius* back two facks
full of Corne, which had each of them 6 foot
high & 1 foot broad: who beleeved that if the
fackes were full he was repaid, and it feems to
have an appearance of truth barely looked on.
But it is moft evident in demonftration, that
the 2 facks of Corn paid by *Sempronius* to *Caius*,
is but halfe of that one fack which he lent him:
for a *Cylinder* or fack having one foot of dia-
meter, and 6 foot of length, is but the 4 part
of another *Cylinder*, whofe length is 6 foot, and
his diameter is 2 foot: therefore two of the
lefler *Cylinders* or fackes, is but halfe of the
greater; and fo *Caius* was deceived in halfe his
Corne.

3. *Incident.*

SOme one from a common Fountaine of a
City hath a Pipe of water of an inch diame-
ter;

ter; to have it more commodious, he hath leave to take as much more water , whereupon he gives order that a Pipe be made of two inches diameter. Now you will say presently that it is reason to be so bigge, to have just twice as much water as he had before : but if the Magiftrate of the Citie underftood Geometricall proportions, he would foon caufe it to be amended , & fhew that he hath not only taken twice as much water as he had before, but foure times as much : for a Circular hole which is two inches diameter is foure times greater than that of one inch , and therefore vvill caft out four times as much vvater as that of one inch , and fo the deceit is double alfo in this.
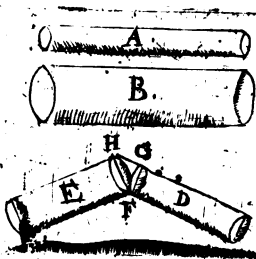
Moreover, if there vvere a heap of Corne of 20 foot every vvay, vvhich vvas borrovved to be paid next yeáre: the party having his Corne in heapes of 12 foot every vvay, and of 10 foot every vvay, proffers him 4 heapes of the greater or 7 heaps of the lefler, for his ovvne heap of 20 every vvay , vvhich vvas lent : here it feems that the proffer is faire, nay vvith advantage , yet the lofle vvould be neare .1000 foot. Infinite of fuch caufes do arife from Geometricall figures, vvhich are able to deceive a Judge or

        Magiftrate

Magistrate, vvhich is not somevvhat scene in *Mathematicall Documents.*

Problem. LXXXVIII.

Containing sundry Questions in matter of Cosmography.

Irst, it may be demanded, vvhere is the middle of the vvorld? I speak not here Mathematically, but as the vulgar people, vvho ask, vvhere is the middle of the vvorld? in this sence to speak absolutely there is no point vvhich may be said to be the middle of the surface, for the middle of a Globe is every vvhere: notvvithstanding the *Holy Scriptures* speake respectively, and make mention of the middle of the earth, and the interpreters apply it to the Citie of *Jerusalem* placed in the middle of *Palestina*, and the habitable vvorld, that in effect taking a mappe of the vvorld, and placing one foot of the Compasses upon *Jerusalem*, and extending the other foot to the extremity of *Europe*, *Asia*, and *Africa*, you shall see that the Citie of *Jerusalem* is as a Centre to that Circle.

2. Secondly, *how much is the depth of the earth, the height of the heavens, and the compasse of the World ?*

Rom the surface of the earth unto the Centre according to ancient traditions, is 3436. miles, so the vvhole thicknesse is 6872 miles, of

of which the whole compasse or circuit of the earth is 21600 miles.

From the Centre 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 Centre 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 be let fall down 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 Centre, and being there it would hang in the aire.

Secondly, if a man should go every day 20 miles, it would be three yeares wanting but a fortnight, before he could go 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 she should runne twice the Circumference of the whole earth.

Fourthly, admit it be supposed that one
should

should go 20 miles in ascending towards the
heavens every day, he should be above 15 years
before he 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, be-
cause that the Orbe of the Sunnes circumfe-
rence 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
dovvne 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 : novv
there is no Bullet of a Cannon, Arrovv , Thun-
derbolt,or tempest of vvinde that moves vvith
such quicknesse.

Eightly, it is of a farre higher nature to con-
sider the exceeding and unmoveable quicknesse
of the starry firmament, for a starre being in the
Æquator,(which is just between the Poles of
the world)makes 12598666 miles in one houre
which is two hundred ,nine thousand nine hun-
dred and seventy foure miles in one minute of
time: & if a Horseman should ride every day
40 miles, he 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

should move about the earth a thousand times in one houre, and quicker than possible thought can be imagined: and if a starre should flye in the aire about the earth with such a prodigious quicknesse, 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 sense 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.*

PROBLEM. XCII.
To finde the Bissextile yeare, the Dominicall letter, and the letters of the moneth.

LEt 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 leap-yeare, as if one remaine , it shewes that it is the first yeare since the Bissextile or Leap-year, if two, it is the second year &c. and if nothing remaine , then it is the Bissextile or Leap-yeare, and the Quotient shews you how many Bissextiles or Leap-yeares there are conteined in so many yeares.

To

To finde the Circle of the Sun by the fingers.

LEt 123, 24, 25, 26, or 27, be divided by 28, (which is the Circle of the Sunne or whole revolution of the Dominicall letters) and that which remaines is the number of joynts, which is to be accounted upon the fingers by *Filius esto Dei, cœlum bonus accipe, gratis* i and where the number ends, that finger it sheweth the yeare which is present, and the words of the verse shew 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 must 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 be 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 & 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.

PROBLEM. XCIII.

To finde the New and Full 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 be 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 year, to which adde 11 makes 34, subtract 30, rests 4 the Epact for the yeare after, and 15 for the yeare folloyving that, and 26 for the next, and 7 for the next, &c.

PROB-

Problem. XCIV.

To finde the Latitude of a Countrey.

THose that dwell between the North-Pole and the *Tropicke* of *Cancer*, have their Spring and Summer between the 10 of *March*, and the 13 of *September* : and therefore in any day between that time, get the sunnes distance by instrumentall observation from the zenith at noone, and adde the declination of the sun for that day to it : so the Aggragate sheweth 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 between 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 XCV.

Of the Climates of countreys, and to finde in what Climate any countrey is under.

CLimates as they are taken Geographically signifie nothing else but when the length

Q

of the longeſt day of any place, is half 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
Countreys under it have the ſhorteſt and lon-
geſt day that can be but 12 houres; But all o-
ther Countreys that are from the Equinoctiall
Circle either towards the North or South of it
unto the Poles themſelves, are ſaid to be in ſome
one Climate or other, from the Equinoctiall
to either of the Poles Circles, (which are in the
Latitude of 66 degr. 30 m.) between each of
which Polar Circles and the Equinoctial Circle
there is accounted 24 Climates, which differ one
from another by halfe an hours time: then from
each Polar Circle, to each Pole there are rec-
koned 6. other Climates which differ one from
another by a moneths time : ſo the whole earth
is divided into 60 Climates, 30 being allotted to
the Northerne Hemiſphere, and 30 to the
Southerne Hemiſpheare. And here note, that
though theſe Climats which are betweene the
Equinoctiall and the Polar Circles are equall
one unto the other in reſpect of time, to wit,
by halfe an houre ; yet the Latitude, breadth,
or internall , conteined between Climate and
Climate , is not equall: and by how much any
Climate is farther from the Equinoctiall than
another Climate, by ſo much the leſſer is the
intervall between that Climate and the next: ſo
thoſe that are neareſt the Equinoctial are larg.,

eſt

eſt, and thoſe which are fartheſt off moſt con-
tracted: and to finde what Climate any Coun-
trey is under : ſubtract the length of an Equi-
noctiall day, to wit, 12 houres from the length
of the longeſt day of that Countrey ; the re-
mainder being doubled ſhews the Climate : So
at *London* the longeſt day is neare 16 houres
and a halfe; 12 taken from it there remaines 4
houres and a halfe , which doubled makes 9
halfe houres, that is , 9 Climates ; ſo *London* is
in the 9 climate.

PROBLEM. XCVI.

*Of Longitude and Latitude of the Earth
and of the Starres.*

*L*ongitude of a Countrey, or place, is an arcke
of the *Æquator* conteined between the Me-
ridian 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 plea-
ſure 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 Iſlands, but now in theſe latter times it
is held to be neare the *Azores*. But why it was
firſt placed by *Ptolomy* at the *Canary Iſlands*, were
becauſe that in his time theſe Iſlands were the
fartheſt weſterne parts of the world that vvas
then diſcovered. And vvhy it reteines his
place novv at Saint *Michaels* neare the

Q 2   *Azor*

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 Weſterne 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 Weſterne part to the Eaſtern part of the world knowne, they ſuppoſed the reſt to be all ſea, which ſince their deaths hath been 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 mark 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

to the divided parallel or *Æquator*, so have you the Longitude required.

Of the Latitude of Countreys.

LAtitude of a Countrey is the distance of a Countrey from the Equinoctiall, or it is an Arke of the Meridian conteined betwéen the Zenith of the place and the *Æquator*; which is two-fold, *viz.* either North-Latitude or South-Latitude, either of which extendeth from the Equinoctiall to either Pole, so the greatest Latitude that can be is but 90, degrees: If any Northern Countrey have the Artick Circle verticall, which is in the Latitude of 66. gr. 30. m. the Sun will touch the Horizon in the North part thereof, and the longest day will be there then 24 houres, if the Countrey have lesse Latitude than 66. degrees 30. m. the Sun will rise and set, but if it have more Latitude than 66. gr. 30 m. it will be visible for many dayes, and if the Countrey be under the Pole, the Sun will make a Circular motion above the Earth, and be visible for a half yeare: so under the Pole there will be but one day, and one night in the whole yeare.

Q 3   To
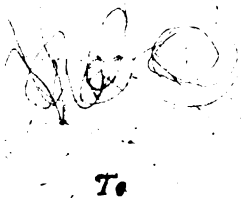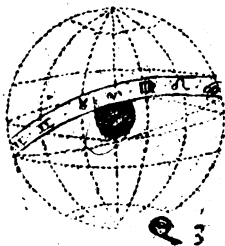
To finde the latitude of Countreys.

IF it be upon a Globé, 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 between the Countrey and the Equinoctiall, which applied unto the Equinoctiall will shew the Latitude of that Countrey; which is equall to the Poles height; if it be upon a Mappe. Then mark what parallel passeth over the Countrey 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 applied to the divided Meridian from that parallel will shew the Latitude of that place.
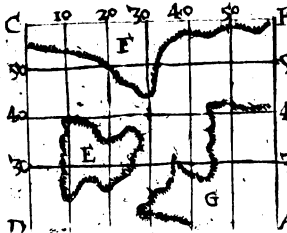
To finde the distance of places.

IF 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 *Æquator*, and the number of degrees shall shewbe distance; each degree being 60. miles. If it be in a Mappe (according to *Wrights* projection)

ection) take the diſtance with a paire of *Com-*
paſſes between 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 conteined between the feet of the *Compaſſes*
ſo much is the diſtance between the two places:
If the diſtance of two places be required in a
particular Map then with the *Compaſſes* take the
diſtance between 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 between
the *Compaſſes*, and apply that to the two places
as often as you can, ſo have you the diſtance
required.

Of the Longitude, Latitude, Declinati-
on, and diſtance of the Starres.

