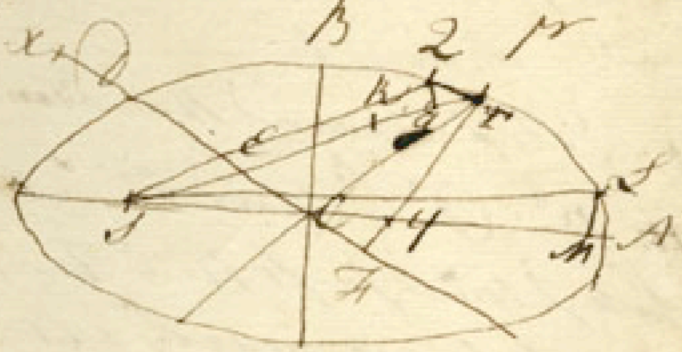
the force which retains the planets in their orbits is inversely as the dist.² —



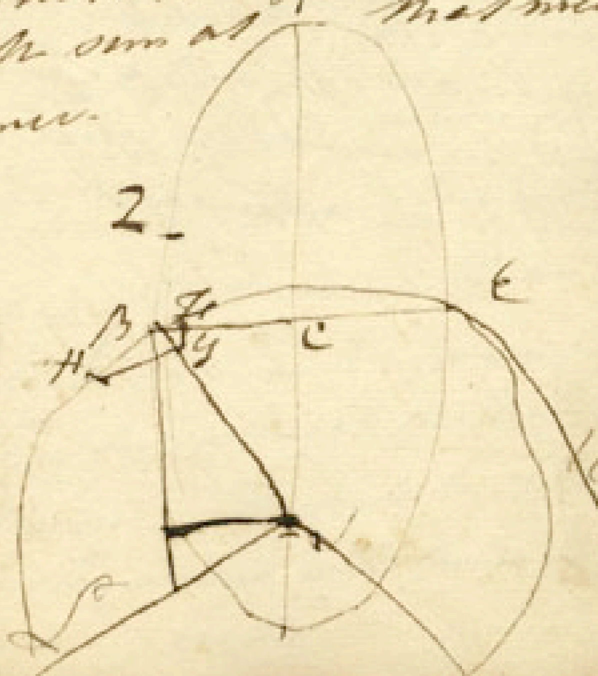
$BC : CO :: CO : CX$
$CA : PH :: PZ : PY$
$SA : SP :: SP : Sk$
$LI : LM :: VP : VA$
$2g : LM :: SA : SP$
$2g^2 : LM^2 :: SA^2 : SP^2$
$2g^2 : LM^2 :: SA : Sk$
$2g : 2g :: CA : PZ$
$I2 : 2g :: CA^2 : PZ^2$
$I2^2 : 2g^2 :: CA : PY$
$I2^2 : 2g^2 :: SA \times CA : SP \times PY$
$I2^2 : LM^2 :: SA \times CA : SP \times PY$
$V^2P : V^2A :: SA \times CA : \ldots CX$ | P
$\ldots A : \ldots P : CB$
$FP : FA :: V^2P \times SA : V^2A \times SP$
$FP : FA :: SA \times CA \times CB : SP \times PY \times CX$

$FP : FA :: SA : Sk$
$FP : FA :: SA^2 : SP^2$ 2 & D

Cor.⁴ the equation of the Anomaly. — When the Planet is at its aphelion its direction is a tangent perpendicular to AB but at P it makes an acute angle and therefore its motion is accelerated —

The vel. at B is that wh. would make it revolve in a circle round the sun at that mean distance.

2.



$BI \times BE : FZ^2 :: BC^2 : CA^2$

$BI \times BE : BG \times BK :: BC^2 : CA^2$

$BI \times BE : GH :: BC^2 : CA^2$

$\therefore FZ^2 = GH^2 \,/\, GZ : PH$ —

this the reason why the planet

does not fall into the sun

at the [illegible]

If the central force should de-

crease as the cubes of the dist-

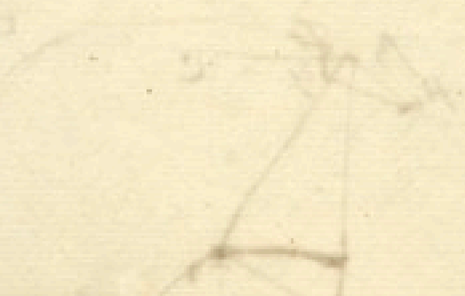
ance then it may be demon-

strated that the planet would

describe an equiangular spiral

round the sun the sun but

would never approach him.



6 Jan.^y 1776

Art.^s of the Phenomena —

Planets not luminous — appear to us

by reflected light — Venus, a [illegible]

a small bell, [illegible] well exhibit

the same app.^s with Venus or the moon

Jupiter and Saturn: both [illegible]

the eclipse of ~~his~~ their Satt.^s — The

[illegible] of Mars by [illegible]

Eclipse of the sun or rather of the

earth — Penumbra — shadow

of the earth from left to right to

a spectator in the moon. breadth

of the shadow, & penumbra —

Eclipse of the Moon — shews the

earth to be round — hence we see

that the sun is bigger than the earth

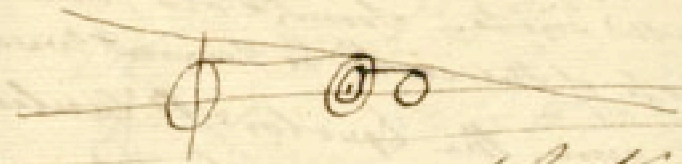
and Moon. — shadow of the [illegible] of

different dimensions, sometimes does

not reach the earth.

When the moon is nearest the the earth the Dimensions of the star is 150 miles and of the Pen.a 4900 — hence it appears that the sun is bigger the earth — Moon never eclipsed — hence also the earth is bigger than the moon. — Eclipses do not happen at every change and full because the moon's orbit is inclined to the plane of the ecliptic — the eclipses can happen unless there be near one of the nodes — Moon's rotn. from the node from change to the next is 30° & the mo. of the node that there can be no eclipse at both. more times. If the Moon is in the 18° from the node there could be an eclipse of the sun — Fig. Ferg.n Moon's earth & & an eclipse for the moon established an angle of 5°.

