The discourse made before the Royal Society the 26 of November 1674. Concerning the use of duplicate proportion in sundry important particulars together with a new hypothesis of springing or elastique motions / By Sir William Petty.

Contributors

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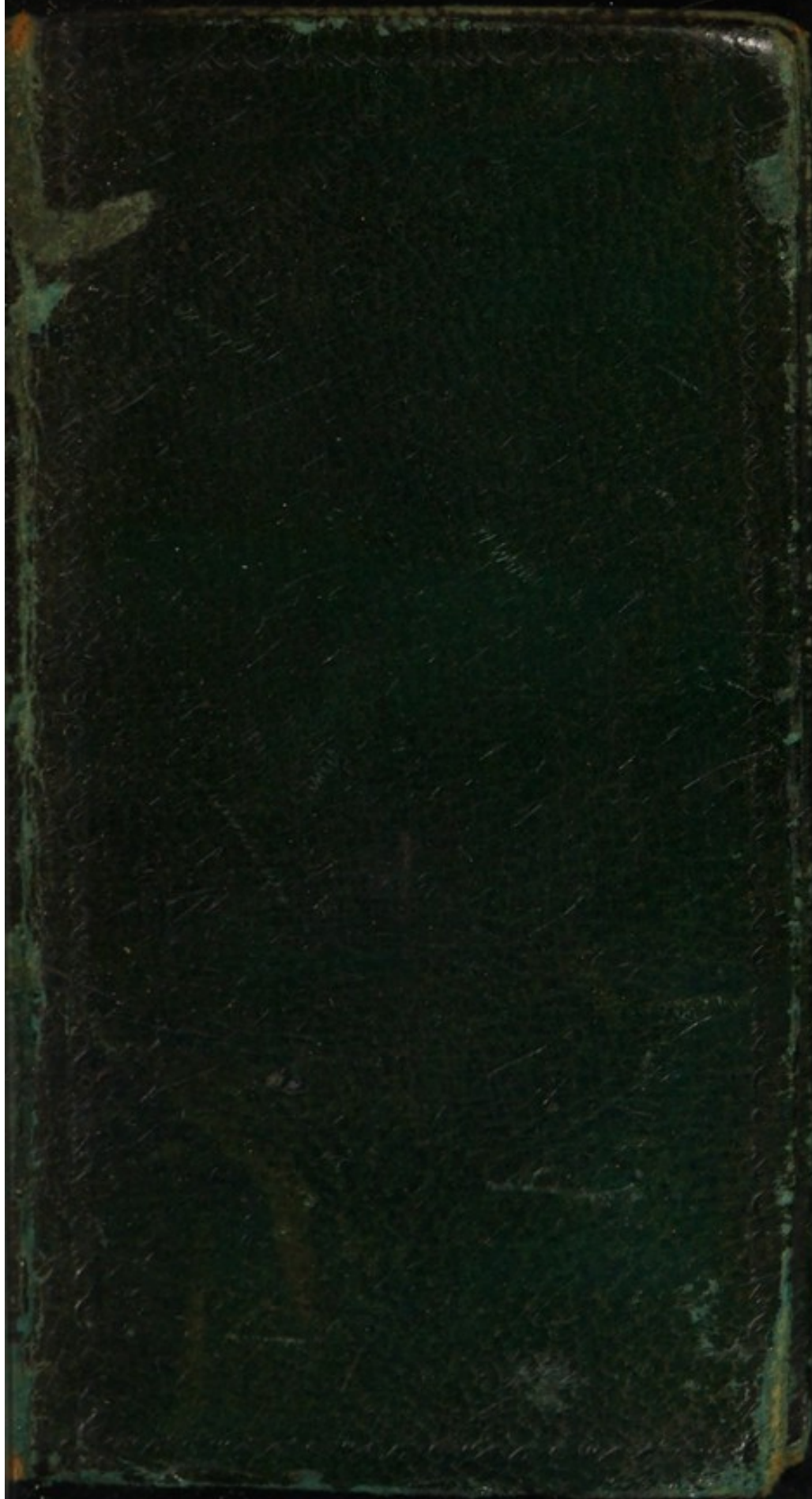
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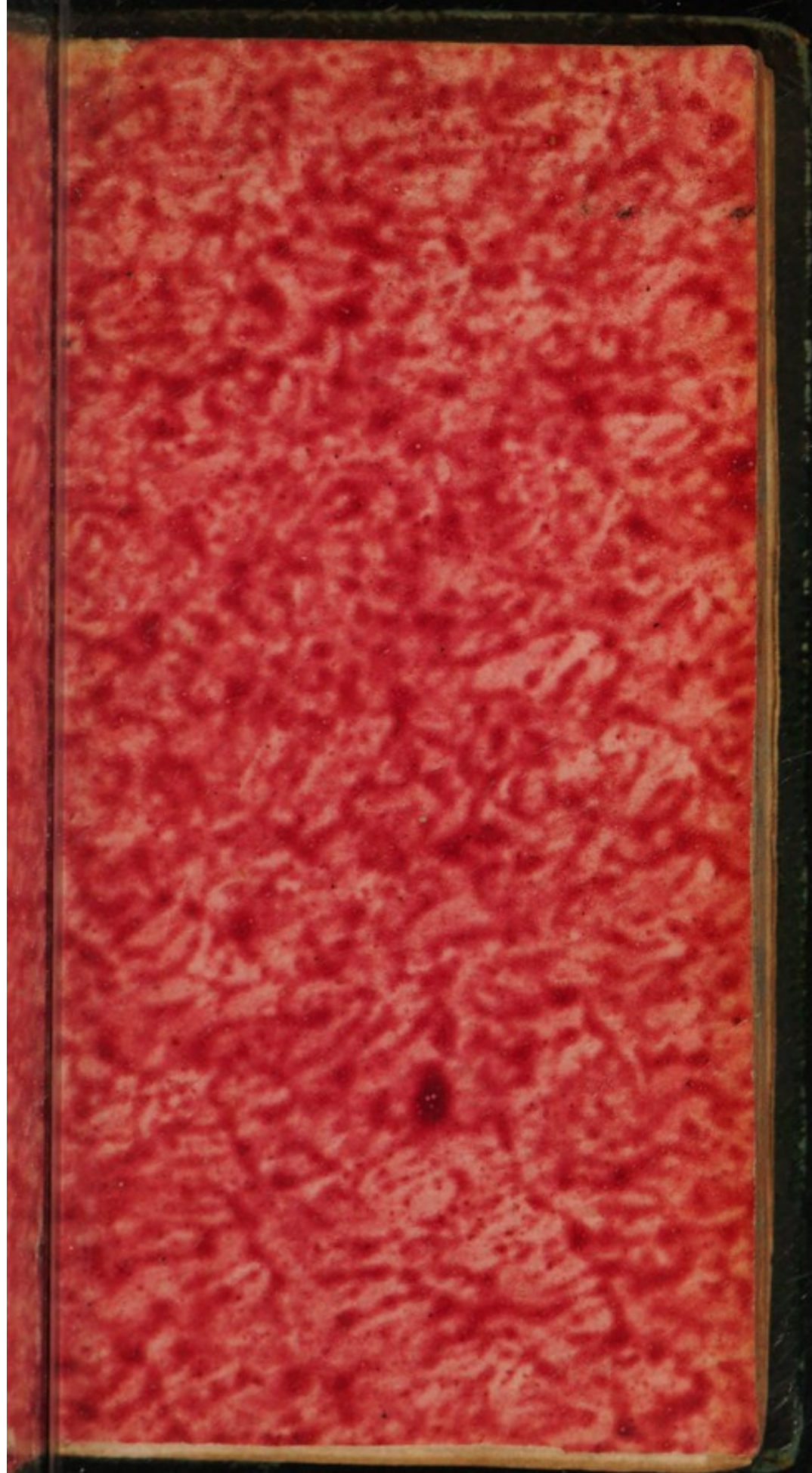
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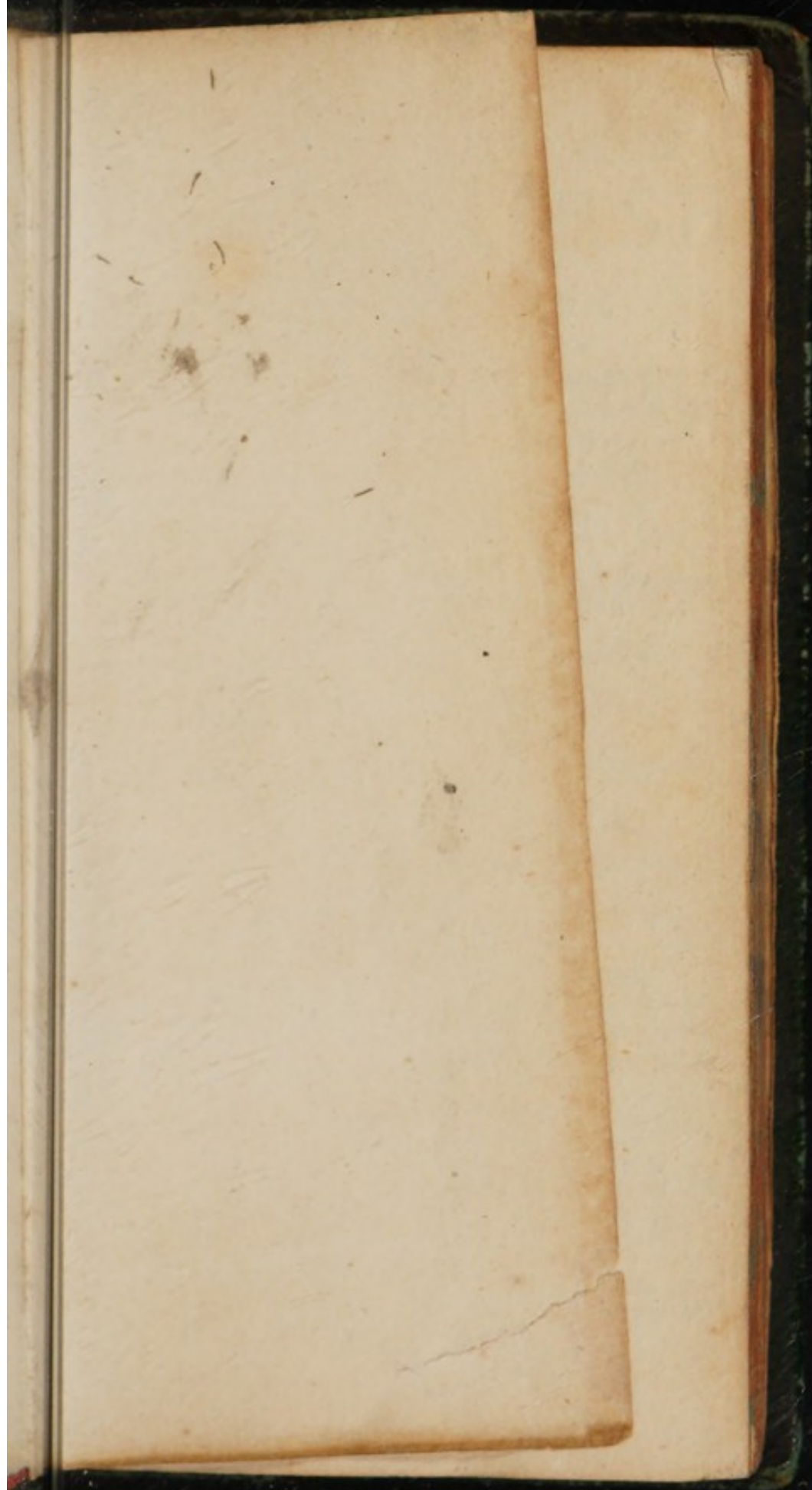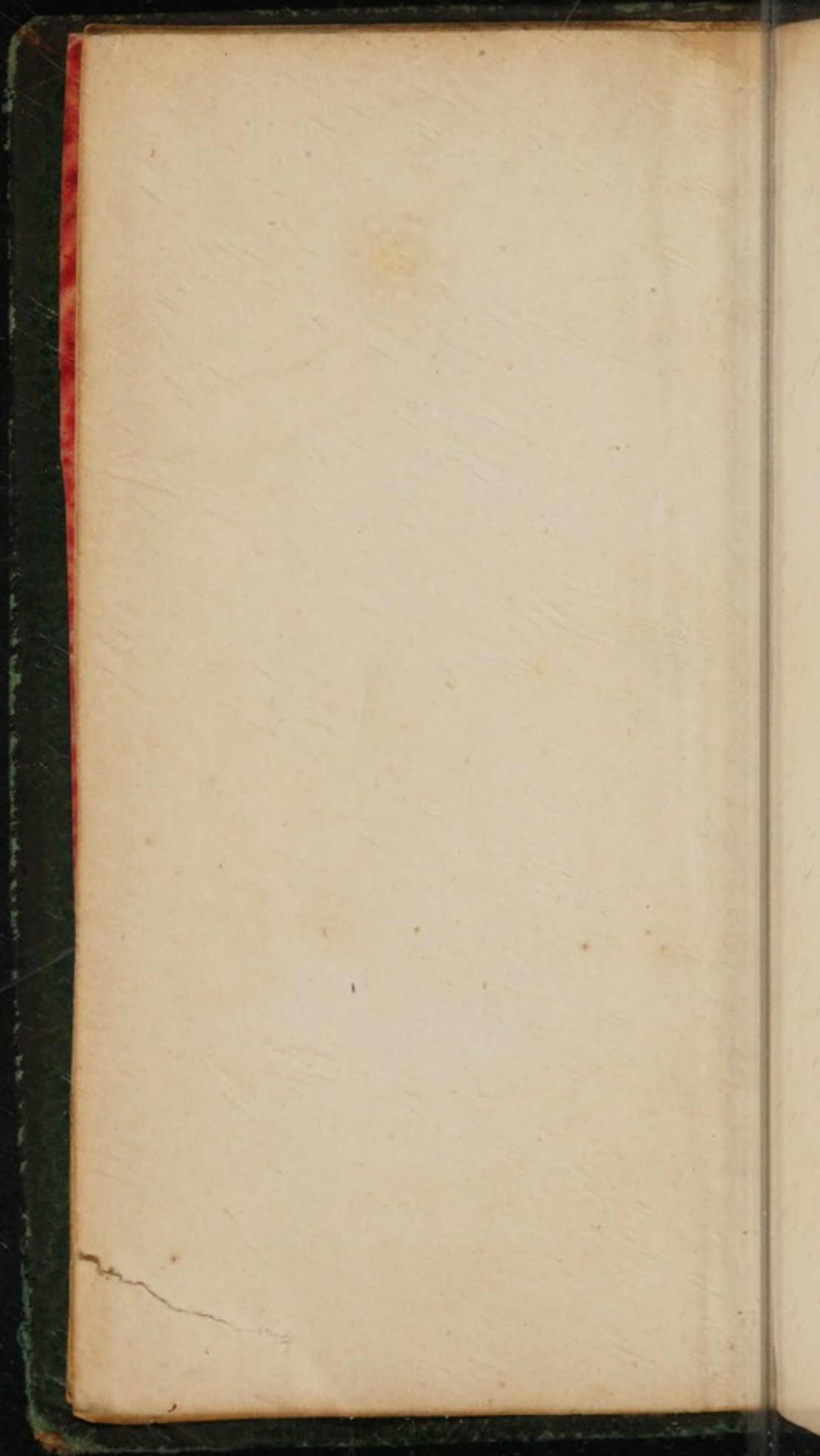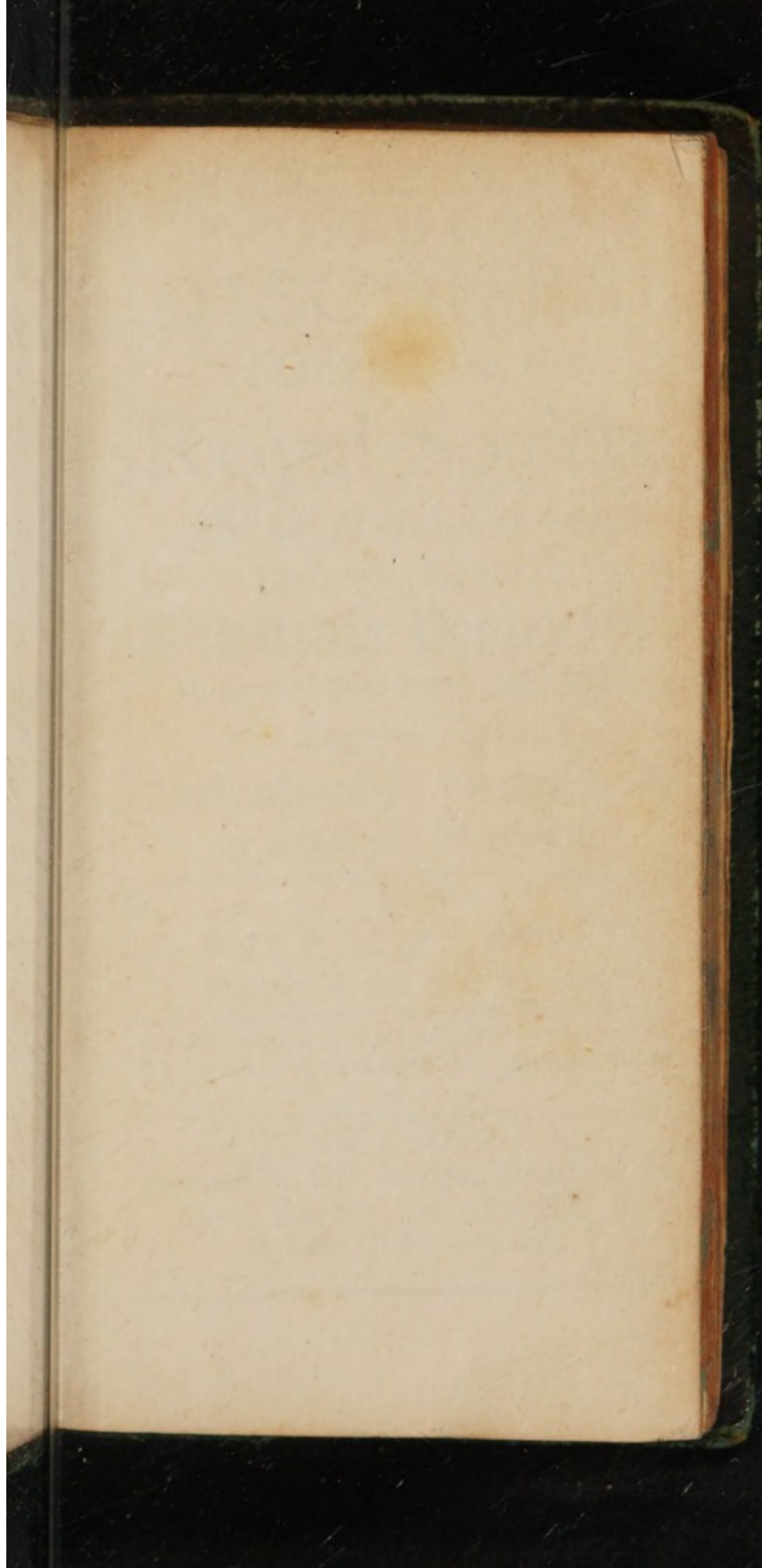
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THE 47858
DISCOURSE
Made before the
Royal Society