THe Declination of a ſtarre is the neareſt
diſtance of a Star from the *Æquator*; the
Latitude of a Starre is the neareſt diſtance of a
Sarre from the *Ecliptick*: the Longitude of a
Starre is an Ark of the *Ecliptick* conteined be-
tween 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 *Ecliptick*. The diſtance between
two Sarres in Heaven is taken by a *Croſſe-ſtaffe*
or other Inſtrument, and upon a Globe it
is done by taking between the feet of the
Compaſſes the two Starres, and applying it

Q 4   to

to the *Æquator*, so have you the distance be-
tweene those two starres.

How is it that two Horses or other creatures being
foaled or brought forth into the world at one and the
same time, that after certaine dayes travell
the one lived more dayes than the other, not-
withstanding they dyed together in one
and the same moment also?

THis is easie to be answered : let one of them
travell toward the West and the other to-
wards the East : then that which goes towards
the West followeth the Sunne : and therefore
shall have the day somewhat longer than if
there had been no travell made, and that which
goes East by going against the Sunne, shall
have the day shorter , and so in respect of tra-
vell 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 Saracen, may
have their Sabbaths all upon one and the same
day though notwithstanding the Saracen 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
Saracen and the Christian begin their travell
upon the Saturday, the Christian going West,
and the Saracen Eastwards, shall compasse the
                                                    Globe

Globe of the earth, thus the Chriſtian at the
concluſion ſhall gaine a day, and the Saracen
ſhall loſe a day, and ſo meet with the Jew every
one upon his owne Sabbath.

Certaine fine obſervations.

1 UNder the Equinoctiall the Needle
hangs *in æquilibrio*, but in theſe parts it
inclines under the Horizon, and being under
the Pole it is thought it will hang verticall.

2 In theſe Countreys which are without the
Tropicall Circles, the Sunne comes Eaſt and
Weſt every day for a halfe yeare, but being un-
der the Equinoctiall the Sun is never Eaſt, nor
Weſt but twice in the yeare, to wit, the 10. of
March and the 13 of September.

3 If a ſhip be in the Latitude of 23 gr. 30 m.
that is, if it have either of the Tropicks verti-
call: then at what time the Sunnes Altitude is
equall to his diſtance from any of the Equi-
noctiall points, then the Sunne is due Eaſt or
Weſt.

4 If a ſhip be betweene the Equinoctiall and
either of the Tropicks, the Sunne will come
twice to one point of the compaſſe in the fore-
noone, that is, in one and the ſame poſition.

5 Vnder the Equinoctiall neare *Guinea* there
is but two ſorts of windes all the year, 6 moneths
a Northerly winde, and 6 moneths a Southerly
winde, and the flux of the Sea is accordingly.

6 If two ſhips under the *Equinoctiall* be 100.
leagues aſunder, and ſhould ſayle Northerly
<div align="right">untill</div>

untill they were come under the Articke circle, they should then be but 50 leagues asunder.

7 Those which have the Artick circle, vertical : when the Sunne is in the Tropick of *Cancer*, the Sun setteth not, but toucheth the western part of the Horizon.

8 If the complement of the Sunnes height at noon be found equall to the Sunnes 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 stile in any Sunne-dyall upon a plaine, maketh a right line, otherwise it is *Eclipticall*, *Hyperbolicall*, &c.

10 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 between the Horizon and the *Zenith*, that is, 45 degrees high.

PROBLEM. XCVII.

To make a Triangle that shall have three right Angles.

OPen the *Compasses* at pleasure : and upon *A*, describe an Arke *B C*. then at the same opening, place one of the feet in *B*, and describe the

the Ark *A C.* Lastly, place one of the feet of
the *Compasses* in *C.* and describe the Arke *A B.*
so shall you have the
sphericall *Æquilate-*
rall Triangle A B C,
right angled at *A,* at
B, and at *C.* that is,
each angle compre-
hended 90. degrees:
which can never be
in any plaine Tri-
angle, whether it be
Equilaterall, Isocelse, scaleve, Orthogonall, or *Opi-*
gonall.
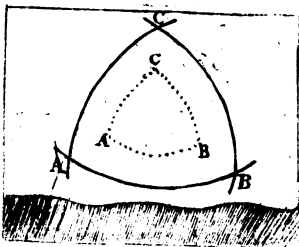
Problem. XCVIII.

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, & can-
not be practised but upon a *Maincordion* :
for the Mathematicall line which proceeds
from the flux of a point, cannot be divided in
that wise: One may have therefore an Instru-
ment which is called *Maincordion*, because
there is but one cord : and if you desire to di-
vide your line into 3 parts, run your finger up-
on the frets untill you sound a third in musick:
if you would have the fourth part of the line,
then

then finde the fourth found, a fifth, &c. so shall
you have the answer.

PROBLEM. XCIX.

*To draw a line which shall incline to another line,
yet never meet : against the Axiome
of Parallels.*

THis is done by help of a Conoeide line, pro-
duced by a right line upon one & the same
plaine, held in great account amongst the An-
cients, 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 *I
A.* augment it to *H.*
then from *A.* draw
lines at pleasure to
intersect the line *I.
M.* in each of which
lines from the right
line, *I M.* transferre
*I H. viz. K B. L C.
O D. P E. 2 F. M G.*
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.
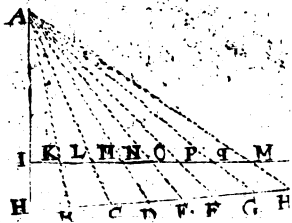
PROBLEM. C.

To observe the variation of the compasses, or needle in any places.

First deſcribe a Circle upon a plaine , ſo that the Sun may ſhine on it both before noone and afternoone : in the centre of which Circle place a *Gnomon* or *wire* perpendicular as *A B*, and an houre before noone marke the extremitie of the ſhadow of *A B*, which ſuppoſe it be at *C*. deſcribe a Circle at that ſemidiamiter *C D F*. then after noone mark when the top of the ſhadow of *A B*.toucheth the Circle , which admit in *D*; divide the diſtance *C D* into two equall parts,which ſuppoſe at *E*.draw the line *E A F*. which is the Meridian line , or line of *North & South* : now if the Arke of the Circle *C D* be divided into degrees . place a Needle *G H*, upon a plaine ſet up in the Centre , and marke how many degrees the point of the Needle *G*, is from *E*. ſo much doth the Needle vary from the North in that place.
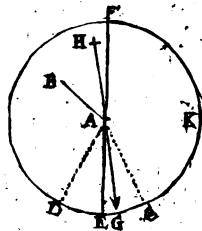
PROB.

PROBLEM. CI.

How to finde at any time which way the wind is in ones Chamber, without going abroad?

VPon the Plancking or floore of a Chamber, Parlor, or Hall, that you intend to have this device, 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 foot with a vane or a scouchen at it to shew the winds without: and at the lower end of this rod of Iron, place a Dart which may by the moving of the vane with the wind without, turne this Dart which is within: about which upon the plaister 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 placi to Compasse by it; for having 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 Roome, you have nothing to do but to look up to the Dart, which will point you out what way the winde bloweth at that instant.
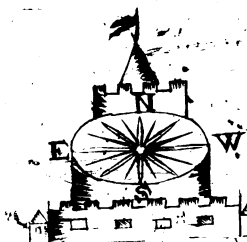
PROB-

PROBLEM. CII.

How to draw a parallel sphericall line with great ease?

FIrst draw an obscure line *G F.* in the middle
of it make two points *A B,* (which serves for
Centres, then place one foot of the Compasses
in *B,* and extend the other foot to *A,* and de-
scribe the *semicircle A C.* then place one foot
of the Compasses in *A,* and extend the other
foot to *C,* and describe the *semicircle C D.*
Now place the Compasses in *B,* and extend the
other foot unto *D,* and describe the *semicircle
D E,* and so *ad infinitum* : which being done
neatly, that there be
no right line seene
nor where the Com-
passes were placed,
will seeme very
strange how possibly
it could be drawne
with such exactnes,
to such which are ig-
norant of that way.
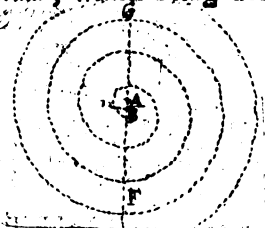
PROBLEM: CIII.

*To meaſure an inacceſſible diſtance, as the breadth
of a River with the help of ones
hat onely.*

THe way of this is eaſie : for having ones
hat upon his head, come neare to the bank
of the River, and holding your head upright
(which may be by putting a ſmall ſtick to ſome
one of your buttons to prop up the chin) pluck
downe the brim or edge of your hat untill 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 breadth of
the River required.

PROBLEM. CIIII.

*How to meaſure a height with two ſtrawes or two
ſmall ſtickes.*

TAke two ſtrawes or two ſtickes which are
one as long as another, and place them at
right Angles one to the other, as *A B*. and *AC*.
then holding *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

ward untill you may
fee the top of the
Tower or tree, which
fuppofe at *E.* So the
diftance from your
ftanding to the Tow-
er or Tree, is equall
to the height thereof
above the levell of
the eye : to which if
you adde your ovvne
height you have the
whole height.
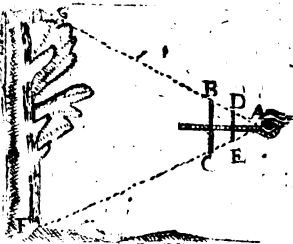
Otherwife.

TAke an ordinary
square wᶜʰ Car-
penters or other
workemen ufe, as *H
K L.* and placing *H.*
to the eye fo that *H
K.* be levell, go back
or come nearer untill
that by it you may fee the top *M.* for then the
diftance from you to the height is equall to the
height.
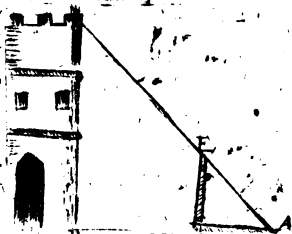
Pᴿᴏᴮ

PROBLEM. CV.

How to make statues, letters, bowles, or other things
which are placed in the side of a high build-
ing, to be seen below of an equall bignesse.

LEt *B C*. be a Pillar 7 yards high, and let
it be required that three yards above the le-
vell of the eye *A, viz.* at *B*. be placed a Globe,
and 9 yards above *B*. be placed another, & 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 appeare
to be of one and the
same Magnitude: It
is thus done, first
draw a line as *A K*.
and upon *K*. erect a
perpendicular *K X*.
divide this line into
27 parts, and accord-
ing to *A K*. describe
an Arke *K Y*. then from *K*. in the perpendicular
K X, account 3. parts, *viz.* at *L*, which shall re-
present the former three yardes, and draw the
line *L A*. from *L*, in the said perpendicular
reckon the diameter of the lesser Globe of what
Magnitude it is intended to be: suppose *S L*,
and draw the line *S A*. cutting the Arke *Y*
K. in *N*. then from *K*. in the perpendicular ac-
count 9 yards, which admit at *T*. draw *T A*, cut-
ting *Y K*. in *O* transferre the Arke *M N*, from

A

A to *P.* and draw *A P.* which will cut the perpendicular in *V.* so a line drawne from the middle of *V. F.* unto the visuall lines *A I,* and *A V,* shall be the diameter of the next Globe: Lastly, account from *K.* in the perpendicular *X K.* 22 parts, and draw the line *W A.* cutting *Y K* in *Q.* then take the Arke *M N,* and transferre it from *Q* to *R,* and draw *A R.* which will cut the perpendicular in *X.* so the line which passeth by the meddle of *X W.* perpendicular to the visuall line *A W,* and *A X.* be the Diameter of the third Globe, to wit 5, 6. which measures transferred in the Pillar *B C.* which sheweth the true Magnitude of the Globes 1, 2, 3. from this an Architector doth proportion his Images, & 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 seen in a direct & 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 Picture
(which painters know well enough to do) af-
terwards put a Candle upon the Table, and in-
terpoſe this figure obliquely , between 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 black head or Ink : and you have
your deſire.