Moon's inclination



The E of the cannot happen unless the Moon be less than 12° of the nodes. Less than the Solar because of the decrease of the conical shadow.

18.y 10.d 7.h 43' period of eclipses —

variation ½ Degree

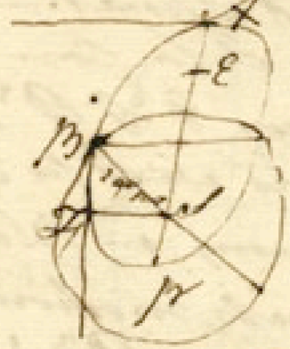
Moon's motion accelerated &c

Then the solar limits are larger that the Lunar it would appear that there should be an eclipse of the than the moon — this not the case &c — Total eclipse of the Sun

gr. duration of a total E. 4' 5"

To estimate the quantity of the eclipse the diam. of the sun and moon are supp^d divided into 12 equal p^ts called digits. Semid. Solis north pole of the earth is turned towards the sun. the Equator p^l circles will be ellipses — Eclipses of the sun will appear very various to a spectator, from the position of the Moon, of the earth node, and of the spectator — App. of an eclipse at the Summ. Solstice and at the Autumnal Equinox. — Lunar eclipses not subject to these variety seen to all the same time.

5 Jan^y 1776



It was demanded

$$F \doteq \frac{v^2}{D}$$

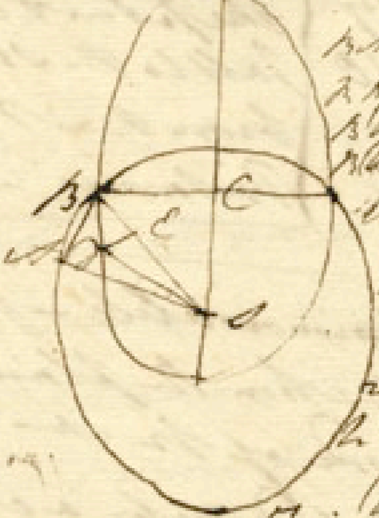
$$\frac{1}{D} \doteq F \doteq \frac{v^2}{D}$$

$$\frac{1}{D} \doteq v^2$$

$v^2 B : v^2 A :: SA : SB$

Therefore the Vel. at A is too small to allow the planet to move round the sun in a circle whose radius is SA. — Velocity at P is too great to allow the planet to move round the sun in a circle whose radius is PS — Diminution on one side — augmentation on the other — If the solar power were ∴ as D^2 the planet will ...

round the Sun is an equiangular
or Logarithmick Spiral.—
If the Law of the Solar force is
something between D^2 & D^3 the
line of the Apsides will be con-
tinually advancing in the di-
rection of planets motion—
If the Solar force was $D^2 + \frac{1}{120}$th
the revol.n of the Apsides would
be very sensible—this vide
this has been * observed, at least
very little and this may be
accounted for on other ~~prin~~
principles



BAS : BDS :: BA : BG
2AS : BDS :: BD : QD
BD : DE :: BS : BC
BD.DE : CG : BC
2BAS : BDS : CG : CB
O : O :: CG : CB

when bodies
move in circles
the C.F. is $\frac{D}{P^2}$

$F = \frac{D}{D};\ F = \frac{1}{D^2}$

In the planets the forces are inversely
:: D^2 the forces are not different
but the same force acting at
different distances. All the
planets at the same dist. and
with the same vel. would
describe = orbits. — Hence the
Centripetal force is :: quantity of
Matter at = distances — Hence
we can find in what bodies eq.l p.t
would seem to be

$M = 15'' \frac{1}{3}$
$V = 29'' 17$
$E = 64'' 10$
$M = 121''$
$J\ 290''$
$S\ 768$

time in which the planets would fall to the sun from their distances

Sun not immoveable — found by observation when the planets are on one side of the Sun — Sun is found to describe a curve round a fixed point. This pt. can exert no force. they are kept in their orbits by their tendencies to each other. [illegible] equal [illegible] which the sun moves round a point — Find of Sun & planets mutually equal — This point has this prop. the —

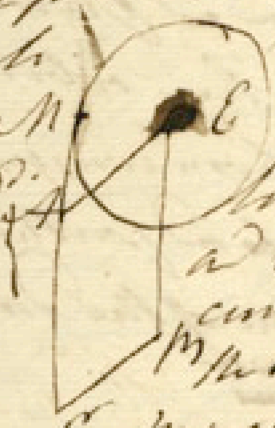
any body has [illegible] inversely as the quantity of matter:

9 Jan. 1776 —

Between the new and full moon the Earth is in her orbit in sine of the distance from conjunction E found nearer to and farther from the sun in sine of the distance from ~~conjunction~~ quadrature

The same thing takes place betw. Ari J. and Sat.
M sometimes very [illegible]

Then the Sun E and M are
bodies regulated by the same
Mechanical forces—
Moon is acted not only
by the force tending to the E
centrally [illegible] by a force
tending M to the Sun

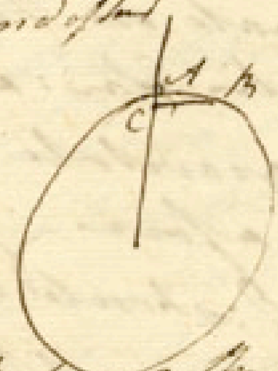


suppose A [illegible]
to the
moon

like a Ship
and boat in a
current may be
the same the [illegible]
[illegible] act equally
both on the ship and boat—
Hence the forces by which the
1st and 2nd [illegible] are the
same in all— Hence in general
the Sun and 1st mutually
tend to other; this is as general
as the [illegible] impenetrability or
perseverance in motion

If [illegible] with the [illegible] force
is the same, a new force—
— Suppose a moon a foot [illegible]
revolve round the earth on its
surface — then
$M^2 : m^2 :: R^3 : \frac{1}{2}D^3$ of the Earth
here we have the greatest [illegible] of
the orbits which the two Moons
in a given time—