The 26. of *November* 1674.

Concerning the Ufe of

Duplicate Proportion

In fundry Important Particulars :

Together with a

New Hypothefis of *Springing*
or *Elaftique* Motions.

BY
Sir *WILLIAM PETTY*, Kt.
Fellow of the faid Society.

Troubles have or can quench my affections to Philofophy, as no diftances of Time or Place have made Me lefs than formerly,

Your GRACES

Moft humble, moft faith-ful, and moft obedi-ent Servant,

ult. Decemb.
1674.

WILLIAM PETTY.

(a)   *To*

To the Right Honourable

WILLIAM

Lord Viscount Brouncker,

PRESIDENT

OF THE

Royal Society;

...then formerly

My Lord,

T HE Observations
...upon the Bills
...of...Mortality,
...were...distinctly
Dedicated to ſ Peers of this
Realm, and alſo to the Preſi-
dent of the Royal Society,
and

(a 2)

To the Right Honourable

WILLIAM

Lord Viſcount *Brouncker*,

PRESIDENT

OF THE

Royal Society.

My Lord,

THE Obſervati-
ons on the Bills
of Mortality
were diſtinctly
Dedicated to a Peer of this
Realm, and alſo to the Preſi-
dent of the Royal Society,

and

and both with good accep-
tance: Wherefore I have alſo
(like the Author of thoſe
Obſervations) Dedicated this
Diſcourſe to his Grace the
Duke of Newcaſtle, for the
reaſons in the foregoing Epi-
ſtle mentioned; and I now
again Dedicate the ſame to
your Lordſhip. Firſt, In Gra-
titude for the ſeveral aſſi-
ſtances I had from your Lord-
ſhip towards the Experiments
mentioned in this Diſcourſe.
Secondly, Becauſe your Lord-
ſhip is an Eminent Judge

in

in those Matters, a Person whose Animadversions I shall take for Kindnesses; and who is able to excuse the Errors, and defend the Truths I have delivered. Lastly, For that near half the whole Discourse relates to Shipping, Artillery, Fortresses, Seabanks, &c. which all concern his Majesties Service, and part whereof are happily entrusted by him to your Lordships Care; I thought I might express My affection to those his Majesties Con-

(a 3)   cernments

cernments even by offering
this my Mite unto them.
Upon the whole Matter, I
have layd hold on this Occa-
ſion, to Publiſh my deſire of
being eſteemed,

My LORD,

Ult. Decemb.
1674.