.. To finde now the point where the eye muſt
ſee it in his naturall forme : it is accuſtomed ac-
cording to the order of Perſpective , to place
this point in the line drawne in height , equall
to the largeneſſe of the narroweſt ſide of the
deformed ſquare, and it is by this way that it is
performed.

PROBLEM. CVII.

How a Cannon after that it hath ſhot, may
be covered from the battery of
the enemy.

LEt the mouth of a Cannon be *I*, the Cannon
M. hiſcharge *N O*, the wheele *L*, the axle-
tree *P B*. upon which the *Cannon* is placed , at
which

which end towards *B*, is placed a pillar *A E*
supported with props *D, C, E, F, G*. about
which the Axeltree
turneth : now the
Cannon being to
shoot, it retires to *H*,
which cannot be di-
rectly because of the
Axletree, but it make
a segment of a circle,
and hides himselfe
behind the wal *Q R*,
and so preserves it selfe from the Enemies bat-
tery, by which means one may avoid many
inconveniences which might arise : and more-
over, one man may more easily replace it againe
for another shot by help of poles tyed to the
wall, or other help which may multiply the
strength.
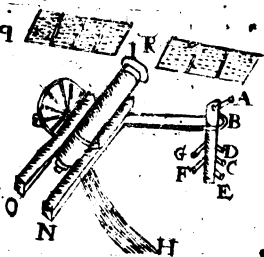
PROBLEM: CVIII.

How to make a Lever, by which one man may
alone place a Cannon upon his carriage,
or raise what other weight
he would.

First place two thick boards upright, as the
figure sheweth, pierced with holes, alike
opposite one unto another as *C D*, and *E F*: &
let *L*, and *M*, be the two barres of Iron which
passeth through the holes *G H*, and *F, K*, the
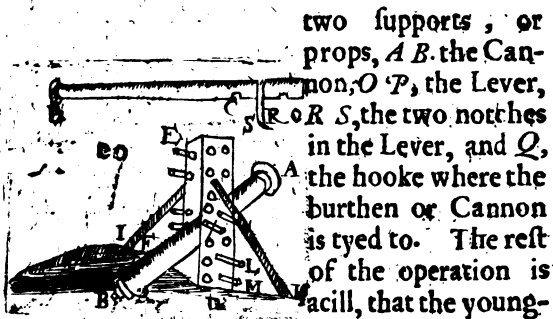
two fupports , or props, *A B.* the Cannon, *O P,* the Lever, *R S,* the two notches in the Lever, and *Q,* the hooke where the burthen or Cannon is tyed to. The rest of the operation is facill, that the youngeft fchollers or learners cannot faile to performe it: to teach *Minerva* were in vaine, and it were to Mathematicians injury in the fucceeding Ages.

PROBLEM. CIX.

How to make a Clock with one onely wheele.
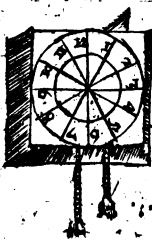
MAke the body of an ordinary Dyall , and divide the houre in the Circle into 12. parts : make a great wheele in height above the Axletree , to the which you fhall place the cord of your counterpoize, fo that it may defcend, that in 12 houres

houres of time your *Index* or *Needle* may make
one revolution, which may be 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
Clock with many wheeles.

PROBLEM. CX.

*How by help of two wheeles to make a Childe to draw
up alone a hogſhead of water at à 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 hook to throw out the
water when it is brought up (this hook muſt be
moveable) let *A B* be the Axis of the wheele
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, vvhich vvheele *S*, beares
proportion to the vvheele *T*, as 8 to 2. let *N* be
a Chaine of Iron to vvhich is tyed the veſſel *O*,
and the other vvhich is in the Pit: *C F* is a piece
of vvood vvhich hath a mortes in 1, and 2, by
vvhich the Cord *I*, paſſeth, tyed at the vvall, as
K H, and the other piece of timber of the little
vvheele as *M*, mortiſed in likevv'ſe for the
R 4   chaine

haine to paſſe through : draw the *Cord I*, by
K, and the wheele will turne, & ſo conſequent-
ly 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 rea-
ſon. This is an in-
vention which will
ſave labour if practi-
ſed; but here is to be
noted that the pit muſt be large enough, to the
end that it conteine two great veſſels to paſſe
up and downe one by another.
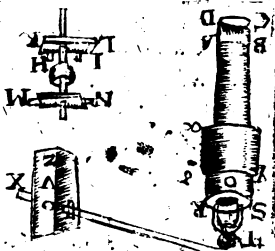
PROBLEM. CXI.

*To make a Ladder of Cords, which may be carryed
in ones pocket : by which one may eaſily
mount up a Wall, or Tree alone.*

Ake two Pullies *A*, & *D*, unto that of *A*,
let there be faſtened a *Cramp* of Iron as *B*;
and at *D*, let there be faſtened a ſtaffe of a foot
and 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 thick (which may be of ſilk becauſe
it is for the pocket:) then ſtrive to make faſt the
<div align="right">Pully</div>

Fully *A*, by the help 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 be-
tvveen your legges as though you vvould sit

uponit : then hold-
ing the *Cord C* in
your hand, you may
guide your selfe to
the place required;
vvhich may be made
more facill by the
multiplying of Pul-
lies. This secret is
most excellent in
Warre, and for lo-
vers, its supportablenesse avoids suspition.

Problem. CXII.

How to make a Pumpe whose strength is marve-
lous by reason of the great weight of water that
it is able to bring up at once, and so by
continuance.

Let *a ç γ δ*, be the height of the case about
two or three foot high, and broader ac-
cording to discretion : the rest of the *Case* or
concavity let be *O* : let the sucker of the Pumpe
vvhich is made, be just for the *Case* or *Pumpes*
head *a ç γ δ*, & may be made of vvood or brasse
of 4 inches thick, having a hole at *E*, vvhich de-
scending
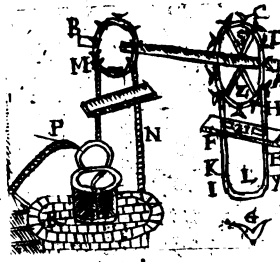
scending raiseth up the cover P, by which issueth forth the water, & ascending or raising up it shuts it or makes it close: *R S*, is the handle of the sucker tyed to the handle *T X*, which works in the post *V Z*. Let *A*, *B,C,D,* be a piece of Brasse, *G* the piece which enters into the hole to *F*, to keep out the Aire. *H,I,K,L*, the piece tyed at the funnell or pipe: in which playes the Iron rod or axis *G*, so that it passe through the other piece *M N*, 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 Gridiron or Iron Grate, which may be tyed in the pit, by which means lifting up and putting downe the handle, you may draw ten times more water than otherwise you could.

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.

L Et *I L*, be the Pit where one would cause water to ascend continually to: ach office

of

ofa 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 aire
enter not in, to which faſten a pipe of lead as
at *E*, which may have vent at pleaſure, then let
there be made a Ciſterne as *B*, which may be
communicative to *A*, by helpe of the pipe *G*,
from vvhich Ciſtern
B, may iſſue the vva-
ter of pipe *D*, vvhich
may deſceud to *H*,
vvhich is a little be-
lovv the levell of the
vvater of the pit as
much as is *G H*. to
the end of vvhich
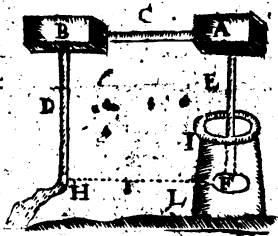
ſhall be ſoldered cloſe a Cock vvhich ſhall caſt
out the vvater by *K H*. Novv to make uſe of
it, let *B* be filled full of vvater, and vvhen
you vvould have it run turne the Cock, for
then the vvater in *B*, vvill deſcend by *K*. and
for feare that there ſhould be vacuity, nature
vvhich abhors it, vvill labour to furniſh and
ſupply that emptineſſe out of the ſpring *F*, and
that the *Pit* dry not, the Pipe ought to be ſmall
of an indifferent capacity according to the
greatneſſe or ſmalneſſe of the ſpring.

PROB.

Problem. CXIIII.

How out of a fountaine to caſt the water very high
different from a Probleme formerly
delivered.

LEt 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 conjoyned
as *Є A*, and *H C*, ſo that no Aire may enter in
at the place of joyning : let each of the Pipes
have a cock *G*, & *L*:
the cocke at *G*, being
cloſed , open that at
I, & ſo with a ſquirt
force   the water
through the hole at
H, then cloſe the
Cocke at *A*, & draw
out the ſquirt , and
open the cock at *G*.
the Aire being before rarified will extend his
dimenſions, and force the water with ſuch vio-
lence, that it will amount above the height of
one or two Pipes : 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 Aire approacheth
to his naturall place , ſo the force will diminiſh.
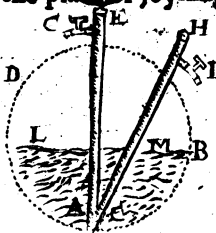
PROBLEM. CXV.

How to empty the water of a Cisterne by a Pipe which shall have a motion of it selfe.

LEt *A B*, be the vessell ; *C D E*, the Pipe: *H G*, a little vessell under the greater, in which one end of the Pipe is, *viz. C*, and let the o-ther end of the Pipe *E*. passing through the bottome of the ves-sell at *F*, then as the vessell filleth so will the Pipe, and when the vessell, shall be full as farre as *P O*, the Pipe will begin to runne at *E*, of his owne accord, and ne-ver cease untill the vessell be wholly empty.
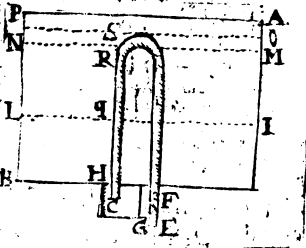
PROBLEM CXVI.

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 vessels of Brasse, Lead, or of other matter of equal substance as are the two vessels *A B*, and *B D*, & let them be joyned together by the two Pillars *M N*, & *E F*: then let there be a pipe *H G*. which may passe through the cover of the vessell *C D*, and passe through *A B*, into *G*, making a little bunch or rising in the cover of the vessell *A B*, so that the pipe touch it not at the bottome :

then let there be foldered 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 *A B*, may be continued unto *I*, that
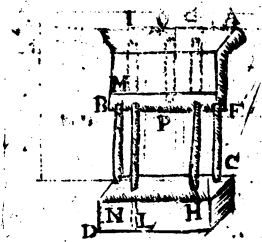
is to ſay, to make an
opening to the cover
of the veſſell *A B*, &
let it have a little
mouth as a Trumpet:
to that end to receive
the water. Then there
muſt further be ad-
ded a very ſmal Pipe
which may paſſe
through the bottome of the veſſell *A B*, as let
it be *O P*, and let there be a bunch; or ſwelling
over it as at *P*, ſo that it touch not alſo the bot-
tome : let there be further made to this leſſer
veſſell an edge in forme of a Baſin to receive
the water, which being done poure water into
the Pipe *I L*, untill the veſſell *C D*, be full, then
turne the whole Machine upſide downe that
the veſſell *C D*, may be uppermoſt, and *A B*,
undermoſt: ſo by helpe of the pipe *G H*, the
water of the veſſell *C D*, will runne into the
veſſel *A B*, to have paſſage by the pipe *P O*.
This motion is pleaſant at a feaſt in filling the
ſaid veſſel with wine, which will ſpout it out
as though it were from a boyling fountaine, in
the forme of a threed very pleaſant to behold.