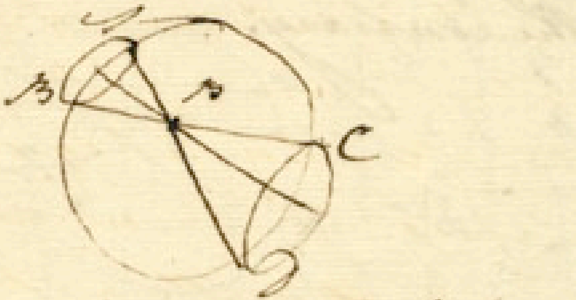
Bodies fall 16.054 in a second of time | this last would move in 1 second $\frac{1}{16.054}$



Then the force of the planets is
the same with terrestrial gravity
the same [illegible] by which bodies
fall [illegible] or [illegible] obstacle is the same
[illegible] with that power which keeps 1st

in their orbits. — Substl. G.n
for the planetary forces —
Since the gravitations of all
the planets are :: to the
quan: of matter at equal
Distances — [illegible] wonder
the Inertia of matter as the
proper test of the quantity
of matter — Pendulums of
different bodies and the same
lengths, vibrate in the same
time. Objection — Since all
bodies ~~[illegible]~~ gravitate to
each other with a force :: to the
and the
bodies on our E: should do the
same but this is not found
except in Magnetism and Elect.y
and these do not follow :: Dn of the
attraction and take place at

could not be observed on account of the
quantity of the Earth's
attraction at the 1st



$AP^2 \times PD^2$: $PD^2 \times PA$ } Hence whether the particle P is placed
it will be equally attracted
and therefore will rest — the
same will happen of the Part.
is enclosed in a thick Shell — then
the whole visible universe
may be enclosed within a
shell to which every part: the
shell is equally attracted. Qr. Shall
Earth may have a cavity within
it and there may be different

Habitable Bodies in that
cavity for ought we know
to the contrary.

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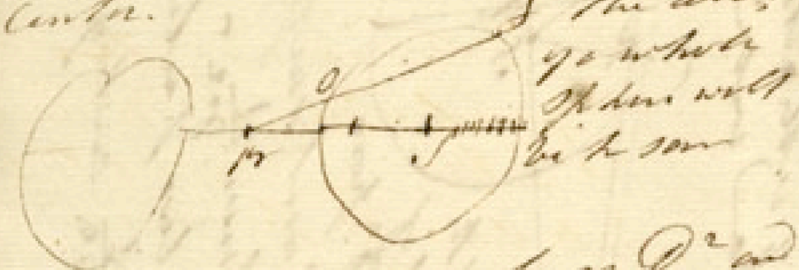
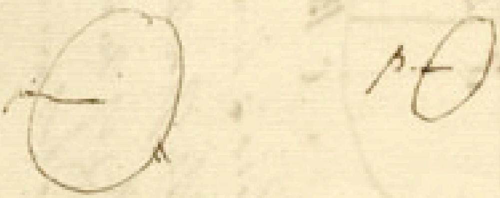
The law of the attraction will be the same if all the matter was condensed into the centre.

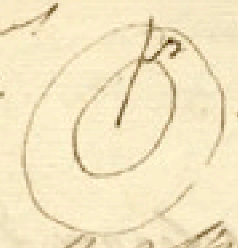


& the att.n of a whole sphere will be the same

At. Sph.s are inversely as D^2 and directly as the quantities Mat: Hence it follows that in similar spher.s the att.n on two particles on their surface will be as the Radii of the spheres.



The Particle P. tends to the centre w.th a force directly :: Dist: that then the Earth



— Hence the attractions of two spheres by each other is the inverse :: D^2 — Hence it appears that if this is the law of the particles it will be the law of the planets which are facts — these cannot be accounted for on any other principle

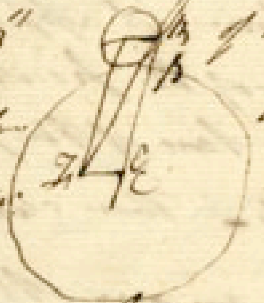
Object: to the outs gravitation — it does not explain the cause the only mention is the facts. G.n is universal property of all bodies

11 Jan.y 1776 —

$\frac{M\ m}{D^2}$ —

Small globe 1 League D.r land on the earth — the angle of deflection is 1' 33'' of the plummet

observator



at point by

Mr Bouguer

Maskelyne observ.

sum of the two deflection in Scotland amounted to about 22'' — each 11'' side of the hill

The plummet will point to the center no where except at the Eq.r and the poles i.e. at the extremities of the two axes

Planets attract each other and consequently disturb each others motions in :: $\frac{Q \text{ in } M}{D^2}$

To find the quant. of M. in the sun

$G \div \frac{M}{D^2}$ — $G \div \frac{D}{p^2}$ time

$\frac{M}{D^2} \div \frac{D}{p^2}$

$M \div \frac{D^3}{p^2}$

$M \div \frac{1}{1} = 1$ J. th Sat.

$D \div$ distance of

$\frac{D^3}{p^2}$ $M : m :: 1 : 1067$

Divide the D^3 by the p^2 in two planets, then 1st quote : 2 quote as the quantities in them is to q. M ...

E^{ts}

8'' $365\frac{1}{4}$

3420 = d $27\frac{1}{3}$

E Moon Matter in Sun

M : Mn : 1 :: 365412

	Matter		Diam.
Sun	365412	=	112.8
Jup.	340	=	11.
Sat.	107	=	10.
Earth	1	=	1.
Mer.	k: .1425		.4 k
Ven.	k 1.171		1.3 k
Mars	k .2		.7 k

	Density	
Earth	1	Sat. 1/4
Jup.	1/4 .23	
Sun	1/4	

Q. M^2 nearly as D^2 of the planets

Gravity proved by the most extensive induction which Nature affords

$\frac{16.\frac{1}{2} M}{R^2}$

Feet

Sun 428 above what fall on the surface of the planets

Jup. 40 1/2

Sat. 16 3 first in a second

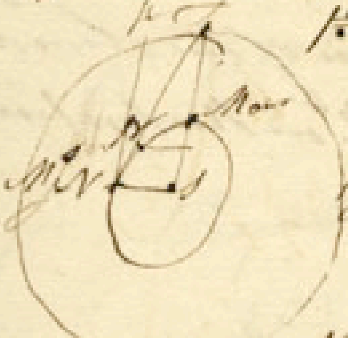
Then the planets move in vacuo. Moon's retardation caused by the resistance of the Earth's atmosphere, this resistance more than sufficient to account for the observed increase of the lunar month.