Your Lordſhips moſt
humble and faith-
ful Servant

WILLIAM PETTY.

ERRATA.

PAge 6. l. 5. r. *Proportion.* p. 44. l. 1. r. *be* for *being.* p. 49. l. 6. r. *&c. be.* p. 49. l. 13. r. *moreover* for *viz.* ibid. l. 14. r. *Mice, or rather some smal Animals (whose correspondent parts are but* $\frac{1}{12}$ *in length of the Horses.)* ibid. l. ult. r. $\frac{12}{144}$ for $\frac{1}{144}$ p. 87. l. 10. r. *Numerus* for *numerous.* ib. l. 11. r. *of* for *or.* p. 88. l. 8. r. *whereof* for *thereof.*

Thurſday Decem. 10. 1674.

At a Meeting of the Councill
of the Royal Society.

WHereas it was deſired by
the Royal Society, *that*
a Diſcourſe made before them by Sir
William Petty *Knight, at their*
Meeting the 26. *of* November
laſt, might be Printed : It is this
day Ordered by the Council of the
ſaid Society , That the ſaid Diſ-
courſe be Printed by the Printer of
the Royal Society.

BROUNCKER, P. R. S.

To his Grace,

WILLIAM,

LORD DUKE OF

NEWCASTLE.

May it pleaſe your Grace,

I Am comman-
ded by the
Royal Society
to Print the Diſ-
courſe, which I made

before them, upon the laſt Meeting-day of *their* laſt year, and next before that of their *Anniverſary E-lection* : Becauſe, as Drapers cut Patterns of their whole Cloth out of an End, not be-cauſe the End is bet-ter than the reſt, but becauſe it may be beſt ſpared ; ſo (I ſuppoſe)
the

the *Society* are con-
tent, that this Exer-
cife pafs for a Sample,
pro tanto, of what they
are doing; for that
the fame may be con-
ceived to confift of
three parts, *viz.* The
firft being an Endea-
vour to explain the
Intricate Notions, or
Philofophia Prima of
Place, Time, Moti-

A 4   on

on, Elasticity, &c. in a way which the meanest Member of adult Mankind is capable of understanding : The *second* being, to excite the World to the study of a little Mathematicks, by shewing the use of *Duplicate Proportions* in some of the most weighty of Humane

mane affairs, which Notion a Child of 12 years old may learn in an hour: And the *laſt* being, without Chymerical Specula--tions, to conſider ſuch points and proper--ties, even in *Atoms* (ſuch, whereof per--haps a Million do not make up one viſible *Corpuſculum*,) as may

A 5 give

give an intelligible Account of the Nexures, Mixtures, and Mobilities of all the parts of the Universe.

In like manner, 'tis the Profession of the *Society*, to make Mysterious things plain; to explode and disufe all insignificant and puzling words;

to

to improve and apply
little small threds o
Mathematicks to vaf
ufes ; and yet not to
neglect the fineft
Confideration, even
of *Atoms*, where the
fame is neceffary.
The which purpofes
of theirs, I venture
to fay, do as much
differ (both as to *dif-*
ficulty and *dignity*)
from

from what is com-
monly called *Wit*
(and which takes
with far the greater
part of Mankind,) as
the skill of Drawing
and Painting a Cloud
or Periwig doth from
that of Designing or
Painting many com-
plicated Figures of
Men and Beasts in
some one Table,
where-

wherein each is per-
fectly to expreſs ſome
particular paſſion, and
all ſtanding together
to contain the true
and entire Spirit of
the Story repreſent-
ed: For, in the *latter*,
preciſe exactneſs is
indiſpenſible, where-
as in the *former*, not
onely liberty always,
but even extravagan-
cy

cy sometimes is not onely tolerable, but laudable. And when I have said this; I withal say, that there is one Glory of the *Sun*, another of the *Moon*, and another of the *Stars*, which may all consist together, without destroying or maligning each other. And

all

all thefe feveral Glo-
ries fhine fteddily in
your Graces Firma-
ment.

Being, I fay, ap-
pointed to publifh
this Exercife, I have
prefumed to dedicate
it to your Grace.
Firft, becaufe the *So-
ciety* have been plea-
fed to order it to be
publifhed; (I dare
not

not fay, as approving
it, but as committing
it to Examination.)
Secondly , becaufe
your Grace doth not
onely love the fearch
of Truth, but did en-
courage Me 30 years
ago as to Enquiries of
this kind. For about
that time, in *Paris*,
Merfennus, *Gaffendy*,
Mr. *Hobs*, Monfieur
Des

Des Cartes, Monsieur *Roberval*, Monsieur *Mydorge*, and other famous men, all frequenting, and caressed by, your Grace and your memorable Brother, Sir *Charles Cavendish*, did countenance and influence my Studies, as well by their Conversation as their Publick

Le-

Lectures and Wri-
tings: Much of which
honours and helps I
ow unto your Grace,
and have a fresh re-
membrance of them.
Thirdly, because my
Lord *Ogle* being now
about to carve a sig-
nificant Figure upon
my Lord his Son, by
his careful Education
of him, I thought it a
service

service to his Lord-
ship, as well as an
Expreſſion of my
Thanks for his for-
mer acceptance of my
Endeavours, to call
upon him, not onely
to inſtruct my Lord
his Son in ſome Ma-
thematicsk, but alſo to
ſtore and ſtock him
with variety of *Mat-
ter, Data* and *Phæno-
mena,*

mena, whereupon to exercise the same; since *Lines* & *Num-bers*, without *those*, are but like Lute-strings without a Lute or a Hand. For, my Lord, there is a *Political Arithmetic*, and a *Geometrical Ju-stice* to be yet further cultivated in the World; the Errors and

and Defects where-
of, neither Wit, Rhe-
toric, nor Interest can
more than palliate,
never cure. For, Fal-
lity, Disproportion,
and Inconsistence can-
not be rectified by a-
ny sermocinations,
though made all of
figurate and measured
periods, pronounced
in Tune and Ca-
dence,

dence, through th[...]
moft advantageou[...]
organs; much lefs b[...]
Grandifonous or Eu[...]
phonical Nonfence[...]
farded with formali[...]
ty; no more than v[...]
cious Wines can b[...]
remedied with Bran[...]
dy and Honey, or i[...]
Cookery with enor[...]
mous proportions [...]
Spice and Sugar[...]
N a[...]

Nam Res nolunt malè administrari.

These are the Reasons, why I have put your Graces Name to this Treatise; though there is a contrary reason, why it should have wholly *shun'd* your Graces sight and knowledg : which is, That your Grace might not perceive how

how little progress
have made in thirty
years time upon thof
Studies. However
hope your Grace wil
take what I have don
for an Argument o
my patience and pei
severance in thef
pleasant, though pro
fitless, Employments
and see, that no hete
rogeneous Cares and
Trouble

A
DISCOURSE
TO THE
Royal Society.

Orafmuch as this *Society* has been cenfured (though without much caufe) for fpending too much time in matters not directly tend- ing to profit and palpable Advantages (as the Weigh- ing of Air and the like)

B   1

I have therefore, to ftreigh-
ten this crooked ftick, benr
it and my prefent Dif-
courfe the quite contrary
way, *viz.* to the *Sails* anc
Shapes of *Ships*; to *Carpentr*;
and *Carriages* ; to *Mills*,
Mill-dams, *Bulwarks* ; to
the *Labour* of *Horfes*, and
to feveral other particu-
lars : The which are not
only grofs enough of them-
felves, but are alfo as grof-
ly handled in this Exercife,
to prevent the further im-
putation of needlefs Nici-
ty,

ty, and to leave room for your own further thoughts upon the same.

And forafmuch as We have been alfo complained of for producing nothing New, I have together with my Inftances and Applications, above and hereafter mentioned, prefented you as an Appendix, to what is faid of *Springs* and other *Elaftique bodies*, with a new Theory (as I think) of *Elafticity* it felf, and that mechanically explicated in

or-

order to make a breach on
this hard Rock in Philoso-
phy, and to chip off a little
of that Block which has
long lain thwart Us, in the
way of Our Enquiries. Up-
on the whole matter I have
followed the Example of
Elderly Divines, who find-
ing their Flocks not to
mend their lives by per-
plexed Difcourfes about
Predeftination, Tranfub-
ftantiation, &c. betake
themfelves at laft to preach
Faith and *Good Wooks*,
Neigh-

Neighbourly Love and *Cha-rity*, or *Doing as we would be done unto*, and the like. For I have in this Exercise declined all Speculations not tending to practice, and ventured at few new Hypotheses, but that of *Elasticity*; rather calling upon you to review your own former Observations, and to apply your *Mathe-maticks* to *Matter*, so as both may be improved to the profitable purposes hereafter mentioned.

Where-

Wherefore the Title and
Scope of this Exercife is;
Several *Inſtances, wherein th*
conſideration of Duplicate &
Subduplicate propoortion, on
wherein the conſideration o
Sides and their Squares is o
uſe in humane affairs. And
the *Inſtances* which I have
pitcht upon for this day
are theſe following, *viz.*

1. In the *Drawing* or
Driving powers, which force
Ships or other bodies
through the water, with
reference to the reſpective
Velo-

Velocities caufed thereby.

2. In the *fhapes* or *fharp-
nefs of bodies*, cutting or di-
viding the water, through
which they are *driven* or
drawn, and in the diffe-
rent Velocities arifing from
thence, where the Bodies
and Forces are equal.

3. In the *Strength of
Timbers* or other homoge-
neous materials applied to
Buildings,to *Carts*, or any
other Machinaments in-
tended for ftrength : And
how by a *Model* to judg

the

the sufficiency of such *En-* *gine* as is reprefented by it.

4. In the effect of *Oar:* upon equal and like *Vef-* fels , according to their *Numbers, Length, Blades ,* and *Motions* with or againft the *ftream* of *fmooth* or *un- even* waters.

5. In the *Motion* or *Tra- velling* of *Horfes,* on their feveral Paces, and with dif- ferent Burthens on them.

6. In the *Strength* and *Velocity* of *Mills* and their *Wheels.*   7. In

7. In the Effects of Gun-powder.

8. In the Distance at which *Sounds* may be heard.

9. In the Distances at which *Odoriferous matters* may be smelt.

10. In the Distance at which the *Objects of Sight* may be seen.

11. In the time of the Returns made by *vibrating Pendules.*

12. In the *Lives* of men and their Duration.

B 5   13.