PROB.

PROBLEM. CXVIII.

How to practise excellently the reanimation of sim-
ples, in case the plants may not be transported
to bo replanted by reason of distance
of places.

Tak ewhat simple you please, burne it and
take the ashes of it, and let it be calcina-
ted two houres between two Creusets wel luted,
and extract the salt : that is , to put water into
it in moving of it; then set it settle : and do it
two or three times, afterwards evaporate it, that
is, let the water be boyled in some vessel, untill
it be all consumed : then there will remaine a
salt at the bottome, which you shall afterwards
sowe in good Ground wel prepared: such as the
Theatre of husbandry sheweth, and you shall
have your desire.

PROBLEM. CVIII.

How to make an infalliable perpetuall motion.

Mixe 5. or 6. ounces of ☿ with is equall
weight of ♃, grinde it together with 10.
or 12 ounces of sublimate dissolved in a celler
upon a Marble the space of foure dayes, and
it will become like Oile , Olive , which distill
with fire of chaffe or driving fire , and it will
sublime

fubjime dry fubftance, then put water upon the
earth (in forme of Lye) which will be at the
bottom of the Limbeck, and diffolve that which
you can; filter it, then diftill it, and there will be
produced very fubtill Antomes, which put into
a bottle clofe ftopped, and keep it dry, and you
fhall have your defire; with aftonifhment to
all the world , and efpecially to thofe which
have travelled herein without fruit.

Problem. CXIX.

Of the admirable invention of making the Philo-
fophers Tree , which one may fee with his eye
to grow by little and little.

TAke two ounces of *Aqua fortis*, and dif-
folve in it halfe an ounce of fine filver re-
fined in a Cappell: then take an ounce of *Aqua*
fortis , and two drams of Quick-filver: which
put in it, and mixe thefe two diffolved things
together , then caft it into a Viall of halfe a
pound of water, which may be well ftopped;
for then every day you may fee it grow both in
the Tree and in the branch. This liquid ferves
to black haire which is red, or white, without
fading untill they fall, but here is to be noted
that great care ought to be had in anointing
the haire , for feare of touching the flefh : for
this compofition is very Corrofive or fearching,
that as foone as it toucheth the flefh it raifeth
blifters, and bladders very painfull.

Pro.

PROBLEM. CXX.

How to make the representation of the great world?

Draw salt Niter out of salt Earth which is found along the Rivers side, and at the foot of Mountaines, where especially are Minerals of Gold and Silver: mix that Niter well cleansed with ♃, then calcinate it hermetically; then put it in a Limbeck and let the receiver be of Glasse, well luted, and alwayes in which let there be placed leaves of Gold at the bottome; then put fire under the Limbeck untill vapours arise which will cleave unto the Gold; augment your fire untill there ascend no more; then take away your receiver and close it hermetically, and make a Lampe fire under it untill you may see presented in it that which nature affords us: as *Flowers, Trees, Fruits, Fountaine, Sunne, Moone, Starres, &c.* Behold here the forme of the Limbeck, and the receiver: *A* represents the Limbeck, *B* stands for the receiver.
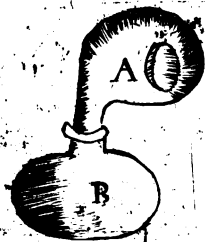
S

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?

THis propofition is not fo thornie and fubtile as it feemes to be, for putting under a Cone of paper a Beetle or fuch like creature, you fhall have pleafure with aftonifhment & admiration to thofe which are ignorant in the caufe: for this animall will ftrive always to free herfelf from the captivity in which fhe is in by the imprifonment of the *Cone*: for comming neere the edge of the Table fhe will returne to the other fide for feare of falling.
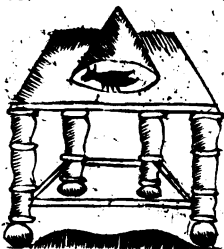
PROBLEM CXXII.

To cleave an Anvill with the blow of a Piftoll.

THis is proper to a Warrier, and to performe it, let the Anvill be heated red hot as one

can possible, in such sort that all the solidity of the body be softned by the fire: then charge the Pistoll with a bullet of silver, and so have you infallibly the experiment.

PROBLEM. CXXIII.

How to rost a Capon carried in a Budget at a Saddle-bowe, in the space of riding 5 or 6 miles?

HAving made it ready and larded it, stuffe it with Butter; then heat a piece 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 kinde, for that it loseth none of its substance, and it is dressed very equally.

PROBLEM. CXXIV.

How to make a Candle burne and continue three times as long as otherwise it would?

VNto the end of a Candle half burned stick a farthing lesse or more, to make it hang

per-

perpendicular in a veſſel of water, ſo that it ſwimme above the water; then light it, and it will ſuſteine it ſelf & float in this manner; and being placed into a fountaine, pond, or lake that runnes ſlowly, where many people aſſemble, it will cauſe an extreme feare to thoſe which come therein in the night, knowing not what it is.
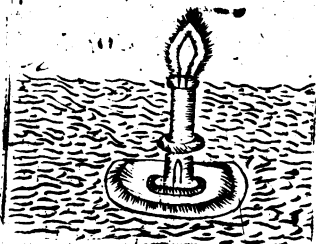
PROBLEM. CXXV.

How out of a quantitie of wine to extract that whi.h is moſt windy, and evill, that it hurt not a ſick Perſon?
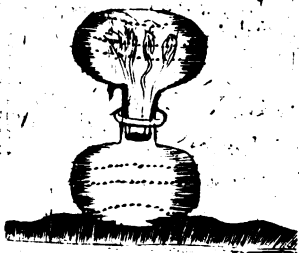
TAke two vials in ſuch ſort that they be of like greatneſſe both in the belly and the neck; fill one of them of wine, and the other of water: let the mouth of that which hath the water be placed into the mouth of that which hath the wine, ſo the water ſhall be

be uppermoſt, now becauſe the water is heavier than the wine, it will deſcend into the other Viall, and the wine which is loweſt, becauſe it 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 wil loſe her vapors in paſſing through the water.

PROBLEM CXXVI.

How to make two Marmouzets, one of which ſhall light a Candle, and the other put it out?

Upon 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 peter very fine, and dry and pulveriſed; and at the end ſet a little match of paper, in the other place ſulphur beaten ſmal, then holding a Candle lighted in your hand, ſay to one of theſe Images by way of command, Blow out the Candle; then lighting the paper with the candle, the ſalt-peter wil 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, & it will immediatly be lighted, which will cauſe an admiration to thoſe which ſee the action, if it be wel done vvith a ſecret dexterity.

S 3   PROB·

PROBLEM.XXVII.

How to keepe wine fresh as if it were in a celler
though it were in the heat of Summer, and
without Ice or snow, yea though it were
carried at a saddle bow, and ex-
posed to the Sun all the day ?

SEt your wine in a viall of Glasse ; and place
it in a Box made of wood , Leather, or such
like : about which vial place Salt-peeter , and
it will preserve it and keep it very fresh: this ex-
periment is not a little commodious for those
which are not neare fresh waters , and whose
dwellings are much exposed to the Sunne.

PUOBLEM. CXXVIII.

To make a Cement which indureth or lasteth
as marble, which resisteth aire and wa-
ter without ever disjoyning or
uncementing ?

TAke a quantity of strong and gluing Mor-
ter well beaten, mixe with this as much
new slaked Lime , and upon it cast Oile of
Olive   or Linseed-Oile , and it will become
hard as Marble being applyed in time.

PROB.

PROBLEM. CXXIX.

How to melt metall very quickly, yea in a shell upon a little fire.

MAke a bed upon a bed of metall with pouder of Sulphur, of Salt-peeter, and saw-dust alike ; then put fire to the said pouder with a burning Charcole , and you shall see that the metall will dissolve incontinent and be in a Masse. This secret is most excellent, and hath been practised by the reverend father *Mercenus* of the order of the *Minims.*

PROBLEM. CXXX.

How to make Iron or steele exceeding hard?

QVench 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 *Armorie* in warlike negotiations.

PROB.

PROBLEM   CXXXI.

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

AFter that you have extracted the burning
spirit of the salt of ♃, by the degrees of
fire , as is required according to the Art of
Chymistrie, the fire being kindled of it selfe,
break the Limbeck , and the Irons which are
found at the bottome will flame and appeare as
burning Coles as soone as they feele the aire;
which if you promptly inclose in a viall 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
Aire get not in. Then will it keep 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 Aire
it takes fire,with which you may light a Match.
This secret merits to be travelled after and put
in practice, for that it is not common, and full
of astonishment , seeing that all kinde of fire
lasteth but as long as his matter lasteth , and
that there is no matter to be found that will so
long indure.

✿✿✿✿✿✿✿✿✿✿✿✿✿

Artificiall   fire-Workes :

Or the manner of making of *Rockets*
and *Balls* of fire, as well for the Wa-
ter, as for the Aire ; with the com-
poſition of Starres, Golden-rain,
Serpents, Lances, Wheels of fire
and ſuch like, pleaſant
and Recreative.

Of the compoſition for Rockets.

N the making of Rockets,
the chiefeſt thing to be re-
garded is the compoſition
that they ought to be fil-
led with ; foraſmuch 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 weak compoſition
being in 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
                    T   are

are charged but with one ounce of Powder un-
to 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
smal beaten, put two ounces of smal Cole dust,
and with this composition charge the Rocket.

For Rockets of 2 or 3 ounces.

Vnto every foure ounces and a halfe of pow-
der dust, adde an ounce of Salt-peter, or to eve-
ry 4 ounces of powder dust, adde an ounce of
ole dust.

For Rockets of 4 ounces.

Vnto every pound of Powder dust adde 4
ounces of Salt peter.& one ounce of Cole dust:
but to have it more slow, unto every 10. oun-
ces of good dust powder adde 3 ounces of Salt-
peter, and 3 ounces of Cole dust.

For Rockets of 5 or 6 ounces.

Vnto every pound of Powder dust, adde 3
ounces and a halfe of Salt peter, and 2 ounces
and a halfe of Coledust, as also an ounce of
Sulphur, and an ounce of fyle dust.

For Rockets of 7 or 8 ounces.

Vnto every pound of Powder dust adde 4
ounces of Salt peter, and 3 ounces of Sulphur.

Of Rockets of 10 or 12 ounces.

Vnto the precedent composition adde halfe
an ounce of Sulphur, and it will be sufficient.

For Rockets of 14 or 15 ounces.

Vnto every pound of Powder dust adde 4
ounces of Salt peter, or Cole dust 2 ½ ounces of
Sulphur

Sulphur and file dust of 1 ½ ounce.

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 ½ ounces of Salt peter, of Cole dust 2 ½ ounces, filedust 1 ½ ounce, and of Sulphur ¼ of ounce.

For Rockets of 3, pound.