Sun = 6500 P^s in the System

12 Jany 4 — 1776

All the planets attract the planets therefore they disturb each other in their motion — The Sun moves & because they the planets are less disturbed than otherwise they would be — Sun agitation of twenty months the Jupiter

p. f 12512 revolution of mars Jupiter —



If Mars was at N and acted upon by Jupiter in a line parallel to J S he would not be disturbed the gravity of Jupiter to

When a inferior planet is in conj with a Super its gravity to the Sun is diminished & vice versa Count & about 54° from the

Of effects of the Sup. P. is to disturb the figure of the inferior planet & to turn of the aphelia motion forward —

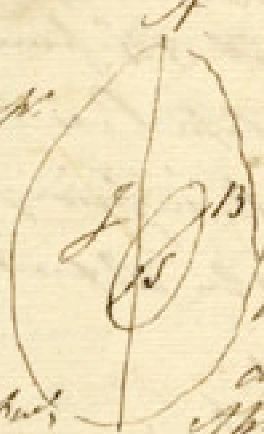
Aphel. of

M.	0° 24'	26	in a 100 years the Aphel. advance
V.	2 46	26	
E	1 25	56	
M	" 20	26	
J.	20	6	
Sat.	1	6	

The actions of the Sup. planets are the cause of M. of the Aph.

Action of Jup. Sat. greater
upon each other than the other

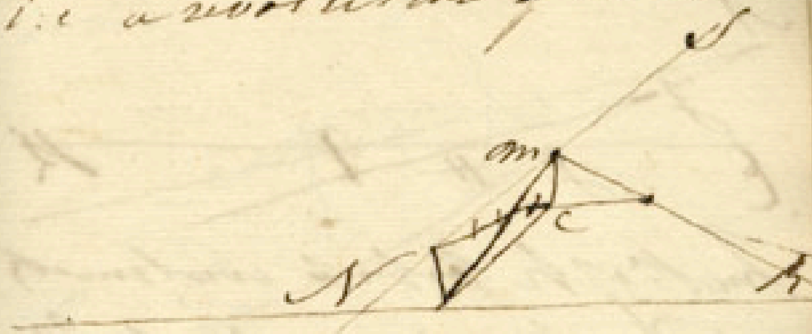
1/2000 of Jup.
on Saturn
sometimes
the longer
axis is
carried backw.



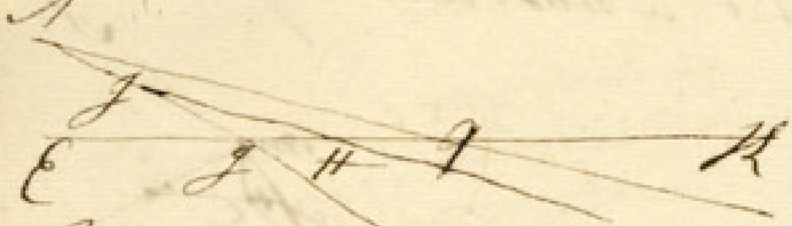
The Saturni on
gravity by
Jupiter
occasions the
weak differ
in Saturn
annual at the
Aphelion & perih.
backward & forward.

Attraction of a Sup. planet
accelerates and sometimes re-
tardates the motion of an inferior
but these are balanced in one
revolution. Action of Sat. very
remarkable in Jupiters Satell.
If all the Pl. lay in the same
plane then disturbance would
be the whole but on [illegible]

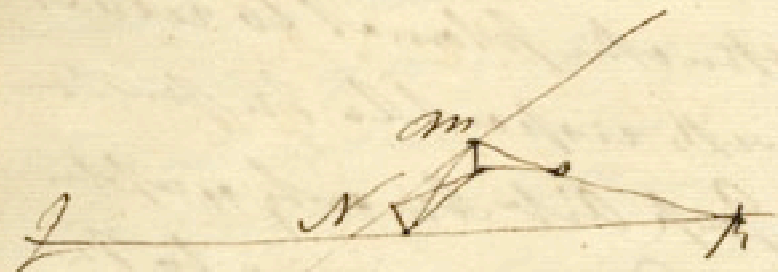
not the arcs another Constant
i.e. a revolution of the nodes



The Effect of one planet
on the orbit of another planet
is to make the nodes of the
other planet to retreat
with respect to the fixed or
Jup. Orb. the only exception
is advances owing to the
action of Saturn

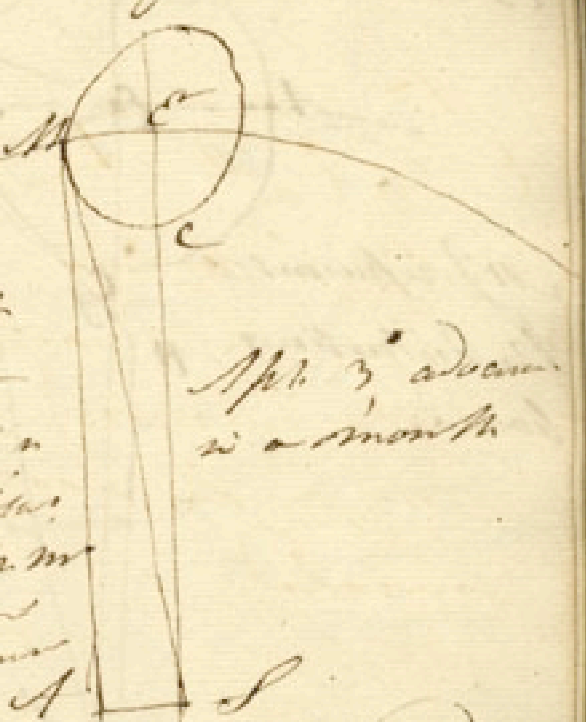


Inclin. of the orbit continually alters when approaching to the node it is increasing, when receding from the node it is diminished.