13. In *Mufical & Sound-ing Bodies*, fuch as Strings and Bells.

14. In the Effects and Motions of *Fire*, and *burning Spirits*.

15. In the *Rifing* and *Falling of Bodies*, but efpecially of *Water* in *Pumps*, Overfhot Mills, Leaks in Ships, the *Heights of Rivers* at their head above their fall into the Sea.

16. In *Bellows*,

17. In the *Prices* of feveral *Commodities*, as *Mafts*, Diamonds:

Diamonds, *large Timber*, *Amber*, *Loadstones*, &c.

18. In *Mill-dams*, *Sea-banks*, and in the *Bulwarks* or Walls of Fortresses.

19. In the *Compression* of *Wooll*, and other *Elastick Bodies*, and of the *Air* within diving Vessels, as also in the Effects of *Skrew-presses* upon several Materials.

Having thus enumerated my several Instances, wherein *Duplicate*, and *Subduplicate proportion* is of great importance; I might now

now fall down-right upon
the Application of thofe
proportions to each of the
refpective matters above
mentioned. But becaufe
Cuftome hath made it al-
moft neceffary to make a
Preface to every Difcourfe,
my Preface to this one *Le-*
cture fhall be fuch, as may
ferve me for many more ;
that is, an Explication of
what I my felf (at leaft) un-
derftand by *Matter, Body,*
Figure, Place, Motion, Quan-
tity, Quality, Habit, Time,
Propor-

Proportion, Weight, Swift-ness, Force, and *Elasticity*; which I shall do without impoſing or ſcarce recom-mending the ſame to any other. For I would be glad, when any man ſpeaks to me in matters of impor-tance, by words which he uſes often, that he would firſt give me a *Dictionary* of ſuch words, to contein what he himſelf meaneth by each of them. Wherefore I ſhall, as a Preface, prefix this Dictionary, wherein I
dare

dare not define *Matter* by
Ens, or *Subftance*, becaufe
I think moft men conceive
Matter better than they do
either of thefe two words;
Ens, or *Subftance*. Nor do
I define the words, *Think*,
Confider, or *Conceive*, by the
words, *Soul*, *Spirit*, *Act*, or
the like, for the fame rea-
fon. But prefuming you
all underftand, *conceive*
imagine, or *fancy* the words
Matter and *Thought*, as
well as any other I can
ufe, I venture to fay as
follow.

followeth , and firſt , That

1. *Place* is the Image or Fancy of Matter, or Matter conſidered.

2. *Quantity*, the Fancy of Place.

3. *Ratio*, ſeveral Quantities conſidered together.

4. *Proportion* , ſeveral like *Rationes.*

5. *Situation*, ſeveral Places conſidered together.

6. *Figure* is Quantity and Situation conſidered together.

7. *Body*

7. *Body* is Matter and Figure confidered toge-ther.

8. *Motion* is change of Place.

9. *Time*, the Image of Motion.

10. *Quality*, feveral Mo-tions confidered together.

11. *Habit*, the fame Mo-tions repeated.

12. *Likenefs*, feveral Fi-gures, or Qualities , and Proportions confidered to-gether.

13. *Swiftnefs*, Time and Place,

Place or Space confidered together.

14. *Force* is Body and Swiftnefs confidered toge-ther.

15. *Right* is the Image of Poffeffion, and is to it as Place to Body.

16. *Elafticity* I fhall fpeak of hereafter.

In the next place, I fup-pofe all the *Firft Matter* of the World to be *Atoms*; that is, Matter Immutable in Magnitude and Figure. I fuppofe *Corpufcles* to be

as

as many Atoms joyned to
gether, as make up a *visib*
or sensible *Object*, and th
all *Juncture* of *Atomes*
made by their *Innate mot*
ons. Moreover I suppos
That every Atom is lik
the Earths Globe or Mag
net, wherein are *three Point*
confiderable, *viz.* two in
the surface, called *Poles*
and one within the sub-
stance, called *Center*, or ra-
ther *Byas*, because in A-
toms we confider neither
Magnitude nor *Gravity.*
Thefe

hefe Atoms alſo may have
ach of them ſuch Motions
s *Copernicus* attributes to
he Earth, or more. Laſtly,
Motion *to* or *from* a Point
makes a *ſtreight Line*, and,
bout it, a *Circle*. But *from*
he Center to ſeveral Points
n the Circle, is *Angle.* We
urther ſay, that the moti-
ons of *Corpuſcles* are com-
pounded of the abovemen-
tioned motions of Atoms;
and the motions of bigger
and Tangible Bodies (*viz.*
their qualities) are decom-
pounded

pounded out of the *Moti-*
ons, Situation, Figure, and
Magnitude of Corpufcles,
and that out of, and by
the premiffes all *Phænomi-*
na in nature muft be fol-
ved. And this is all th
Preface I fhall trouble yo
with, being (as was faid)
the *Dictionary* wherein t
find what I mean by ever
material word I intend t
ufe in this enfuing Exer-
cife, which we thus begin
viz.

The

The First Instance,

Wherein Duplicate, and Sub-duplicate Ratio or Pro-portion is confiderable, Is

IN the *Velocities* of two equal and like *Ships*; which Velocities, I fay, are the *fquare Roots* of the *Powers* which either drive or draw them; as, for ex-ample, Such two Ships having fails near double

to

to each other, or as 49

25, the Velocity will be

5, the square Root of ??

unto 7, the like Root

49. Again, if the fails

near triple, or as 49

16, there the Velocity fha

be as 7 (the Root of 49

to 4 (the Root of 16.) So

as a *quadruple Sail* is r

quifite to *double* fwiftnef

and *noncuple* to *treble* ; tha

is, The fails muft be in du

plicate proportion to th

fwiftnefs of the Ship ; o

this, in fubduplicate to

that. Again

Again, let there be two ships of Equal fails, but of unlike or unequal fharp-nefs, fuppofe the head of one extremely obtufe or quite flat, and the head of the other to be an *Ifofceles triangle* added thereunto ; fay, the fwiftnefs of thefe bodies fhall be as the Roots of the Perpendicular of that Triangle to the Root of half the Bafe, or half breadth of the fame. Se-condly, Or if the fame Tri-angular head be cyphered

away

away into an Angle fro[m]
bottom to top ; then,
the Root of the fame Pe[r]
pendicular is to the Ro[ot]
of the Depth or Thic[k]
nefs, fo are the Velociti[es]
Thirdly , If the faid hea[d]
be cyphered both way[s]
together , then the Pr[o]
portion of Velocities fha[ll]
be as half of one of t[he]
above mentioned Propo[r]
tions added to the oth[er]
whole Proportion : Ex. g[r.]
Suppofe the Perpendic[u]
lar of the triangle-hea[d]

be 36, the half breadth 9, and the whole depth be 4; then the one Proportion shall be as 6, the Root of 36, to 3, the Root of 9 : The half of which Proportion is as 6 to 6 ; and the other Proportion is as 6, the Root of 36, to 2, the Root of 4. Now add the Proportions of 6 to 6, to that of 6 to 2, the sum will be, as 36 to 12, or as 3 to 1.

Fifthly, Suppose two Paralellepipedons of unequal heads or resistances, *Ex.gr.*

C   as

as 8 to 5, or 64 to 40 : And
ſuppoſe the Sail on the big-
ger , to that on the leſſer
to be as 9 to 4, or 72 to 32;
then the Velocity of th
bigger ſhall be to the Velo-
city of the leſſer , as th
Root of 45 is to the Roo
of 32. For if the Reſiſtan-
ces be as 64 to 40; them
if the ſail of the bigger t
that of the leſs were pro
portionable to the Reſi-
ſtances, the ſail of the leſ
ſhould be 45, whereas w
ſuppoſe it but 32. Where
force

fore the Velocity fhall be as the Root of 45, which is almoft 7, to the Root of 32, which is about 5½, that is, as about 14 to 11.

Memorandum, That wetting of Sails (by leſſening the interſperſt apertures between the threds of the ſail-cloth) doth make the ſail, as it were, bigger; which biggerneſs may be known and meaſured by the increaſe of the Ships velocity upon ſuch wetting. For, if the Ship ſhould

C 2   move

move one tenth part quick
er after wetting than be
fore, we may conclude th
Sails are fwollen to th
equivalent of about $\frac{1}{5}$ pa
bigger ; for 100 (who
Root is 10) exceeds 8 11
whofe Root is 9, by abou
$\frac{1}{5}$ of 100.

By thefe ways the diffe
rent Velocities , arifin
from the different Trim c
the fame Ship, may be al
fo computed, the beft Trin
being that which make
leaft refiftance, *cæteris pa*
ribus. Now

Now, having faid thus much of the Effects of Sharpnefs and Sails, (the two principal caufes of Velocity in fhipping, and unto which all others may be referred;) I fhall add, That the want of thefe two Advantages are the chief caufe, why fhort, bluff, undermafted Veffels fail cheaper than others.

For fuppofe two Ships of equal burthens, but of unlike dimenfions, the main Beam of the one be-

C 3 ing

ing scarse $\frac{1}{3}$ of the Kee
length, and in the other,
full $\frac{1^{th}}{5}$; I say first, that th
Hull of the latter shall co
$\frac{1}{3}$ part more than that of th
former, and the advantag
as to sailing shall be scarc
$\frac{1}{6}$ part. Again, suppose, th
sharper could carry $\frac{1}{2}$ a
much sail more as the bluf
fer, whereof the advantag
in sailing would be $\frac{1}{6}$ par
more, in all $\frac{1}{3}$. Now, wherc
the Sails are as 2 to 3 .
the Masts and Yards must
be as 4 to 9 in substance ;
and

and in value much more : And where the Masts and Yards are as 4 to 9 in weight and bulk, the Cordage and Rigging must be answerable : And where the Masts, Yards, Sails, and Rigging are great, the Wind-taught of the Ship will correspond, and will require proportionable Cables ; and the weight of the Anchor must follow the size of the Cable, and the number of hands must be proportionable to all the

C 4   pre-

premisses : So as the one
Ship will cost at least
double as much as the o-
ther, and will sail at double
charge of Wages and Vi-
ctuals, Ware and Tare,&c:
Now if no trading Ship be
(one time with another)
above $\frac{1}{10}$ of her whole
reign under sail, or 6 days
in 60, suppose the sharper
and larger-sail'd Ship sail
in 4 dayes what the other
performs in 6; the diffe-
rence will be but 2 dayes
in 60, or $\frac{1}{30}$ part of the Wa-
ges,

ges and Victuals, and o-
ther charges ; whereas the
charges is suppofed to be
more than double. I fay,
this confideration is of
great weight in Veffels of
burden, efpecially fuch as
carry grofs and cheap bul-
ky Commodities, neither
liable to damage or perifh-
ing : Of which goods 7
parts of 10 of all Sea-
carriage do confift. But
on the other hand, where
fafety againft Enemies,
fpeedy difpatch upon im-

C 5.   portant

portant occafions, or pre:
occupation of a Market ar:
in the cafe, there fharpnef
and great Sails may be ad:
mitted to the greateft pro:
portions practicable.