Vnto every pound of Salt peter adde 6 ounces of Cole dust, and of Sulpher 4, ounces.

For Rockets of 4, 5, 6, or 7, pound.

Vnto every pound of Salt peter adde 5 ounces of Cole dust, and 2 ½ ounces of Sulphur.

For Rockets of 8, 9, or 10 pound.

Vnto every pound of Salt peter, adde 5 ½ ounces of Cole dust, and of Sulphur 2 ⅓ 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 be filled with a more weaker composition.

Of the making of Rockets and other Fireworkes.

FOr the making of Rockets of sundry kindes, divers moulds are to be made, with their Rolling pins, Breaths, Chargers, &c. as may be seen here in the figure. And having rolled a Case of paper upon the Rolling pin for your mould, fill it with the composition belonging to that mould as before is delivered :

now

now may you load it on the top, with Serpents, Reports, Stars, or Golden Raine: the Serpents are made about the bignesse of ones little finger, by rolling a little paper npon a small stick, 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 kinde of starres are made with this mixture following; unto every 4 ounces of Salt-peter, 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
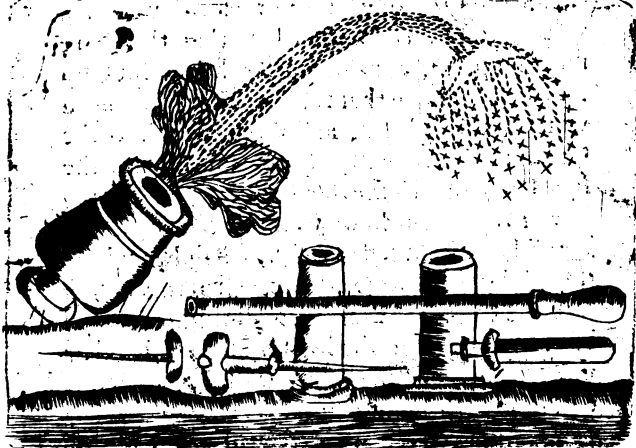
towe; and then tying it up in the form of a ball
as great as an Hasel-Nut or a little Wal-nut,
through which there must be drawne a little
Primer to make it take fire. Touching the ma-
king of the Golden Raine, that is nothing but
filling of Quilles with the composition of your
Rockets somewhat hard. 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 Aire, and
come downe like streames of Gold much like
the falling downe of Snow being agitated by
some turbulent winde.

Of

Of recreative fires.

[1] PHilostrates saith, that if wine in a platter be 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 Aire may not go 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 Cubboard there will appeare unto him the figure of many cleare starres.

2 If *Aquavita* have Camphire 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 deceitful are made of halfe powder, covered over with Tallow, and the other halfe is made of cleane Tallow, or Waxe, with an ordinary week; this Candle being lighted, and the upper halfe consumed, the powder will take fire, not without great noise and astonishment to those which are ignorant of the cause.

4 A dozen or twenty smal Serpents placed secretly under a Candlestick that is indifferent big, which may have a hole passe through the socket of it to the Cardle, through which a piece of primer may be placed, and setting a smal *Candle* in the socket to burne according to

to a time limited : which Candleſtick may be
ſet on a ſide Table without ſuſpition to any;
then when the Candle is burned, that it fires
the primer, that immediately will fire all the
Serpents, which overthrowing the Candleſtick
will flye here and there, intermixing them-
ſelves, ſometimes in the Aire, 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 be fired, though the whole powder
together makes not an ounce, and hath no
ſtrength to do ſuch an effect.

How to make fire run up and downe,
forward and backward.

TAke ſmall Rockets, and place the taile 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 flye to *B*, which will come back
againe to *A*, and fire another at *C*, that will
flie at *D*, which will fire another there, and flie
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 inter-
mix themſelves in the Aire, and upon the
ground, and every one will extinguiſh with a
report : and here may you note that upon the

<div align="center">T 4   Rockets</div>

Rockets may be placed fierie Dragons, Comba-
tants, or such like to meet one another, having
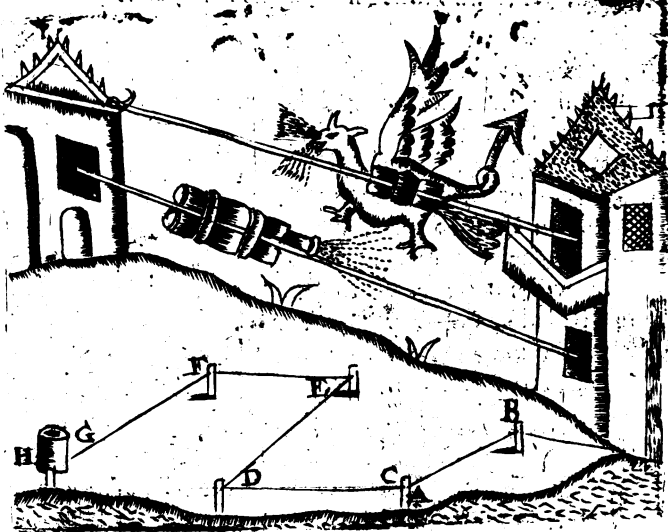
lights placed in the Concavity of their bodies
which will give great grace to the action.

How to make Wheels of fire.

TAke 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 hoope or
round Circle place your Rockets, to which
you may place Lances of fire between each
　　　　　　　　　　　　　　Rocket:

Rocket: let this wheele be placed upon a standard as here is represented, and place a piece of Primer from one Lance to another, then give fire at *G*, which will fire *F* that *E*, that will fire
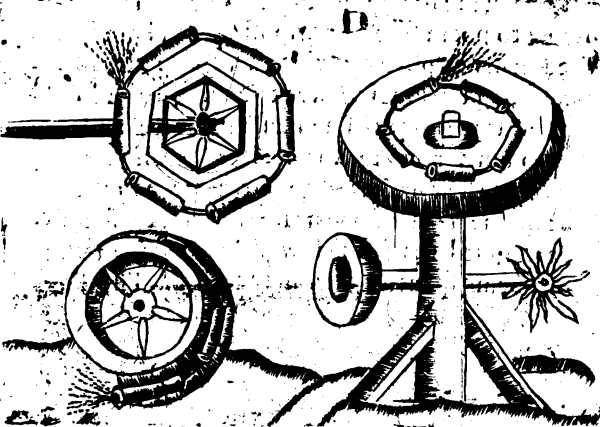
D, that *C* and that will fire the Rocket at *A*: then immediatly the wheel will begin to move, and represent unto the spectators a Circle of changeable fire, and if pots of fire be tied to it, you will have fine sport in the turning of the wheele and casting out of the Serpents.

Of night-Combatants.

Clubbes, Targets, Faulchons, and Maces charged with severall fires, do make your night-Combatants, or are used to make place amongst a throng of people. The Clubbes at the ends are made like a round Panier with

<div align="right">small</div>

small sticks, filled with little Rockets in a spi-
rall forme, glued and so placed that they fire
but one after another; the Maces are of di-
vers fashions, some made oblong at the end,
some made of a spirall forme, but all made hol-
low to put in several composition, and are boar-
ed in divers places, which are for sundry Roc-
kets, and Lances of weak composition to be
fired at pleasure: The Faulchons are made of
wood in a bowing forme like the figure *A*,
having their backes large to receive many Roc-
kets, the head of one neare the neck of ano-
ther, 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 channeled in spiral lines to containe primer

to

to fire the Rockets one after another, which is all covered with thinne covering of wood, or Pastboard, boared with holes spirally also; which *Rockets* must be glued and made fast to the place of the Channels: Now if two men, the one having a Target in his hand, and the other a Falchion, or Mace of fire, shall begin to fight, it will appeare very pleasant to the Spectators: for by the motion of fighting, the place will seem to be ful of streames of fire; and there may be adjoyned to each Target a Sunne or a burning Comet with Lances of fire, which will make them more beautifull and resplendent in that action.

Of standing Fires.

SVch as are used for recreation, are *Collossus*, *Statues*, *Arches*, *Pyramides*, *Chariots*,
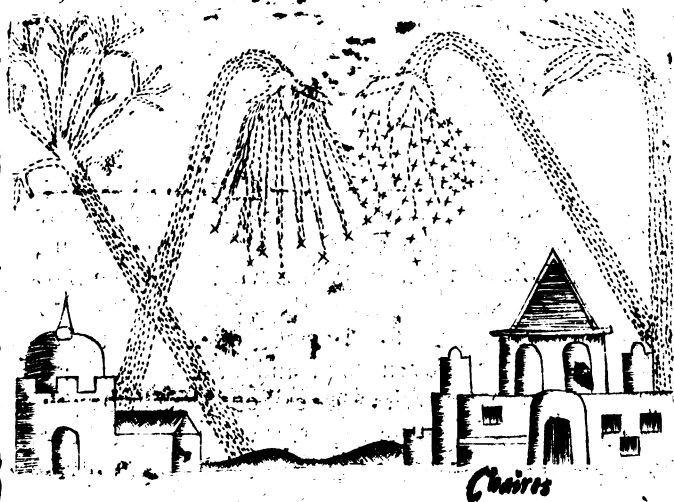
Chaires

Chaires of triumph and such like, which may be accommodated with Rockets of fire, and beautified with sundry other artificiall fires; as pots of fire for the Aire which 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, Lanthornes of fire, Candles of divers uses, and colours in burning, and whatsoever the fancie of an ingenious head may allude unto.

Of Pots of fire for the Aire, which are throwne out of one Case one after another of a long continuance.

MAke a long Trunk as *A G*, and by the side *A H*, let there be a Channel which may be fiered with flow primer or composition; then having charged the Trunk *A G*, with the Pots of fire for the Aire at *I G E C*, and make the Trunk *A G*, very fast unto a Post as *I K*, give fire at the top as at *A*, which burning downewards will give fire to *C*, and so throw out that Pot in the Aire, vvhich being spent, in the meane time the fire vvill burne from *B* to *D*, and so fire *E*, and throvv it out also into the Ayre, and so all the rest one after another vvill be throvvne out : and if the Pots of fire for the Aire vvhich are cast out, be filled vvith diverse Fire-vvorkes, they vvillbe so much the

more

more pleasant to the beholders. These Trunks of fire doe greatly adorne a Firevvorke, and may conveniently be placed at each angle of the vvhole vvorke.
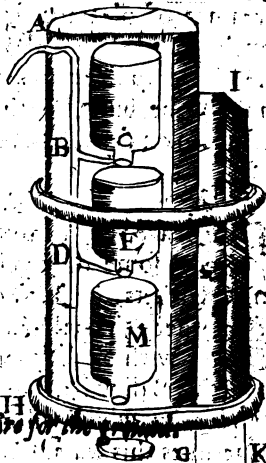
Of Pots of fire for the ground.

MAny Pots of fire being fired together do give a fine representation, and recreation to the spectators, and cause a vvonderfull shout amongst the common people vvch are standers by; for those Pots being filled vvith Balles of fire and flying Serpents for the Aire,
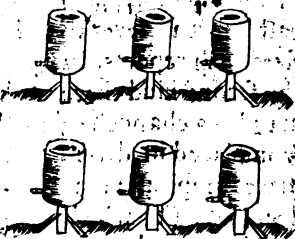
they vvill so intermix one vvithin another, in flying here and there a little above the ground, and giving such a volley of reports that the Aire vvill rebound vvith their noise, and the vvhole place be filled vvith sundry

streames

ſtreames of pleaſant fire; which ſerpents will
much occupie theſe about the place to defend
themſelves in their upper parts, when they will
no leſſe be buſied by the balls of fire, which
ſeeme to annoy their feet.