Node in motion continually to balance each other also the mean Nod. balance each other at the end of every revolution.

Perturbations in the Moon orbit



M E
1. 13²
1 : 179

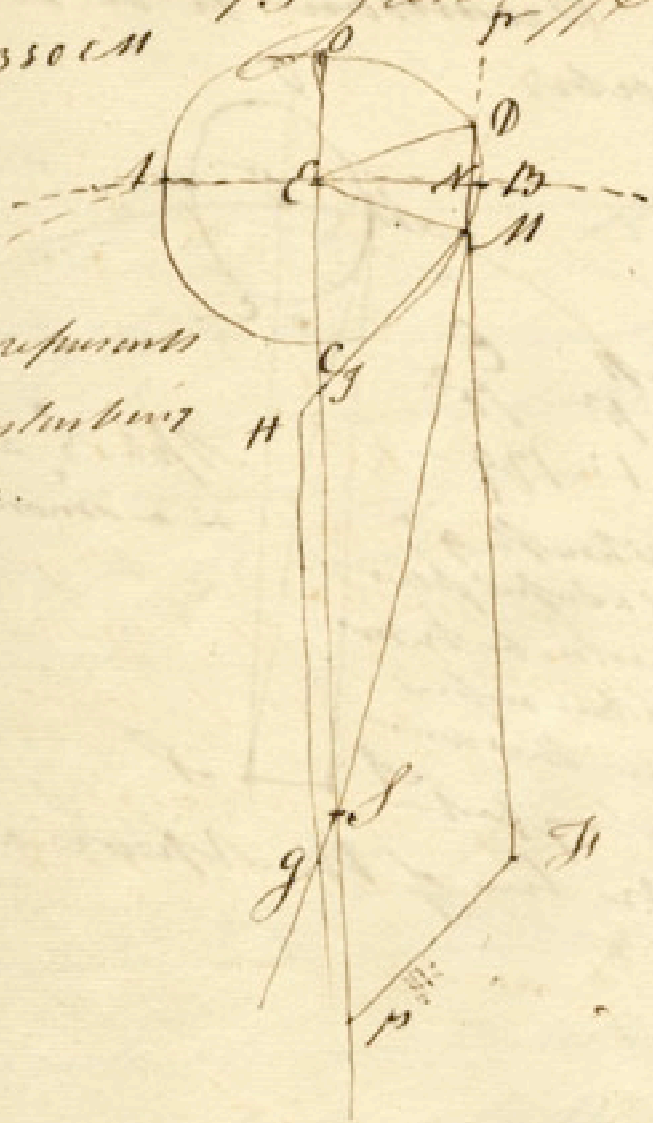
when the 9ⁱ of a Superi. plan. is under the M of the inferi. is under the sun is strongest

Apl. 3° advan. in a month

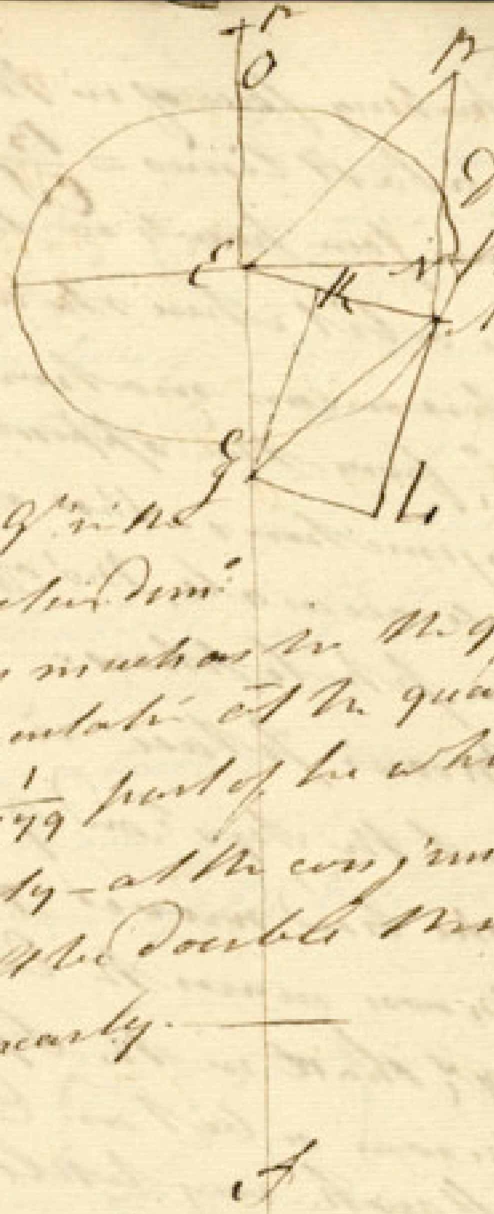
The line of the Apsides advance

15 Jan^y 1776

ET = 380 EM



MJ represents the Disturbing Force.



Moons G^y in the conjunction dimi-
-nishes as much as the quad^r
ure augmentation of the quadrate
is = $\frac{1}{179}$ part of the whole
gravity — at the conjunction
it will be double this quant
= $\frac{1}{90}$ nearly.