Having thus digreffed:
I mind you that we faid
Velocities are the Roots ::
Refiftances and Extent ::
Sails, &c. It may be well
askt, How we know th:
fame, fince that very few
Seamen or Shipwrights, ei:
ther in their writing or dif:
courfes feem to underftan:

or own this important Po-
fition. To which I anfwer,
that I have by many Ob-
fervations, Calculations,
and Comparifons, found
the fame to be *præter propter*
true, although there be ma-
ny circumftances which in-
termingle themfelves in
this Experiment, fo as to
difturb and confound it :
As namely, The ill placing
of Mafts, The ill cutting
and ftanding of Sails, The
ill Trim of the Veffel, with
the Cleannefs or Foulnefs

of

of the fame ; The Sails
more or lefs worn or wet ;
as alfo taught or flack Rig-
ging, &c. Wherefore not
onely to avoid thefe laft
mentioned Intricacies, but
alfo to make thefe Pofitions
Examinable by every one
that defires it ; I fay, that
the different Velocity of
Bodies (of feveral fharp-
neffes, and as drawn or dri-
ven by different Powers of
knocks or falling weights,)
have been by my felf and
others much experimented

in

n large *Canales*, or *Troughs* of water, fitted with a convenient Apparatus for that purpose, and by no man more, nor more judiciously, than by the Right Honorable the Lord *Brouncker*, President of this Society. For I do not think it hard to conceive, that Weights and Sails are powers of like Effect, and reducible to the same Principle; so as if a Body have moved in double velocity, when drawn by a quadruple weight;

weight ; and in triple, whee
by a noncuple weight ;
doubt not but the fam
will hold in Sails, or othe
impellent Powers of th
fame proportions.

And for the further clean
ing or eafier trying hereof
I offer two fmall Machinal
ments heretofore made in
this Society : The one, to
meafure the Velocity of the
Wind, and the other its
Power or Equivalency to
Weight ; whereby it did
and will appear, when the
windl

wind is of double velocity, it will ſtir a quadruple weight; and the like in o-ther caſes according to the proportions of Roots and Squares above mentioned. The ſame may alſo be ſeen even in any good Turnſpit-Jack, where a quadruple weight makes double Velo-city (at the ſame diſtances of Time from the begin-ning of the Motion) both in the time of the Weights deſcent, as alſo in the Revo-lutions of the Fly, and each

in-

termediate Wheel. Now
perhaps the reafon of thefe
Phænomena may be here
expected; to which I an-
fwer,that the many paralle
Inftances above and here-
after mentioned, do, like
concurrent witneffes, prov
the premiffes, at leaft as to
any practical ufe. And a
for giving other reafon
(which I take to be Ex-
plaining this Subject from
the very firft Principles o
Atomical Matter, and *Moti-*
on) I leave it to difcourfe

s too long for this Exer-
cife.

The Second Instance

in the Strength of Timber, &c.

Et there be Square Rods
or Pieces made of any
clean Timber, or other Ma-
terials , whofe Ends let
be fupported with conve-
nient Blocks or *Fulcra* :
Thefe Rods in Experience
will bear weight hung in
the

the middle of them, a
cording to the proporti
of their lengths or diftanc
between the *Fulcra*; that:
to fay, a Rod A. being
double length to the R
B. will bear $\frac{1}{2}$ the weig
which B can bear; and b
ing of triple length, it wi
bear one third ; *& fic*
cæteris. Again, let two
thofe equal and ali
fquare Rods be placed on
upon the other (fo as t
touch and fit,) then the tw
together fhall bear 4 time
a

much as one alone, and
three of them, placed as a-
fore-faid, fhall bear nine
times as much, and fo on
in proportion of Roots to
fquares. Again, lay the
fame two Rods fide by fide,
to each other, then they
fhall bear but double, three
fhall bear triple, and fo
forward, in *Arithmetical*
roportion. From whence
it follows, that four of them
placed fquare, fhall bear
ight times as much as one
lone. But if the fame four

Rods

Rods taken as One, beii...
of double length making ...
Octuple quantity to Or...
they fhall bear but fo...
times the weight of O)...
alone. So as two like p)...
ces of Timber, that are ...
cubical or triplicate pr...
portion of their Sides, a...
ftrong but according ...
duplicate proportion , ...
the Squares of their refp...
ctive Sides ; and conf...
quently, to have like Veffe...
(differing in Content ...
the Cubes of their lil...
Sides...

ides) equally ſtrong, the
imber of which they con-
ſiſt muſt be *Quadrato-qua-*
ratic; that is to ſay , a
hip of 400 Tuns, equally
ſtrong with one of 50,
muſt have not only 8 times
s much Timber in it, but
6 times ; which is ſeldom
r never done. Which de-
ſect is the true Reaſon, why
reat Shipping is both
Dearer and Weaker than
mall Shipping, (no Ship
n the world being ſo
ſtrong as a Nutſhel ;) I ſay,
Weaker,

Weaker , for what is he
faid ; and *Dearer*, for wh
fhall be faid hereafter
the fixteenth Inftance
Mafts,Diamonds,&c. An
on the other hand , if th
Timbers were Quadrat:
quadratic , then the Shi
of 400 Tuns would l
loaden with her own M
terials ; if the Ship of 5
Tuns were not over-tim
bered.

Now, for not well un
derftanding thefe matters
many men defigning Em
gine

nes of ſtrength, do make
odels of ſuch Màchina-
ents by a Scale (ſuppoſe
herein an inch repreſents
oot,) by which the Mo-
l is the $\frac{1}{1728}$ part of the En-
ne intended : And there-
on they conceive, that if
e Model be ſtrong e-
ugh to bear $\frac{1}{1728}$ part of
at the great Machina-
ent is intended to bear ,
at then the ſaid great Ma-
inament will be ſtrong
ough. Whereas indeed
e Model muſt bear the
full

full $\frac{1}{144}$ of what is intend

for the great Machiname

otherwife great mifchii

will appear in the Wo

Wherefore the Square

the Linear Difference ll

tween the Model and H

gin, is the meafure and w

of trying the ftrength a

fufficiency fought for : T

ignorance whereof h

made many a poor Pro

&tor. Upon thefe Prim

ples, a Cask which will h

a Tun, ought to have

times as much Timber

, as the Cask which holds
nely a Barrel , or $\frac{1}{8}$ of a
un ; provided one be as
rong as the other (which
not ufually feen.)For the
igger Veffels, *Carts*, &c.
ey are ufually the weaker,
ompar'd with the ftrength
f the leffer; which appears
fo in *Animals*, whofe
rength is as the Square
oots of their weights and
bftance, *viz.* if 1728.
ice were equiponderate
o one Horfe, the faid Horfe
s but $\frac{1}{144}$ part as ftrong as
D   all

all the said Mice.

From thefe confidera
ons the Scantlings of *Tim
ber* in Buildings muft
adjufted ; as for examp
Let the Walls of any Roo
be infinitely, that is, fu
ciently ftrong ; let tt
length and the breadth
the Room be given : Ne
fuppofe the Room is to
made fo ftrong, as that ev
ry foot and a half fqua
fhall bear a Man , and i
that 31 $\frac{1}{2}$ fquare feet fhou
bear a Tun weight, (re
koni

oning 14 men to the
un :) Laftly, let the
rength of the Timber be
fo given. Now the Que-
ions are, to find the
cantlings of the Girders,
ife, &c. firft in fquare
ieces, and afterwards by
tering the Squares into
ore advantageous oblong
izes; as for example,
et the Room be fuppofed
6 foot long and 20 broad,
viz. 520 foot in the *Area*,
nd able to receive about
50 men, and to bear a-

D 2   bout

bout 16 Tuns. Suppo
the Timber be such ,
whereof a Rod of an in
square, and 20 foot lon
will bear $\frac{1}{20}$ part of an hu
dred weight; or, that
such Rods, or a Board
20 inches broad, and
foot long within the wall
an whole hundred weigh
and so the whole Floor co
sisting of about 16 suc
Boards, but 1600. Now
the same Board were planc
of 4 inches thick, it woul
bear 16 times 1600 or 25
hun

undred weight : If 5 inch-
, 400 hundred weight :
ut the whole weight de-
gned being but 325 hun-
red, fome fize between 4
nd 5 inches thick will
ffice in this cafe, where
e fuppofe the Floor to be
F planck without Gife or
irder. Next, fuppofe in-
ead of this Planck there
e ufed Gife of double
hicknefs to the faid
lanck, and placed at qua-
ruple diftance ; I fay, the
ffect and Strength will be

E 3   the

the fame with half the ftuff,
And I alfo fay, that co
Girder alone of 18 incll
fquare, and 20 foot lor
is near Equivalent to tt
17 Gifes of 9 inches dec
and $4\frac{1}{2}$ broad-aboveme
tioned ; which Girder H
but half the ftuff which t
Gife had ; as the Gife d
contein but half the ftu
which the $4\frac{1}{2}$ inch-Plan
firft mentioned did co
tein. Which faving
ftuff is the reafon of diw
ding Plank into Girder
                        Gif

rife, and Board. Where
ote, that thefe Proporti-
ns and Scantlings are not
ffered as exact and beft
or practice, but onely to
ntimate the method of in-
quiring into thefe matters.
o ufeful in the world.