Of Balles of fire.

THeſe are very various according to a mans
fancy; 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 cove-
red 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 rolle
ſometimes this way, ſometimes that way, be-
tween the legs of thoſe that are ſtanders by,
if they take not heed, 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 man-
ner, againſt which
may be placed as many ſmall petards 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 Rockers in
the middle: this Ball may be ſhot out of a
                                        morter-

morter Peece, or charged on the top of a Roc-
ket : for in its motion it will flye here and there,
and give many reporrs in the Aire : because of
the discharge of the petards.
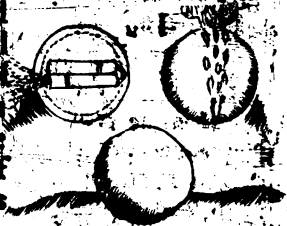
Of fire upon the Water.

Places 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, Pagins , Castles, or such like,
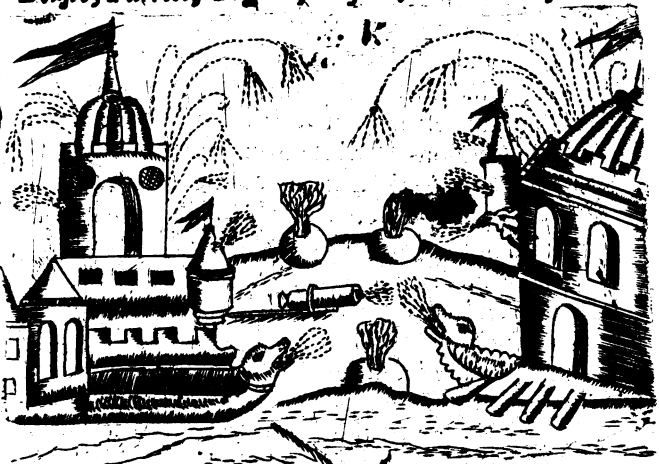
to receive or hold the diversity of Fire-workes
that may be made within it, in which may play
divers fires , Petards, &c. and cast out many
simple Granadoes, Balls of fire to burne in the
water,

water-Serpents and other things, and often
times these boates in their incounters may hang
one in another, that so the Combatants with
the Targets, and Maces 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 tri-
umph and victory of the fight gotten.

Of Balls of fire which move upon the water.

THese may be made in forme of a Ball stuf-
fed with other little Balls, glued round
about and filled with composition for the wa-
ter, which fiered, will produce marvellous 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 pier-
ced in sundry places, to which holes, may be
set small Balles ful of composition for the water
which small Balls must be peirced deep and
large, and covered with Pitch, except the hole:
in which hole must
be first plated a little
quantitie of grain-
Powder; and the
rest of the hole filled
up with compo-
sition; and note
further that these
Iron Cannons, must

be
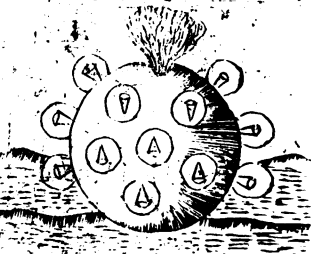
be filled with a flow composition; but such which is proper to burne in the water : then must these Cannons with their small Balls be put so together that it may make a Globe, and the holes in the Cannons be answerable to the hollow Balls, and all covered over with Pitch and Tallow; afterwards pierce 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.

STanding 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 bighesse of ones finger, which are filled with a composition for Lances. But if these Lances be filled with a compositi-

V

on,

-on, then (unto every 4 ounces of powder adde
2 ounces of Salt-Peter, 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 mischie-
vous effect.

How to shoot 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 be 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 ser-
viceable it may be.
To the head of such
Rockets, may be pla-
ced Petards, Balls of fire, Granadoes, &c. and
so may be applyed to warlike affaires.

How

How a Rocket burning in the water for a certaine
time, at laſt ſhall fly up in the Aire
with an exceeding quickneſs.

TO do this, take two Rockets, the one equall
to the other, and joyne them one unto ano-
ther in the middle at *C.* in ſuch ſort that the
fire may eaſily paſſe from one to another: it be-
ing thus done, tye the two Rockets at a ſtick in
D, and let it be ſo long and great that it may
make the Rockets in the water hang, or lye up-
right: then take a pack-thread and tye it at *G.*
and let it come double about the ſtick *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 mount-
ing quick out of the water by the looſe tying at
C. and the Bullet at the pack-thread, will leave
the other Rocket in the vvater : and ſo aſcend
like a Rocket in the Aire, to the admiration of
ſuch as knovv not the ſecrecie.

Y 2
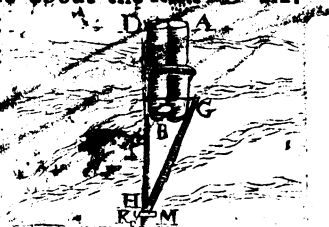
Of the framing of the parts of a Fire-Worke,
together, that the severall workes
may fire one after another.

CAuse a frame to be made as *A B C D.* of
tvvo foot square every yvay, or thereabouts
(according to the quantity of your severall
vvorkes) then may you at each angle have a
great Lance of fire to stand, vvhich may cast
out Pots of fire as they consume: upon the
ledges *A B. B C.* and *C D.* may be placed
small Lances of fire about the number of 30 or
60, some sidevvise, and others upright, betvveen
these Lances may be placed Pots of fire sloping
outvvards, but made very fast, and covered ve-
ry close, that they chance not to fire before they
should; then upon the ledges *R E. F G. H I.*
and *A D* may be placed your soucisons, and
behinde all the vvork may be set your Boxes of
Rockets, in each of vvhich you may place 6, 9,
12. or 20 small Rockets: Novv give fire at *A.*
(by help of a piece of primer going from one
Lance to another) all the Lances vvill instant-
ly at once be lighted, and as soone as the Lance
at *A* is consumed, it vvill fire the Channell
vvhich is made in the ledge of the frame vvhich
runnes under the Pots of fire, and as the fire
goes along burning, the Pots vvill be cast forth,
and so the rank of Pots upon the sides of the
frame *A B. B C.* and *C D.* being spent, the
soucisons vvill begin to play being fiered also
by a Channel vvhich runnes under them, upon
the
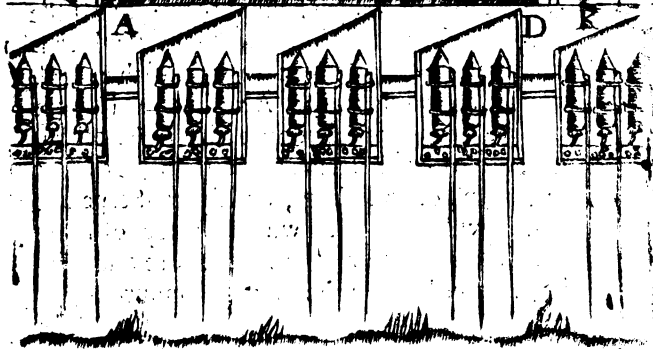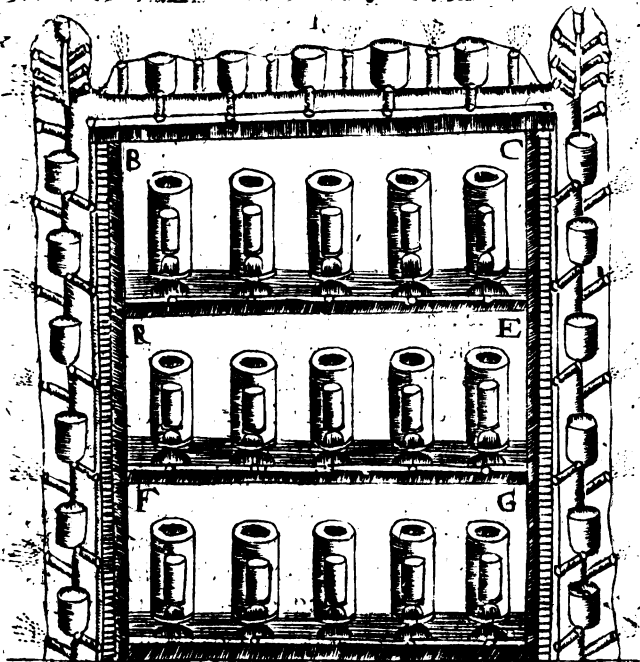
the ledges *A D, H I, F G*, and *R E.* then when
the *Soucions* are spent upon the last ledge *R E.*
there may be a secret Channel in the ledge *C D*
which may fire the Box of Rockets at *K.* and
may fire all the rest one after another, which
Boxes may be all charged with severall Fire-
Workes : for the Rockets of the first Box may
be loaden with Serpents, the second with Stars,
the third with Reports, the fourth with Gold-
en raine, and the fifth with small flying Ser-
pents; these mounting one after another and
flying to and fro will much inlighten the Aire
in their ascending, but when these Rockets dis-
charge 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 Aire, others
like flashes of lightning, others like the glitte-
ring 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-works) then shall
you see ascending in the Aire but as it were
onely a quill of fire, but once the *Balon* taking
fire, the Aire 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 Aire and Fir-
mament with their rebounding clamour.

<div align="right">The</div>

The making of which with many other rare and excellent Fire-workes, and other practises, not onely for recreation, but also for service: you may finde in a book intituled *Artificiall Fire-workes*, made by Mr. *Malthus* (a master of his knowledge) and are to be sold by *VVilliam Leake*, at the Crowne in Fleet-street, between the two Temple-Gates.

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 avoid prolixitie, and so past by things reiterated.

FINIS.

Y Ork's Heraldry , Folio
A Bible of a very fair large Roman letter, 4º

Orlando Furioso Folio.

Callis learned Readings on the Stat. 21. Hen. 80. Cap. 5 of Sewers

Perkins on the Laws of *England*.

wilkinsons Office of Sheriffs.

Vade Mecum, of a Justice of Peace.

The book of Fees.

Peasons Law.

Mirrour of Justice.

Topicks in the Laws of *England*.

Skea de significatione Verborum.

Delaman's use of the Horizontal Quadrant.

wilby's 2d set of Musique, 3 4 5 and 6 Parts.

Corderius in English.

Doctor *Fulk's* Meteors.

Malthus Fire-workes.

Nyes Gunnery & Fire-workes Maior with Annotations, by *Wil. Austin* Esquire.

Mel Helliconium, by *Alex. Rosse*.

Nosce teipsum, by Sr *John Davis*

Animadversions on *Lillies* Grammer.

The History of *Vienna*, & Paris

Lazarillo de Tormes.

Hero and *Leander*, by *G. Chapman* and *Christoph. Marlow*.

Alcilia or *Philotas* loving folly.

Bishop *Andrews* Sermons.

Adams on Peter.

Posing of the Accidence.

Amadis de Gaule.

Guillielim's Heraldry.

Herberts Travels.

Baccas Tales.

Man become guilty, by *John Francis Senalt*, and Englished by *Henry* Earl of *Monmouth*.

The Ideot in 4 books; the first and second of Wisdom ; the third of the Mind; the fourth of Statick Experiments of the Ballance.