Perturbing force of in the moon at all times = $\frac{BC}{CS^3}$

There are four points in the moon orbit where she will have her mean motion — viz 45° from the oppositions and conjunctions this is not quite accurate, tho' often by some philosophers —

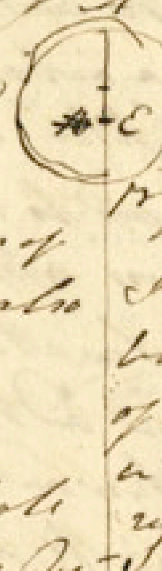
The Moon's place is the same at the Syz^s and Q^ds as if she had moved equally

The Moon nearer the Earth at the Q^s than in the Syz^s

The Moon orbit an Ellipse this will make very little error

Out from the Syzygy to 54°.35 —

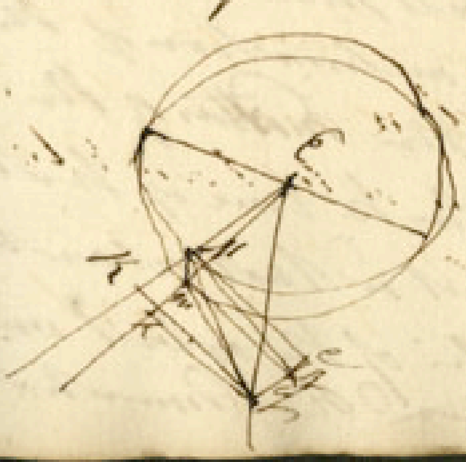
16 Jan^y 1776 —



Equ^n of the orbit is changed from 5 to 7½ — The position of the orbit is also altered

The diminution of gravity in the Apsides whilst they coincide with Syz^s they advance but when the line of the Apsides is in the Q^s they repeat —

Upon the whole the Lunar Apsides advance about 3° every mo^th — The Moon's orbit is inclined to the plane of the Ecliptic



The moon when leaving the node will by the action of the sun move in an orbit less incl.d to the Ecliptic by which the node is removed to the western - When the moon approaches a node the inclination of the orbit is increased & the node is still moved backward

When the N.s in the Syz.

When the Moon is in Nodes

Nodes in the quadratures

In these three cases the action of the sun will produce no altern either in the inclination of the orbit or in the motion of the nodes - When the line of the Nodes lies in the first and last octants the inclination of the orbit will be more near the ... months and

Nodes in the q.s Moon in the Syz.s produces the greatest incl.n

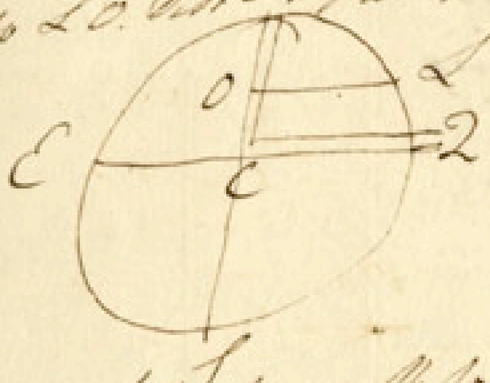
These Circumstances are all but once supposing the force of the sun the same - In winter the line moves is about 24' greater than in Summer this owing

17th Jany 1776

Of the figure of the Planets

was the earth fluid it would
necessarily be a sphere but the
centrifugal force will alter

Any particle L will recede
from the center with a force
:: to L O. Dist. N from the cent



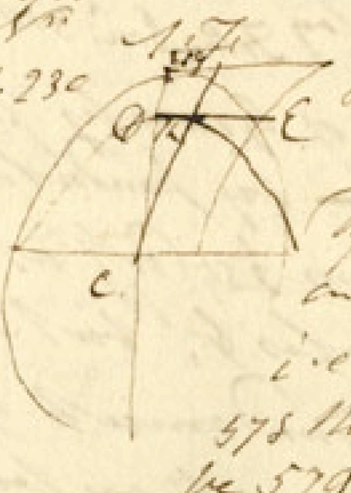
Measured from the north to the Center
and from the center to ~~the~~ Q
Whirling rings show the figure
of the earth, but not justly
because there is an Auxiliar
force which is not in the earth

The same thing will happen
tho the earth be partly sphere
and partly [illegible] — As the Moon is
[illegible] high at the Equator as
at the N. we may conclude the
Earth has yielded to this force

To determine the figure of the
Earth $\frac{2}{4}$ such a part. centr. F.

$\frac{1}{289}$ of the gravity of the particle
on the Equator = Cen. F.
[illegible]

229 to 230



Difference E. O.
in [illegible] $\frac{1}{578}$
i.e. of the Eq. D is
578 the polar will
be 579 —

this will be the case if the Earth
is a homogeneous body

Gravity of any particle is not
towards the centre but a little
towards the Equator. it is also
altered by the super-incumbent
matter at the Eqr. on both of
these accounts the earth which
than it would be from the C.F.
True figure can only be had by
mensuration alone — these have
not been made with sufficient accuracy
plummet deranged — 304 : 305
210 : 211
hill — Observatory Father Boni 310 : 311

Diminution of Gravity found
another way — by pendulums
If a pendulum $\frac{1}{289}$ Diff. at the
Eqr. & the poles &c. but the
difference is found much greater
in pendulums than by the
measurements, by wh. the E

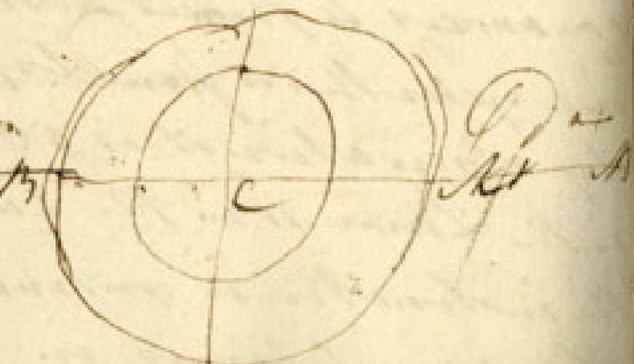
In Jupiter the axes = 9 : 10
or by Mr. Bosh: 12 : 14 —
In the Sun $\frac{1}{3700}$ part Diff —
a quantity too small for observ:

A ring of moons adhering to each
it would undergo all the changes
that take place in the moon
Diminution till it touches the
earth the consequences &c — Math:
at the Equator constitutes such
a ring. The joint action of the S
and M on this ring makes the
equinoxes to precede about 52''
in a year this is found by calcul
— by observation it is 50'' also
in the Lunar so in the Earth's
the inclination is continually
changing 4 times in the
year sometimes slower & faster

The poles of the Earth will
in 25920 years thus vary by

Of the Tides

Earth and moon tend to
each other — Every particle
on the surface of the Earth will
have its G.y diminish by its
tendency to the moon — This
would be in those solids & waters
accumulate on the waters
Elevation on both sides



Tides — inequality of the Sun's
action on different parts of the
earth and the difference of the
centrifugal force arising from
the rotation of the Earth and moon
round their common center of G.y
Elevation under the moon &
than the opposite.