The Third Instance

In the *Oars of a Boat,&c.*

TO determine or make
a good eftimate of the
power of *Oars,* I firft, for

D 4   eafier

eafier calculation, fuppo[..]
a Paralellipipedon-Bo[..]
or Veffel, of breadth fit fc[..]
a pair of Skulls, *viz*. of a[..]
bout 5 foot broad, and [..]
length fufficient for 9 fuc[..]
Skulls or Oars, *viz*. abou[..]
30 foot long, and one foo[..]
deep , and to draw bu[..]
three inches water. Next[..]
I fuppofe, that every Skull[..]
ler with his Skulls anc[..]
Bench, &c. their weight t[..]
be equivalent to three Cu[..]
bical foot of water; fo a[..]
every pair of Skulls (with[..]
its[..]

its appurtenances) depres-
es or finks the Veffel $\frac{1}{50}$ of a
foot, or about $\frac{1}{4}$ of an inch.
Now, fuppofe alfo a fmooth
calm ftanding water , in
which one Rower will row
his Veffel 12000 foot, or
bove two miles in an hour
or 3600 feconds; I fay then,
hat, if one *Remex* or Skuller
move 12 quarters or 3 inch-
s draught, 12000 feet for-
ard in 3600 feconds; then
like Rowers fhall move
he fame Veffel , drawing
5 quarters , or $3\frac{3}{4}$ inches
D 5   of

of water, the fame 1200
feet, in 1800 feconds *plu*
360 feconds, or in all, 216
feconds : And that 9 fha
row the fame Veffel, as tll
Root of 21 to the Root
108, which is, as near 3 to
or in $\frac{3}{7}$ of the time that on
Rower alone could ha
done the fame. Agai
fuppofe each Oar lengthe
ed from two to three, an
that as many ftroaks a
made in the fame time
before ; then the Velocii
fhall increafe proportiom
bly.   B

But suppose, that the Oars remain of the same length, but that the *Blade* be doubled ; then the Velocity shall increase but according to the Roots of that doubling, or as 10 to 7, or 7 to 5, &c. supposing still the same number of stroaks, within the same time, in every Case or Experiment.

Again, suppose these Experiments be made not in still water, but in water which runs 6000 foot an hour ;

hour; then, *againſt* th
ſtream the Velocity will b
leſſened by one half, an
accelerated anſwerabl
with it.

Laſtly, if the ſaid wate
be ſo rough, as that th
Veſſel heavs and ſets, ſup
poſe 20 degrees of the Qua
drant in it; then, foraſ
much as the Boats way will
be encreaſed as much as the
Tangent of 20 degrees ex-
ceeds the *Radius*, the way o
Velocity of the Boat muſt
abate proportionably.

𝕿𝖍𝖊

The Fourth Instance

In the *Motion of Horses.*

SUppose an Horse can travel 5 miles an hour with 200 pound burthen on his back ; then with half the said burthen he shall travel 7 ; and with double but three miles and a half. Again , suppose a Horse with 200 pound burthen can endure to travel 10 hours *per diem* ; then

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

with half the fame burthe
he may endure 14 hours
and with double but
hours. Laftly, fuppofe
Horfe (as Race-horfes) ca
run after the rate of fou
miles in $\frac{1}{8}$ of an hour, o
32 miles *per* hour., the
they can run about 6 mile
$\frac{1}{28}$ in $\frac{1}{4}$, or after the rate o
$24\frac{1}{7}$ miles *per* hour; anc
in one half an hour can ru
8 miles, or after the rate o
16 miles *per* hour ; anc
in a whole hour can rum
$12\frac{1}{14}$ miles ; and in 2 hours
can

can run 16 miles, or 8 miles *per* hour ; and in 4 hours can run 24 miles, at 6 miles *per* hour ; and in 8 hours 32, or 4 miles *per* hour ; and in 16 hours may go 48 miles, or 3 miles in an hour. All which agrees well enough with Experience.

The

The Fifth Instance,

In *Mills*.

WHere the wind blows, suppose, on a *Saw-mill* , in double Velocity; there the Saw-mill, which carried but one Saw shall carry four ; If treble, shall carry nine. And the like is true of water gushing out upon the floats of Under-shot Mills ; as may be seen in the Stampers of Paper-Mills, the Stocks of Fulling—

Fulling-Mills ; and other
Works of the like nature.

The Sixth Instance,

In *Gunpowder*.

THe way of a Bullet,
shot out of a good
Gun, is as the square Roots
of the quantity of the Gun-
powder fired ; I say , of
owder fired , because what
oes out unburnt, goes ra-
her as Shot than Powder ;
nd the Length of Guns sig-
ifies only the constraining
of

of the Powder within th
Lines of Direction, till
be all fired : The ufe
hard ramming and fcrew
ing of Guns, being alfo th
fame ; and the excellenc
of Powder being to fi
quick, and before it go
out of the Gun. I fay ther
fore, the Velocities caufe
by Gun-powder are as th
Roots of the Powder fire
that is to fay, 4 pound
Powder, all equally fire
within the Piece, fhall car
ry a Bullet twice as far a
on

one pound fhall do; and in *Time*, as 10 to 7; which laft mentioned numbers are the Roots of the double diftances afore-mentioned. Now, if the Capacity of the Concave of Guns ought to be, as the Weight of their Bullets or Powder; then, if the juft length of any one Gun hath been well found by good Experimentation, then may alfo be known the length of every Gun for every Bullet refpective-ly. As, for example, fup-

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

pofe a Gun, that carries
Ball of 5 inches Diameter
be 10 foot long in the Con-
cave, then the Content of
the faid Concave will b
3000 Cylindrical inches
Now the queftion is, how
long muft the Piece be
which carries a Bullet of
7 inches Diameter? I fay
that forafmuch as th
Weight of the 5 inch Bul-
let, to that of 7, is as 12
to 343; the Concave of th
greater Gun muft be in
the fame proportion to

3000

000, *viz.* 8232 like inches, so as it may contein and re a proportionable quanity of powder : Which 232 being divided by the *Area* of the Bullet, 49, the Quotient will be 168 inchs, or 14 foot ; that is (to peak shortly and plainly) *the Length of Guns must be measured by the Diameters of their respective Bullets.* I annot say, I have tried the ffects of Gunpowder to be n the abovemention'd proortion, but have credibly

heard

heard it to be fo ; and bee
caufe of the Similitude o
Sails,Weights, Knocks,am
the other points above de
fcribed, unto this of Gun
powder, I believe it ; am
recommend it to your fu
ther thoughts and exper
ence.

The Seventh Instance.

Of *Sounds*.

Et there be many *Equ*
Sounds ; I fay, that th
Diftances, at which the
ma

may be heard, are the
roots of the Numbers of
such Sounds. For, four
Musquets will be heard
twice as far as one, and
nine thrice; and so of the
rest. By which reckoning,
the hearing of some of our
Fleets Engagement with
the *Dutch* even to S. *James*'s
Park near this City is ea-
sily solved; and the truth
of that Observation doth
reciprocally countenance
this Doctrine. For sup-
pose both Fleets (consist-
ing

ing of two hundred Shi
great and fmall) had
bout 12000 pieces of Or
nance on board them
which at a *Medium* fupp
to be Demi-Culverin
Suppofe alfo, that a Dem
culverin, with the fame ci
cumftances of Wind a
Air, may be as eafily hea
five miles, as the faid E
gagements were heard 1
miles. Then I fay, th
1024 of the faid 120
Guns firing together,
very near the fame tim
mig

might (as they were) be
well heard 160 miles ; and
hat about 4000 such Guns
might as well be heard 300
miles , as one Demi-Cul-
erin five miles ; which laft
oint I add, to prevent the
nbelief of a probable mat-
er, when it fhall happen.
Tow what effect this had in
he *Popes* Prefage of the
attel of *Lepanto*, I know
ot.

E   **The**

The Eighth Instance

Of *Smells*

I Say the fame of *Smells* viz. that the Diftance at which they are perceive are the Roots of the Quam tity of the Matter out c which they are emittedl which Doctrin I apply t folve what I once did hardd ly believe, *viz.* that Ship coming from *America* to wards *Portugal*, did fme the Rofemary and othe
odor

doriferous herbs 60 miles
ff from the Land : The
hich feems not only cre-
ible, but very likely. For,
a foot fquare of a Rofe-
ary-Field may be fmelt
ne Perch or Rod (whereof
20 make a mile,) then a-
out 8000 Acres of Land,
hereon fuch fented Plants
o grow (or a piece of
and about 4 miles long,
nd 3 miles broad ; or 6
iles long, and 2 miles
oad) may be fmelt 64
les : And 72000 Acres

E 2   of

of the like Land, or a par=
cel of such Land about 1
miles square, may be sme:
as many *leagues*, or nea
200 miles. And this Con
fideration I pitch upon, a
one of the grounds where
upon I would build a De
ctrin concerning the Influ
ence of the Stars, and oth
Celestial or remote Bodi
upon the Globe of t
Earth, and its Inhabitant
both Men and Brutes.

The Ninth Instance:

Concerns *Visible Objects.*

Say alſo, that four equal and like *Candles* will give light but twice as far as one, and 9, thrice as far ; and that 16 will alſo en-lighten but 4 times as far as one, &c. And if a Flag or Ships-Vane of a yard ſquare may be ſeen a league off Sea, it muſt be 2 yards ſquare, or 4 ſquare yards

E 3   to

to be feen 2 leagues, an
fo forward. But whoeve
will make experiment here
of, muft firft confider, ho
many miles in thicknefs cc
a Middling, Clear, and D
aphanous Air do make a
Opaque. For we find, tha
although a very thin plat
of clear Glafs feems to hi
der our fight of near Ob
jects but very little; ye
we alfo know, that grea
number of them (fuppo
one hundred) can fcarc
be feen through at all
                          Here

Hereunto alfo muſt be ad-
ded the Conſideration of
the Convexity of the Earth;
and then I doubt not, but
his Doctrin (of Roots and
Squares) rectified and cor-
rected with the two addi-
tional Conſiderations laſt
mentioned, will hold con-
cerning Viſible and Lucid
Bodies, as was above pro-
pounded.

E 4 𝕿𝖍𝖊

The Tenth Instance,

In the Time of the Vibration of Pendules.

THe times in which th
Returns of a *Vibra*
ting **Pendulum** are made
are the Roots of the Di
ftances between the Cen
ter of the Pendulum, and
the Center upon which i
moves. I fhall need t
make no application of thi
Truth , fince we all enjoy
th

the benefit of it in our more
regulated Clocks and Mea-
sures of Time, which are
now in common use, and
from whose Improvements
we may most hopefully ex-
pect a better measure of
Longitude upon the Sur-
face of the Earth. The fur-
ther uses which may be
made hereof, (it being a
very simple and examina-
ble Experiment) is to wit-
ness and give evidence to
other the more abstruse and
complicate Positions, which

E 5 are

are of the like and parallell
Nature.

The Eleventh Instance

In the *Life of Man*, and itss
Duration.