The life and Reign of *Hen.* the Eighth, written by the L. *Herbet*

Cornwallis Essays, & Paradoxes.

Clenards greek Grammar 8º

Antalucis, or the house of light: A discourse written in the year 1651, by *S N.* a modern Speculator.

A Tragedy written by the most learned *Hugo Grotius* called, *Christus Patience*, and translated into Engl. by *George Sand*

The Mount of Olives: or Solitary Devotions, by *Henry Vaughan* Silurist With an excellent discourse of Man in glory, written by the Reverend *Anselm* Arch Bishop of *Canterbury*.

The Fort Royall of Holy Scriptures, by *I. H.*

      P L A Y E S.

Hen. the Fourth. *Philaster*,

The wedding. The Hollander.

Maids Tragedie. King *Lear*.

The gratefull Servant.

The strange Discovery.

Othello; the Moor of *Venice*.

The Merchant of *Venice*.

THE
DESCRIPTION
AND USE
OF THE DOVBLE
Horizontall Dyall.

WHEREBY NOT ONELY THE
Houre of the Day is shewn; but also the
Meridian Line is found:

And most ASTRONOMICALL Questions,
which may be done by the GLOBE:
are resolved.

INVENTED
AND
WRITTEN BY W. O.

Whereunto is added, The Description of the
generall HOROLOGICALL RING.

LONDON,
Printed for WILLIAM LEAKE, and are to be sold
at his Shop at the signe of the *Crown* in
Fleetstreet, between the two
Temple Gates. 1652.

THere are upon the Plate two severall Dyals. That which is outermost, is an ordinary diall, divided into houres and quarters, and every quarter into three parts which are five minutes a piece : so that the whole houre is understood to contein 60 minutes. And for this dyall the shadow of the upper oblique, or slanting edge of the style, or cocke, doth serve.

The other diall, which is within, is the *projection of the upper Hemisphere, upon the plain of the Horizon* : the *Horizon* it self is understood to be the innermost circle of the limbe : and is divided on both sides from the points of *East* and *West* into degrees, noted with 10.20.30, &c. As far as need requireth : And the center of the Instrument is the *Zenith*, or *Verticall point*.

Within the *Horizon* the middle straightline pointing *North* and *South* upon which the style standeth, is the *Meridian* or twelve a clock line : and the other short arching lines on both sides of it, are the *houre lines*, distinguished accordingly by their figures : and are divided into quarters by the smaller lines drawn between them : every quarter conteining 15 minutes.

The two arches which crosse the houre lines, meeting on both sides in the points of intersection of the sixe a clocke lines with the Horizon, are the two semicircles of the *Ecliptick* or annuall circle of the sun : the upper of which arches serveth for the *Summer* halfe yeere ; and the lower for the *Winter* half yeer : and therefore divided into 365 dayes : which are also distinguished into twelve moneths with longer lines, having their names set down : and into tenths and fifts with shorter lines :

and

and the rest of the dayes with pricks as may plainly be seene in the diall.

And this is for the ready finding out of the *place of the Sun every day*: and also for the shewing of the *Suns yeerely motion*, because by this motion the Sun goeth round about the heavens in the compasse of a yeer, making the four parts, or seasons thereof, namely, the *Spring* in that quarter of the *Ecliptick* which begins at the *intersection on the East* side of the diall, and is therefore called the *Vernall intersection*. Then the *Summer* in that quarter of the *Ecliptick* which begin at the *intersection with the Meridian* in the highest point next the *Zenith*. After that, *Autumne* in that quarter of the *Ecliptick* which beginneth at the *intersection* on the *West* side of the diall, and is therefore called the *Autumnall intersection* and lastly, the *Winter* in that quarter of the *Ecliptick*, which beginneth at the *intersection, with the Meridian* in the lowest point next the *Horizon*.

But besides this *yeerely motion*, the Sun hath a *diurnall*, or *daily motion*, whereby it maketh day and night, with all the diversities and inæqualities thereof: which is expressed by those other *circles drawn crosse the houre lines*; the middlemost whereof, being grosser then the rest, meeting with the *Ecliptick* in the points of the *Vernall*, and *Autumnall intersections*, is the *Equinoctiall*: and the rest on both sides of it are called the parallels, *or diurnall arch of the Sun*, the two outermost whereof are the *Tropicks*, because in them the sun hath his furthest *digression* or *Declination* from the *Æquinoctiall*, which is degrees $23\frac{1}{2}$: and thence beginneth againe to return towards the *Equinoctiall*. The upper of the two *Tropicks* in this nor Northerne *Hemisphere* is the *Tropick* of *Cancer*, and the sun being in it, is highest into the North, making

X 2   king

king the longest day of Summer : And the lower next the *Horizon* is the *Tropick* of *Capricorne* ; and the sun being in it, is lowest into the *South*, making the shortest day of winter.

Between the two *Tropicks* and the *Æquinoctiall*, infinite such *parallel circles* are understood to be conteined : for the sun, in what point soever of the *Ecliptick* it is carried, describeth by his *Lation* a circle parallel to the *Æquinoctiall* : yet those parallels which are in the instrument, though drawn but to every second degree of *Declination*, may be sufficient to direct the eye in imagining and tracing out through every day of the whole yeere in the *Ecliptick*, a proper circle which may be the diurnall *arch of the sun* for that day. For upon the right estimation of that imaginary parallel doth the manifold use of this instrument especially rely : because the true place of the sun all that day is in some part or point of that circle. Wherefore for the better conceiving and bearing in minde thereof, every fift *parallel* is herein made a little grosser then the rest.

For this inner diall serveth the shadow of the upright edge of the style ; which I therefore call the *upright shadow.*

And thus by *the eye and view onely to behold and comprehend the course of the sun, throughout the whole yeere both for his annuall and diurnall motion*, may be the first use of this instrument.

I I Use. To finde the *declination of the sun* every day.

Looke the day of the moneth proposed in the *Ecliptick*, and mark how many degrees the prick shewing that day, is distant from the *Æquinoctiall*, either on the Summer or Winter side, *viz.* North or South.

<div align="right">Example</div>

Example 1. What will the *Declination* of the fun be upon the eleventh day of *August?* look the eleventh day of *August* and you shall finde it in the fixth circle above the *Equinoctiall* : Now because each parallel standeth (as hath been said before) for two degrees, the fun shall that day decline Northwards 12. degrees.

Example 2. What declination hath the fun upon the 24 day of *March?* look the 24 day of *March*, and you shall finde it betweene the second and third northern parallels, as it were an half and one fift part of that distance from the second : Reckon therefore four degrees for the two circles, and one degree for the halfe space : So shall the Suns declination be five degrees, and about one fift part of a degree Northward that same day.

Example 3. What declination hath the fun upon the 13 day of *November?* look the 13 day of *November*, and you shall finde it below the *Equinoctiall* ten parallels, and about one quarter which is 20 degrees and an halfe southward. So much is the declination. And according to these examples judge of all the rest.

III. Use. *To finde the diurnall arch , or circle of the funs course every day.*

The fun every day by his motion (as hath been said) describeth a circle parallel to the *Equinoctiall*, which is either one of the circles in the diall , or some-where betweene two of them. First, therefore seek the day of the moneth ; and if it fall upon one of those parallels ; that is the circle of the funs course that same day : But if it fall betweene any two of the parallels, imagine in your minde, and estimate with your eye, another parallel through that point betweene those two parallels keeping still the same distance from each of them.

Y 3

As

As in the first of the three former examples, The circle of the Suns course upon 11 of August shal be the very sixt circle above the *Equinoctiall* toward the center.

In example 2. The circle of the *suns course* upon the 24 of March shall be an imaginary circle between the second and third parallels still keeping an half of that space, and one fifth part more of the rest, from the second.

In example 3. The *circle of the suns course* upon the 13 of November : shall be an imaginary circle between the tenth and eleventh parallels below the *Equinoctiall*, still keeping one quarter of that space from the tenth.

I I I I Use. *To finde the rising and setting of the sun every day.*

Seek out (as was last shewed) the imaginary circle or parallel of the suns course for that day, and marke the point where it meeteth with the horizon, both on the *East* and *West* sides, for that is the very point of the suns rising, and setting that same day, and the houre lines which are on both sides of it, by proportioning the distance reasonably, according to 15 minutes for the quarter of the houre, will shew the houre of the suns rising on the *East* side, and the suns setting on the *West* side.

V Use. To know the reason and manner of the *Increasing* and *decreasing* of the *dayes and nights* throughout the whole yeere.

When the Sun is in the *Equinoctiall*, it riseth and setteth at 6 a clock, for in the instrument the intersection of the *Equinoctiall* and the *Ecliptick* with the *Horizon* is in the six a clocke circle on both sides. But if the sun be out of the *Equinoctial*, declining toward the *North*, the intersections of the parallel of the sun with the *Horizon* is before

before 6 in the morning, and after 6 in the evening: and the *Diurnall arch* greater then 12 houres; and so much more great, the greater the Northerne Declination is. Againe, if the sun be declining toward the South, the intersections of the parallel of the sun, with the *Horizon* is after 6 in the morning, and before 6 in the evening: and the *Diurnall arch* lesser then 12 houres; and by so much lesser, the greater the Southerne Declination is.

And in those places of the *Ecliptick* in which the sun most speedily changeth his declination, the length also of the day is most altered: and where the *Ecliptick* goeth most parallel to the *Equinoctiall* changing the declination, but little altered. As for example, when the sun is neer unto the *Equinoctiall* on both sides, the dayes increase and also decrease suddenly and apace; because in those places the *Ecliptick* inclineth to the *Equinoctiall* in a manner like a streight line, making sensible declination. Again, when the sun is neere his greatest declination, as in the height of Summer, and the depth of Winter, the dayes keep for a good time, as it were, at one stay, because in these places the *Ecliptick* is in a manner parallel to the *Equinoctiall*, the length of the day also is but little, scarce altering the declination: And because in those two times of the yeer, the sun standeth as it were still at one declination, they are called the *summer solstice*, and *winter solstice*. And in the mean space the neerer every place is to the *Equinoctiall*, the greater is the diversity of dayes.

Wherefore, we may hereby plainly see that the common received opinion, that in every moneth the dayes doe equally increase, is erroneous.

Also we may see that in parallels equally distant from the *Equinoctiall*, the day on the one side is equall to the night on the other side.

<div align="center">

X 4   VI Use.

</div>

VI. Use. *To finde how far the sun riseth, and setteth from the true east and west points, which is called the suns Amplitude ortive, and occasive.*

Seek out (as was shewed in III *Use*) the imaginary circle, or parallel of the suns course, and the points of that circle in the *horizon*, on the East and West sides cutteth the degree of the *Amplitude ortive*, and occasive.

VII Use. *To finde the length of every day and night.*

Double the houre of the sunnes setting, and you shal have the length of the day; & double the hour of the sunnes rising, and you shal have the length of the night.

VIII Use. *To finde the true place of the sun upon the dyall, that is, the point of the instrument which answereth to the place of the sun in the heavens at any time, which is the very ground of all the questions following.*

If the dyall be fixed upon a post : Look what a clock it is by the outward dyall, that is, look what houre and part of houre the shadow of the slanting edge of the style sheweth in the outward limbe. Then behold the shadow of the upright edge, and marke what point thereof is upon that very houre and part in the inner dyall among the parallels, that point is the true place of the Sunne at the same instant.