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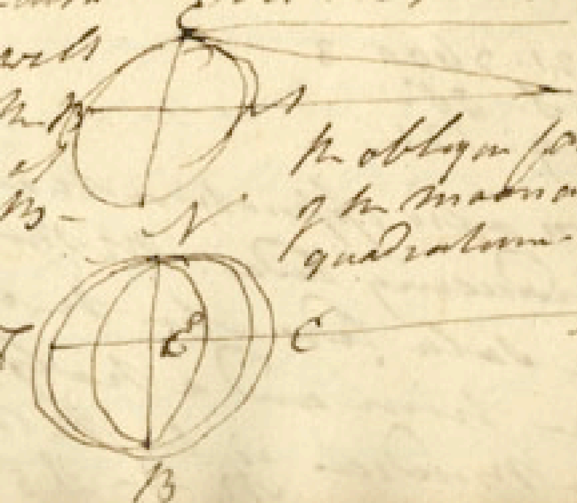
This is a third cause of the
Tides. The greater attraction
of the Earth on the particle
at Earth
rain the B
water at
the B —



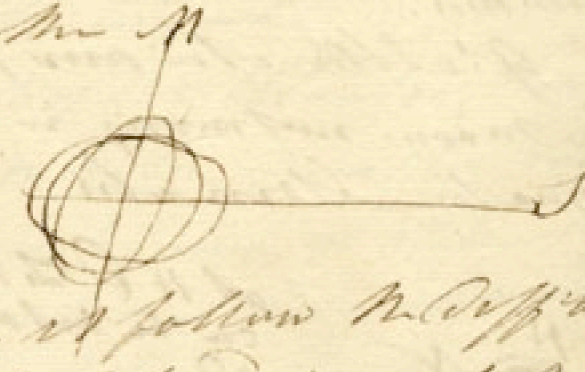
the oblique force
of the moon on the
quadrature —

By the revolution of the
Earth from West to East every
place would have two tides in
a ~~tid~~ day – Moon moves to the
east – high water not when the
moon is on the meridian. If the
water met with no resistance
high W would happen 3 hours
after the moon passes the Mer:
but the friction of the water the
tides are altered 1½ or 2 hours after the Mer. pass
of the tide under the moon –

3721 : 3600 3
C S. OS
119 : 121

Sun also operates on the earth
in producing tides. We should
have solar tides when the sun
is an hour and a half past
the meridian is by the Moon
M $\frac{1}{30}$ S 5625

At the time of new and full
the tides ought to be greater
But when the M: is in the
quadratures. the actions
of the Sun and moon oppose
each other

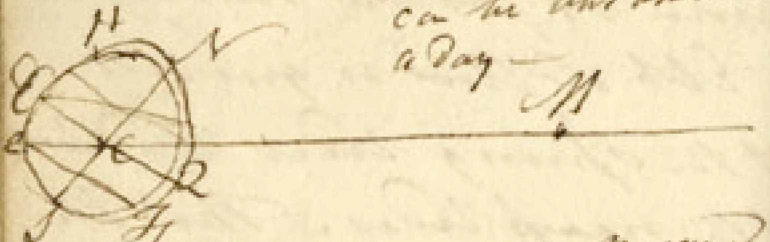


hence it follow the diff. betw
the Ebb and flood is greatest
at the spring tides and least
at the neap tides. Tho' the
action of the Sun is greater
than that of the Moon on
the earth yet tides follow the
moon because the diff. of the action
on the surface; center, and opposite
of the earth is much greater than

that of the sun on account of
his great distance from the earth.
All disturbing forces are in
the moon :: C³ therefore the
tides greater in winter than in
summer.

Q: Alternate ones for
the moon not moving in the
Equator — Sun also

A H C The tw-
ce be two one tide
a day —



when the moon is on the same
side of the equator with the spect.
the day tide is the greatest and v:v.
when the moon is under the horiz:
& the Equinoxes the tides ought
to be nearly equall

That the tides may have
their full effect it is necessary
that the sea should extend at
least to 90°. Hence we can expect
no tides in the Medit: Baltic.
A greater tide at to the north
& south of the Atlantic, than
in the middle. Great tide in
the English Chan: on account of
its situation — Tide up rivers &c
happens latter. Tides in the
German ocean — At Dover very
irregular on account of Brit
situation between two seas.

M ⊙ E
1 : 35000000
1 : 13,000000 } 1 : 2.69 / M S 2½ : 1

1 : 44000
E & 90000
raised by moon

Effect of the sun to
raise the water about
2 feet

Here an argument in support of the Copernican Syst.
From the different actions of the sun and moon on the tides we calculate the quantity of matter in each &c. by proceeding in this manner we find the center of gravity between the sun & earth within the body of the sun, and the center of G^y between the Earth and Moon is the point which Thung places it, and which observation confirms.

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Of the Aereal tides —
— The change in the Atmosphere would be $\frac{1}{50}$ Inch which would be be observable in the Barom: of the Atmosphere was = density of Earth. — But the Earth is ten [illegible] not so high — and much rarer —
— Trade winds owing in a great measure to the aerial Tides
— Suppose the moon covered wt. water Tides in the moon = 94 Feet
Suppose this mass should freeze or turn solid and projected round the earth. The action of the earth on this egg like figure by accumulation will at length bring one side always to face the earth. This motion not

10 x All Mo: un: Method

of any given line will move
thro' twice the space in the
~~same time~~

11 x 10 Any body falling thro' a given
space acquires a velocity which will
carry it thro' twice that space in the
~~same time~~

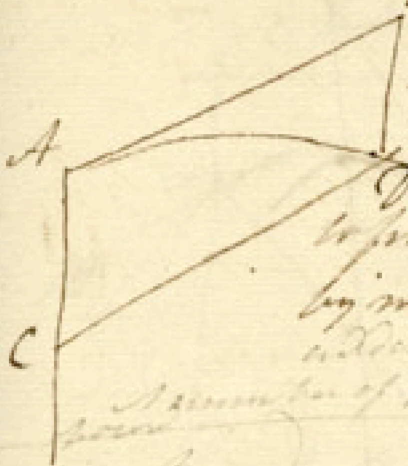
$32.2 = g$ | h = height
t = time
v = velocity

$h \div \frac{t \times 32.2}{2}$
$v \div t \times 32.2$ } these three formula respect bodies ... ing
$t \div \frac{\sqrt{2h}}{5.674}$ = sq root of 32.2

$t \div \frac{v}{32.2}$ rising to any height with a given v.