IT is found by Experi-
ence , that there are
more persons living of be-
tween 16 and 26 years old,,
than of any other Age or
Decade of years in the
whole life of Man (which
David and *Experience* say,
to

to be between 70 and 80 years:) The reasons whereof are not abstruse, *viz.* because those of 16 have passed the danger of Teeth, Convulsions, Worms, Rickets, Measles, and Smallpox for the most part: And for that those of 26. are scarce come to the Gout, Stone, Dropsie, Palsies, Lethargies, Apoplexies, and other Infirmities of Old Age. Now whether these be sufficient reasons, is not the present Enquiry;

but

but taking the afore-menti-
oned Affertion to be true ;;
I fay, that the Roots of eve-
ry number of Mens Ages
under 16 (whofe Root is
4) compared with the faid
number 4 , doth fhew the
proportion of the likely-
hood of fuch mens reach-
ing 70 years of Age.   As
for example ; 'Tis 4 times
more likely, that one of 16
years old fhould live to 70,
then a new-born Babe. 'Tis
three times more likely ,,
that one of 9 years old
fhould

should attain the said age of 70, than the said Infant. Moreover, 'tis twice as likely, that one of 16 should reach that Age, as that one of 4 years old should do it ; and one third more likely, than for one of nine. On the other hand, 'tis 5 to 4, that one of 26 years old will die before one of 16 ; and 6 to 5, that one of 36 will die before one of 26 ; and 3 to 2, that the same person of 36 shall die before him of 16 : And so forward ac-
cording

cording to the Roots of
ny other year of the decl
ning Age compared withi
number between 4 and 5
which is the Root of 2
the moſt hopeful year fc
Longævity , as the mea
between 16 and 26 ; and
the year of perfection, a
cording to the ſenſe of Oi
Law, and the Age for who
life a Leaſe is moſt valu
ble. To prove all which,
can produce the accomp
of every Man, Woman, an
Child, within a certain P
ri

ſh of above 330 Souls ;
which particular Ages
being caſt up, and added
together, and the Sum divi-
ded by the whole number of
Souls, made the Quotient
between 15 and 16 ; which
call (if it be Conſtant or
uniform) the Age of that
Pariſh, or numerous *Index*
of Longævity there. Many
of which Indexes for ſeve-
ral times and places, would
make an uſeful Scale of Sa-
lubrity for thoſe places; and
better Judg of Ayres than

the

the conjectural Notions w
commonly read and talk o
And fuch a Scale the *Kin*
might as eafily make for a
his Dominions, as I di
this for this one Parifh.

The Twelfth Instance

In *Mufick.*

TAke a *Mufical Strin*
one end thereof be
ing faftned ; hang unto th
other (over a convenier
Bridg) any weight whic
may ftrain it to fome graw
Mufical Tone or Note; the
fc

some other ſtring of near
the ſame length, Uniſone
hereunto.   Laſtly, inſtead
of the firſt weight, hang to
the firſt String the Quad-
ruple of the ſame weight;
and it will appear, that the
ſtring with the quadruple
weight ſhall yield a Tone
an 8th or Diapaſon above
ſelf, when ſingly charged.
The reaſon is, becauſe the
quadruple weight doubles
the number of Vibrations,
(2 being the Root of 4:)
and for that the *Ratio For-*
malis

malis of Tones lieth in tt
number of the Vibratiom
and of the Diapasons,
the doublnefs of fuch nu
bers. By the fame Meth
of hanging-on fevei
weights at one end of t
fame String, all Tones m
be produced, of which fu
String is capable. T
Tones or Notes alfo of lil
Bells and Drums do follo
the fame proportions
their Tenfion and Metta
fo as able Artifts can ca
Bells in Tones affigned.

The Thirteenth Instance,

Of *Fire and Spirits*.

Et a Cylindrical Flat-bottom Veſſel be filled with Water, and let it be tried, in what time one Lamp or Candle would make the water boyl through, or come up to its greateſt heat : Then ſee, in how much leſſer time, 2, 3, or 4 more like fires will haſten the ſame effect. I

can-

cannot speak positive:
hereof, but know from f(
veral Observations, thi
the Acceleration abovefaii
shall not be made in Aritll
metical Proportion ; for
afmuch as I know, that ii
Fire-works great Fires arı
more profitable than fmall
as in Brewers Coppers, anı
Iron-works may be feen
wherein double Fires pro
duce more than double di
patch or advantage. I fhal
therefore fufpend this mati
ter, and pafs to the meafu:
rin

ng of the *Spirituosity* of
iquors , or in what pro-
ortions several Liquors
ontein more or less of in-
ameable or ardent parts.
ow in this case I conceive,
e Consideration of Roots
nd Squares is also mate-
al ; for I understand by
rength or multitude of
pirits, the Space, greater
lesser, into which such
iquors will be rarified,
will fill with Spirits :
s for example, if a Pint
Water rarified into Va-

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

pour will fill a Globe b
of 3 foot Diameter; and l
Pint of rectified Spirit
Wine will fill a Globe
fix foot diameter, or 8 tim
as large as that of Wate
I shall say, that there is
times as much Spirit or W
pour in one as in the othe
But if these Liquors we
put into open Lamps
Veffels, there the fpace
which the Spirits rife, a
the Roots, whofe Squar
do fhew the Spirituofity
thofe Liquors: *Ex. gr.* L
the

ere be a Lamplike Veſſel
common *Aquavitæ* ; in
ich place a Week as high
the ſame will burn by
e riſing of the Spirit un-
it , ſuppoſe an inch a-
ve the ſurface of the Li-
or : Now, let there be a
e Equal veſſel with ſuch
Spirit , as will riſe up
gher, ſuppoſe to a Week
aced two inches above
e Surface ; in this caſe, I
, that the latter Liquor
quadruple in ſtrength or
tent of Spirit to the for-
mer ;

mer ; for 'tis certain, th
as the Spirit rifeth dou
upwards, fo alfo it emitt
or rarifieth it felf dou
alfo fideways ; and con
quently the quantity of
Spirit or Vapour muft
quadruple ; and fo of otl
proportions.

The Fourteenth Inſtance,

Of Riſing and Falling Bo-
dies ; but particularly of
Waters in Pumps and
River-ſtreams.

Et it be obſerved in the
Tranſparent Pipe of a
orcing Pump, at how ma-
y ſtroaks the Water is for-
ed from the Bottom to
he Top ; and let as many
arks be made at the ſeve-
l places unto which the

F   Water

Water mounted at ever
ftroak (which ftroaks w
fuppofe to be all in Equa
Times;) it will appear,tha
all the faid Divifions wi
be according to the Pro
portions or the Logarithm
above-mentioned. As fo
the Defcents and Accelera
tions of falling Bodies, th
Times are the Roots o
thefe *Spaces*, which the
fall in the faid times refpe
ctively. The great effe
whereof we fee in *Overfhot*
Mills, where a little wate
falling

falling upon a Wheel of a large Diameter, produceth wonderful Effects ; the which may be well compu- ted upon the Principles we hold forth.

Waters also have greater Forces in the above-menti- oned proportions, as the hole or place whereat they iffue is lower from their Surface ; as may be feen in all Breaft- and Undershot- Mills ; where it is pleafant to divide the Sinking of the water into Equal Spa-

ces

ces, and to count the
Clacks, Revolutions or
Stroaks made within the
Time of the waters finking
every fuch equal Space:
for therein the above-men-
tioned Logarithmes may
alfo be obferved.

Unto this head may be
referred the *Leakage of
Ships*. For let there be a
hole in a Ship fomewhere
under water; then let it be
feen, what water comes in
at the faid hole, within any
fpace of Time; then let
the

the like hole be made at double the perpendicular diftance from the top of the water, and there fhall come in four times as much as at the upper hole; and let a third be at three diftances, and that fhall admit 9 times as much, &c. Again, let there be two E-qual holes or Leaks in a Ship, the one at Head, and the other at Stern, and let the Ship be in motion; then the Leakage at the Head is compofed of the preffure of

F 3   the

the water from the Surface:
and of the Ships Motion
together. Moreover, if the
Ship make double way, the
Leakage will be quadruple:
if treble way, noncuple, &c.
Wherefore to ftop Leaks a-
fore, the Ship muft ftop its
motion, lye by, or bear up
to go with the Wind and
Sea , &c.

Laftly, I fhall add, that
the Swiftneffes of Waters
or River-ftreams , are
the Roots of the Power
that caufes them ; which
caufes

caufes are Steepnefs or De-
fcent in a fharper Angle
from the Perpendicular.
Wherefore knowing by ob-
fervations, what degree of
Steepnefs caufeth any de-
gree of Swiftnefs ; hereby,
and by our Doctrin, the
Height of ground where a-
ny River rifeth above its
fall into the Sea, may be
computed.

F-4 The

The Fifteenth Instance,

In the *Blaſt of Bellows.*

IN Iron-work Furnace
are the greateſt and moſt
regular moving Bellow
that are any where uſed
the which are commonly
turned by the eveneſt over-
ſhot Wheels. Now the
Times wherein theſe Bel-
lows riſe and fall, are
Roots of the Strength of
ſuch Bellows-blaſt upon
the

the fire; for rifing in double Quicknefs admits double air in the fame Time; which being in like manner fqueezed out a-gain, double Quicknefs makes double Expulfion, and confequently double Swiftnefs; (the whole paf-fing through the fame wire-pipe in half the time;) and double Swift-nefs makes quadruple ef-fects upon the fire or Fur-nace, as aforefaid.

F 5

The

The Sixteenth Instance,

In the *Price* of *several Commodities.*

SUppose a *Mast* for small Ship be of 10 inches Diameter, and as is usual, of 70 foot in heighth and be worth 40 s.; then a Mast of 20 inches through and double length also shall not onely cost eight times as much, according to the Octuple quantity o Timb

Timber it conteins, bu
fhall coft 16 times as much
or 32 *l.* And by the fame
Rule, a Maft of 40 inches
through fhall coft 16 times
32 *l.* or 516 *l.* Of which
laft Cafe there have been
fome inftances. But where
as it may be objected, That
there are no Mafts of
four times 70, or 280 foot
long, I ftill fay, that the
Rule holds in common pra
ctice and dealing. For, i
a Maft of 10 inches thick
and 60 foot long, be worth
30 *s.*

30 s; a Maſt of 20 inches
throughout, and 80 foot
long, ſhall be worth 15 l.
And a Maſt of 40 inches
thorough, and 100 foot
long (not 280 foot) ſhall
be worth near 100 l.

Moreover, ſuppoſe Dia-
monds or Pearls be equall
and like in their Figures,
Waters, Colours, and Even-
neſs, and differ onely in
their Weights and Magni-
tudes; I ſay, the Weights
are but the Roots of their
Prices, as in the Caſe a-
fore-

foregoing. So a Diamond of Decuple weight, is of Centuple value. The same may be said of Looking-glaſs-Plates. I might add, that the Loadſtone A, if it take up 10 times more than the Loadſtone B, may be alſo of Centuple value.

Laſtly, A Tun of extreme large *Timber* may be worth two Tuns of ordinary dimenſions; which is the cauſe of the dearneſs of great Shipping above ſmall; for the Hull of

of a Veſſel of 40 Tuns ma
be worth but 3 *l. per* Tun
whereas the Hull of a Ve
ſel of 1000 Tuns may
worth near 15 *l. per* Tun
From whence ariſes a Rul
how by any Ships Burthe
to know her worth by th
Tun, with the Number an
Size of her Ordnance, *&c.*

The Seventeenth Instance,

In *Mill-Dams*, *Sea-Bancks*, and *Bulwarks* of *For-tresses*.