If the dyal be not fixed, and you have a *Meridian line* noted in any window where the Sunne shineth : place the *Meridian* of your dyal upon the *Meridian* line given, so that the top of the stile may point into the north : and so the dyal is as it were fixed, wherefore by the former rule you may finde the place of the Sunne upon it.

If the dyal be not fixed, neither you have a Meridian line, but you know the true houre of the day exactly : hold the dyal even and parallel to the Horizon, moving it

it till the slanting edge of the stile cast his shadow justly upon the time or houre given ; for then the dyal is truly placed, as upon a post. Seek therefore what point of the upright shadow falleth upon that very houre, and there is the place of the Sun.

But if your dyal be loose, and you know neither the Meridian nor the time of the day. First, by the day of the moneth in the Ecliptique, finde the suns parallel, or diurnall arch for that day, then holding the dyal level to the horizon, move it every way untill the slanting shadow of the style in the out ward limbe, and the upright shadow in the Sunnes diurnal arch, both shew the very same houre and minute, for that very point of the Sunnes parallel, which the upright shadow cutteth, is the true place of the Sun on the dyal at that present.

But note that by reason of the thicknes of the style, and the bluntnesse of the angle of the upright edge, the Sun cannot come unto that edge for some space before and after noone. And so during the time that the Sunne shineth not on that upright edge, the place of the Sunne in the dyal cannot be found. Wherefore they that make this kinde of double dyal, are to be careful to file the upright edge of the style as thinne and sharpe as possible may be.

That which hath here bin taught concerning the finding out the Suns true place in the dyal, ought perfectly to be understood, that it may be readily, and dexteriously practised, for upon the true performance thereof dependeth all that followeth.

IX Vse. *To finde the houre of the day.*

If the dyal be fastned upon a post, the houre by the outward dyal, or limbe, is known of every one, and the
<div align="right">upright</div>

upright shadow in the Suns parallel, or diurnal arch will also shew the very same houre.

But if the dyall be loose, either hold it or set it parallel to the Horizon, with the ftyle pointing into the north and move it gently every way untill the houre shewed in both dialls exactly agreeth, or which is all one, finde out the true place of the Sun upon the dyall, as was taught in the former question, for that point among the houre lines sheweth the houre of the day.

X Vfe. *To finde out the Meridian, and other points of the Compaſſe.*

First, you muft feek the true houre of the day (by the laft queftion) for in that fituation the Meridian of the dyall ftandeth directly north and fouth : and the eaft pointeth into the eaft, and the weft into the weft, and the reft of the points may be given by allowing degrees $11.\frac{1}{4}$ unto every point of the compaffe.

X I Vfe. *To finde out the Azumith of the ſun, that is, the diſtance of the Verticall circle, in which the ſun is at that preſent, from the Meridian.*

Set your diall upon any plain or flat, which is parallel to the horizon, with the Meridian pointing directly north or fouth, as was laft shewed : then follow with your eye the upright shadow in a ftreight line, till it cutteth the *horizon* : for the degree in which the point of interfection is, shal shew how far the funs *Azumith* is diftant from the eaft and weft points, and the complement thereof unto 90; shal give the diftance thereof from the meridian.

X I I Vfe. *To finde out the Declination of any Wall upon which the ſun ſhineth, that is, how far that wall ſwerveth from the north or ſouth, either eaſtward or weſtward.*

Take

Take a board having one streight edg, & a line stricken perpendicular upon it ; apply the streight edg unto the wall at what time the sun shineth upon it, holding the board parallel to the horizon : Set the dyal thereon, and move it gently every way, untill the same hour and minute be shewed in both dyals: and so let it stand : then if the dyal have one of the sides parallel to the Meridian strike a line along that side upon the board, crossing the perpendicular, or else with a bodkin make a point upon the board, at each end of the meridian, and taking away the instrument from the board, and the board from the wall, lay a ruler to those two points, and draw a line crossing the perpendicular : for the angle which that line maketh with the perpendicular, is the angle of the declination of the wall. And if it be a right angle, the wall is exactly east or west : but if that line be parallel to the perpendicular, the wall is direct north or south without any declination at all.

You may also finde out the declination of a wall, if the dial be fixed on a post not very far from that wall ; in this manner. Your board being applyed to the wall, as was shewed, hang up a thred with a plummet, so that the shadow of the thred may upon the board crosse the perpendicular line : make two pricks in the shadow and run instantly to the dyal and look the horizontal distance of the suns Azumith, or upright shadow from the meridian. Then through the two pricks draw a line crossing the perpendicular: and upon the point of the intersection, make a circle equal to the horizon of your Instrument, in which Circle you shal from the line through the two pricks measure the Horizontal distance of the upright shadow, or Azumith from the meridian, that way toward which the Meridian is : draw

a line

a line out of the center, to the end of that arch measured
and the angle which this last line maketh with the per-
pendicular, shall be equall to the declination of the
wall.

XIII Vse. *How to place the dyall upon a post without
any other direction but it selfe.*

Set the diall upon the post, with the stile into the
North, as neere as you can guesse: then move it this way
and that way, till the same houre and minute be shewed
both in the outward and inward dials by the severall sha-
dowes, as hath been already taught, for then the diall
standeth in its truest situation; wherefore let it be nailed
down in that very place.

XIIII Vse. *To finde the height of the sun at high noon
every day.*

Seeke out the diurnall Arch or parallel of the suns
course for that day, (by *Vse III.*) and with a paire of
Compasses, setting one foot in the center, and the other in
the point of intersection of that parallel with the Meridi-
an, apply that same distance unto the Semidiameter di-
vided: for that measure shal therein shew the degree of
of the Suns altitude above the the Horizon that day at
high noon.

XV *Vse. To finde the height of the sun at any houre or
time of the day.*

Seeke out the diurnal Arch, or parallel of the suns
course for that day: and marke what point of it is in
the very houre and minute proposed. And with a paire
of Compasses, setting one foot in the Center, and the other
in that point of the parallel, apply the same distance upon
the Semidiameter divided: for that measure shall shew
the degree of the suns altitude above the Horizon at that
time.

                                                    And

And by this meanes you may finde the height of the ſun above the Horizon at every houre throughout the whole yeere, for the making of rings and cylinders and other inſtruments which are uſed to ſhew the houre of the day.

XVI Vſe. *The height of the ſun being given, to finde the houre, or what it is a clocke.*

This is the converſe of the former : Seeke therefore in the Semidiameter divided, the height of the ſun given. And with a paire of Compaſſes ; ſetting one foot in the center, and the other at that height, apply the ſame diſtance unto the diurnall arch, or parallel of the Sun for that day : for that point of the diurnall arch, upon which that ſame diſtance lights, is the true place of the ſun upon the dial ; and ſheweth among the houre lines, the true time of the day.

XVII Uſe. *Conſiderations for the uſe of the inſtrument in the night.*

In ſuch queſtions as concerne the night, or the time before ſun riſing, and after ſun ſetting, the inſtrument repreſenteth the lower Hemiſphære, wherein the *Southerne* pole is elevated. And therefore the parallels which are above the Æquinoctiall toward the center, ſhall be for the *Southerne*, or winter parallels : and thoſe beneath the Æquinoctiall, for the Northerne or Summer paralles ; and the Eaſt ſhall be accounted for Weſt, and the Weſt for Eaſt ; altogether contrary to that which was before, when the Inſtrument repreſented the upper Hemiſphære.

XVIII Uſe. *To finde how many degrees the ſun is under the Horizon at any time of the night.*

Seeke the Declination of the ſun for the day propoſed
<div align="right">ſed</div>

sed (by *Use II.*) And and at the same declination the contrary side imagine a parallel for the sun that night: and mark what point of it is in the very houre and minute proposed: And with a pair of compasses, setting one foot in the center, and the other in that point of the parallel, apply that same distance unto the semidiameter divided: for that measure shall shew the degree of the suns depression below the Horizon at that time.

XIX Use. *To finde out the length of the Crepusculum, or twylight, every day.*

Seek the declination of the sun for the day proposed (by *Use II.*) And at the same declination on the contrary side imagine a parallel for the sun that night. And with a paire of compasses setting one foot in the center, and the other at 72 degrees upon the semidiameter divided, apply that same distance, unto the suns nocturnall parallel: for that point of the parallel, upon which that same distance shall light, sheweth among the houre lines, the beginning of the twilight in the morning, or the end of the twilight in the evening.

XX Use. *If the day of the moneth be not known, to finde it out by the dyall.*

For the working of this question, either the diall must be fixed rightly on a post, or else you must have a true Meridian line drawn in some window where the sun shineth, wherefore supposing the diall to be justly set either upon the post, or upon the Meridian. Look what a clock it is by the outward diall, and observe what point of the upright shadow falleth upon the very same minute in the inner diall, and through that same point imagine a parallel circle for the suns course; that imaginary circle in the *Ecliptick* shall cut the day of the moneth.

Of

I. *The description of it.*

THis Instrument serveth as a Diall to finde the hours of the day, not in one place onely (as the most part of Dials do) but generally in all Countreys lying North of the *Æquinoctiall*; and therefore I call it the generall Horologicall *Ring*.

It consisteth of two brazen circles: a Diameter, and a little Ring to hang it by.

The two circles are so made, that though they are to be set at right angles, when you use the Instrument: yet for more convenient carrying, they may be one folded into the other.

The lesser of the two circles is for the *Æquinoctiall*, having in the midst of the inner side or thicknesse, a line round it, which is the true *Æquinoctiall* circle, divided into twice twelve hours, from the two opposite points in which it is fastened within the greater.

The greater and outer of the two circles is the *Meridian*: One quarter whereof, beginning at one of the points in which the *Æquinoctiall* is hung, is divided into ninety degrees.

The Diameter is fastened to the *Meridian* in two opposite points or poles, one of them being the very end of the Quadrant, and is the *North Pole*. Wherefore it is perpendicular to the *Equinoctiall*, having his due position. The diameter is broad, and slit in the middle: and about the slit on both sides are the moneths and dayes of the yeer. And within this slit is a little sliding plate pierced through with a small hole: which hole in the motion of it, while it is applied to the dayes of the yeer, representeth the *Axis* of the world.

The

The little Ring whereby the Inſtrument hangeth, is made to ſlip up and down along the Quadrant : that ſo by help of a little tooth annexed, the Inſtrument may be rectified to any elevation of the *Pole*.

II. *The uſe of it.*

IN uſing this Inſtrument , Firſt, the tooth of the little Ring muſt carefully be ſet to the height of the *Pole* in the Quadrant, for the place wherein you are.

Secondly, the hole of the ſliding plate within the ſlit, muſt be brought exactly unto the day of the moneth.

Thirdly, the *Æquinoctiall* is to be drawn out, and by means of the two ſtuds in the *Meridian* ſtaying it, it is to be ſet perpendicular thereto.

Fourthly, Gueſſe as neer as you can at the houre, and turn the hole of the little plate toward it.

Laſtly, Hold the Inſtrument up by the little Ring, that it may hang freely with the *North Pole* thereof toward the North : and move it gently this way and that way, till the beams of the Sun-ſhining thorow that hole, fall upon that middle line within the *Æquinoctiall*: for there ſhall be the houre of the day : And the *Meridian* of the Inſtrument ſhall hang directly *North* and *South*.

FINIS.

DO NOT CIRCULATE