SUppose any Wall, Dam, or Banck, to be just sufficient to keep out or resist the Sea, or other Stream against the appulse of its waters, being of a cer-tain force; I say, that to make this Wall or Damm strong enough against a

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

double fwiftnefs of ap
pulfe, it muft be augmen
ted by quadruple thic
knefs; and if it muft b
made fufficient againft th
greateft violence which e:
ver was obferved, then tha
violence being known, i
the Root of the number by
which the Walls thicknefs
muft be augmented.

So Cannon-Bullets do
Execution or batter in *du-*
plicatâ ratione of their
fwiftnefs; and therefore
Ramperts muft be ftrong:
and

and thick in *duplicatâ ra-
tione* of the said swiftness,
which depends upon the
Distance of the Battery,
and the degrees of Tardati-
on, which Bullets make in
very part of their way be-
tween the Gun and the
Rampert, which they are
to batter. Where note,
that Bullets commonly beat
out a Cone of Wall, whose
Vertex is in the Bullets En-
try, and like the Conical
Fovea to be seen in the
Sand of an Hourglass.

The

The Eighteenth Instance.

In the *Compression of Yield-*
ing and Elastic Bodies,
as Wooll, &c.

SUppose some Cylindri-
cal or other parallell-
sided Vessel, fill'd with
Wool, or Down, or Fea-
thers, or other *Elastic Ma-*
terials; let the same be
covered with a moveable
Head (such as in pressing
of Pilchards they call a
Buck-

uckler ;) then first ob-
serve, how low the Buck-
er defcendeth by its own
weight; and then upon
his Head or Buckler lay
a triple weight, to make
the whole quadruple, and
it will appear, that the
Buckler will sink but juft
as much lower ; and being
Nonecuple, another like
space lower : So as the fe-
veral Spaces of Depreffi-
ons are the Roots of the
depreffing Powers. From
thence may be feen, how
the

the Force muſt be increaſ-
ed at every Turn or Thread
of a Screw-Preſs; which
being done according
the proportions here un-
derſtood, I doubt not
but a Light Subſtance with
a convenient *Apparatus*
might be compreſſed unto
the Denſity and Weight e-
ven of Gold. But, that Sil-
ver might be ſo condens'd
I made no queſtion, till I
heard of ſome Anomaly in
the practice, which I muſt
better conſider of. The
further

urther Truth whereof doth
ppear in the *Under-water-*
ir within the Veſſels of
ater-Divers, who the low-
they go, do find their
ock of Air more and
ore to ſhrink ; and that
cording to the Roots of
e Quantities of the
per-incumbent Water or
eight. In like manner
ke a Bow, and hang
y weight to the middle
its ſtring, and obſerve
ow low it draweth the ſaid
ring. Now, if you ſhall

<div align="right">qua-</div>

quadruple the fame weigh
it will draw down doub
the firft diftance, and nor
cuple will draw it dow
treble , &c. So as in
drawn Bow, let the Arro
be divided into *quotcunq*
partes , each equal part
the Tenfion carrieth th
Arrow to an Equal D
ftance , notwithftandin
each equal part of the Ten
fion was made by Unequ
power, and that each equ
Space or Part alfo of th
Arrows firft flight require
Unequa

nequal Force, *viz.* leaſt
ſtrength at firſt, and moſt
laſt; and that, in the
proportion firſt mention-
d. So in the *Fuze* of a
Watch, the greateſt ſtrength
of the Spring is made to
work upon the ſhorteſt *Ve-*
ris; and the leaſt upon the
longeſt, ſo as to equalize
the whole. The like alſo
happens in the *Traction of*
Muſcles upon two Bones
with a turning Joynt be-
tween them; which Bones
and Muſcles make a Tri-
angle

2

angle, whereof the Muſc
is the Baſe, ſubtending tt
Angle-Joynt. Now in tt
working, the Muſcle
ſtrongeſt, when the *Ve*
is ſmalleſt, as lying m
obliquely ; and *vice verſ*
when the Muſcle and m
ving Bone come to make
right Angle.

An Appendix

OF

ELASTICITY.

HAving done with the Confideration of du-plicate and fubduplicate proportion in *Elaftic* Bo-dies and Materials, I hope it will not be amifs to fub-joyn a fhort Appendix of *Elafticity it felf*, whereby to draw forth the better

G   thoughts

thoughts of other men ff
Countenance or Correct
on. Wherefore I fay
followeth ; *viz.*

First, Suppofing *eve*
Body to have a *Figure*
Pofiture of its own, out
which it may be difturbe
by *External Force* ; I fa
that *Elafticity* is the pow
of *recovering* that *Figur*
upon removal of fuc
Force.

2. I think it eafieft t
confider *Elaftic, Springing*
or *Refilient* Bodies, as *La*
                    mina

inæ, *Laths*, or *Lines* ; fo
s a ftreight Lath, being
y force bent *circularly*,
oth upon the removal of
hat Force, return to be
reight again by its *Elafti-*
ty ; and a *Circular Hoop*
eing forced ftreight, leaps
ack into its own crooked-
efs by its *Elafticity*.

3. *Elaftic* Bodies in
heir returns do overfhoot
heir own Natural Pofiture,
nd vibrate *cis citrà* the
oint they feek, as doth a
endulum, or *Magnetic-*

Needle,

Needle , till at length th(e)
reft ; the one in his *Pe*(r)
pendicular , and the oth(er)
in his *Meridian.*

4. An *Elaſtic* Body is (a)
grofs *Tangible* Body, whi(ch)
is made of *Corpuſcles* , (which are)
the fmalleſt Bodies that c(an)
poffibly be *feen* ; and the(ſe)
Corpuſcles are made of *A*(*-*)
toms, or the fmalleſt bod(ies)
in Nature (fuch as where(of)
a *Million* doth not perha(ps)
make one of the *Corpufcl*(es)
laſt mentioned.)

5..

5. I know no reason, why we may not, upon occasion, suppose *Atoms* to be of *several Figures* and *Magnitudes*, provided we suppose them *immutable*, such as *Corpuscles* are not; grofs tangible Bodies being very mutable by the various Additions and Detritions that befal them.

6. I suppose in every *Atome three such points* as we all see and know to be in the *Globe of the Earth*, and in every *Magnet*, *viz.* two

G 3   *Poles*

Poles in its *Superficies*, an[...]
a *Central* point *within* it[...]
substance, which I call it[...]
Byas. The Heavens al[...]
visibly have their *Poless*[...]
and must have a *Center*[...]
Gravity or *Magnitude*, [...]
some other *Central* and *pra*[...]
dominant Point. [...]

7. I suppose every A[...]
tome may move about hi[...]
own *Axis*, and about othe[...]
Atoms also, as the *Moon*[...]
does about the *Earth*; *Ve-*[...]
nus and *Mercury* about the[...]
Sun; and the *Satellites*[...]
Jovis[...]

Jovis about *Jupiter*, &c.

8. I suppose, that the *Byas* of one Atome may have a tendency towards the *Byas* of another near it, and that the Byasses of many Atoms may tend to some common point without them; as we see in *Electrical* Bodies, and in the *Globular drops* of Water and Quicksilver, and all Mucilaginous Substances.

9. I suppose, that all Atoms have, like a *Magnet*,

G 4   *two*

two Motions, one of *Gravity*
whereby it tendeth to
wards the Center of th
Earth, and the other o
Verticity, by which it tend
eth towards the Earths
Poles, and whereby Mag.
nets joyn to each other by
their *Oppofite Poles*.

10. All Atoms by their
Motion of *Verticity* or *Po—*
larity, would draw them—
felves, like Magnets, into
a ftreight Line, by fetting
all their Axes in *directum*
to each other; did not the
Moti-

Motion of their respective
Byasses towards each other,
and towards other Points,
curb them into a *Triangle*,
whereof the *Two Axes* of
Two Atoms are two sides,
and the distance between
the Byass of each making
the third side : Wherefore
I call the *Polar* Motion a-
bove-mentioned, the Mo-
tion of *Rectitude* ; and the
Motion of the *Biasses*, the
Motion of *Angularity* or
Curvity, or the Angular or
Curve Motion.

11. I

11. I suppose, that all these Motions may be of different *Velocities*, and that by *Contra-colluctations* they ballance each other, some time into *seeming* rest: I say, *seeming*, because perhaps there is *no* rest in Nature.

Lastly, I might suppose (even without a Metaphor) that Atoms are also *Male* and *Female*, and the *Activ* and *Susceptive* Principles of all things; and that the above-named Byasses are the

the Points of Coition: For,
that *Male* and *Female* ex-
tend further than to *Ani-*
mals, is plain enough; the
fall of *Acorns* into the
ground, being the Coition
of Oaks with the Earth.
Nor is it abſurd to think,
that the words in *Geneſis*,
[*Male and Female crea-*
ted he them] may begin to
take effect, even in the
ſmalleſt parts of the *firſt*
Matter. For although the
words were ſpoken onely
of *Man*; yet we ſee they
                    certain-

certainly refer to other A-
nimals, and to *Vegetablee*
in manner aforesaid, an
consequently not impro-
bably to all other *Principlee*
of *Generation*.

Conclusion.

To Conclude, I hope
I may say, that these my
Principles, are *Principles in-*
deed ; for there can be no
fewer nor *easier* than *Matter*
and *Motion*. My *Matter* is
so simple, as I take notice

of

of nothing in each Atome,
but of *three such Points* as
are in the Heavens, the
Earth, in Magnets, and in
many other Bodies. Nor
do I suppose any *Motions*,
but what we see in the
greater parts of the Uni-
verse, and in the parts of
the Earth and Sea.

Again, all the Motions
I fancy in my Atoms, may
be represented in grofs
Tangible Bodies, and con-
sequently may be made *in-
telligible* and *examinable.*

More-

Moreover, I hope none o
my Suppofitions are incom
fiftent with each other, no
do neceffarily infer any
abfurdity or falfehood.

And laftly, I hope they
folve all the *Phænomena* o
Elaftisity, and, as I think
of *Hardnefs, Fixednefs, Te-*
nacity, Fluidity, Heat, Moi-
fture, Fermentation, and the
reft. All which is hum-
bly fubmitted to the Cen-
fure of this *Society* ; whofe
Atoms or infeparable Mem-
bers I wifh may happily
Con--

Conglomerate, and Unite
hemfelves into the moft
ixed and moft noble Bo-
dies amongft the Sons of
Men.

FINIS.

That is with Johnson shall —

Sun Left Chelsea Rothenburg

had 2 Sacks of francs

Inread not till youth fourth