$h \div \frac{v^2}{64.4}$ = to which ~~the~~
a body will rise } these two formula respect bodies let fall from any height

Bodies projected obliquely



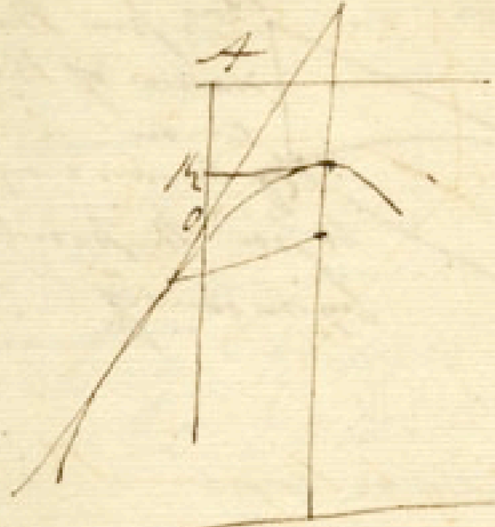
To find the nature of the curve

Common way is to find the points D by means of the a... ... formula:

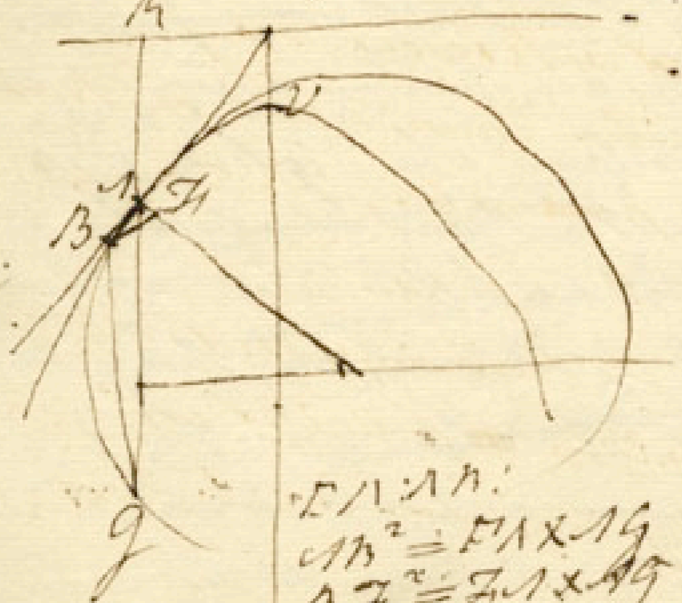
A number of points are thus given

A 24 pounder would throw a bullet 4 miles perpendicular if it met with no resistance from the air, but on account of the resistance its height changes will not throw it above ... of the height a little more; therefore the gravity of any body at all the different distances from the ~~circle~~ earth which we can make any experiments on may without any sensible error be supp...

parab.



22 Jan. 17



$\Sigma\Lambda : \Lambda K :$

$AB^2 = \Sigma\Lambda \times AG$

$AZ^2 = Z\Lambda \times AG$

22d Jany 1776

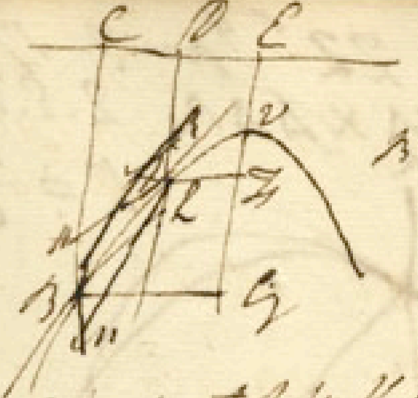
$BZ = ZA \times \Delta AR$ 2.E.D.

$\Gamma \div \frac{v}{Ch}$

If a body falls from K to A
and then projected along AB
it will describe a parabola
whose Diam. is AD, and KA =
¼ parameter, AB Tangent.

1st Corrol.

Vel. at any point in the Curve
will be = to the Vel. acq. in fall
from the Directrix to that
point.

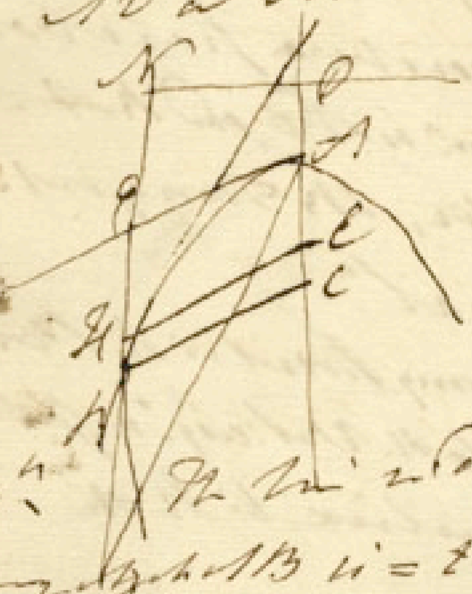


$AC : AD :: v^2 : v'^2$

II. V at ath the V, B and H

u BK

III. Times of describing the arcs AV and VB :: DE and CC



4. The line of describing any arc AB is = t the following thro' AC

$t^2 FB : t^2 GC = \frac{FB \cdot GC^2}{v^2 B : v^2 C}$

$t^2 FB : t^2 GC = \frac{HB^2 \cdot HC^2}{BD : CD}$

HB : HC :: BH : AV

5. t Dv : AB = t Dv : AE with an uniform motion at A.

The penetration of a great — in cannon — point blank at 1000 yards distance away to the cannon being thicker at the breach than at the muzzle — of some use in taking shot along the Ditch &c by Mr Vauban — Observe use of the ... for bomb shells.

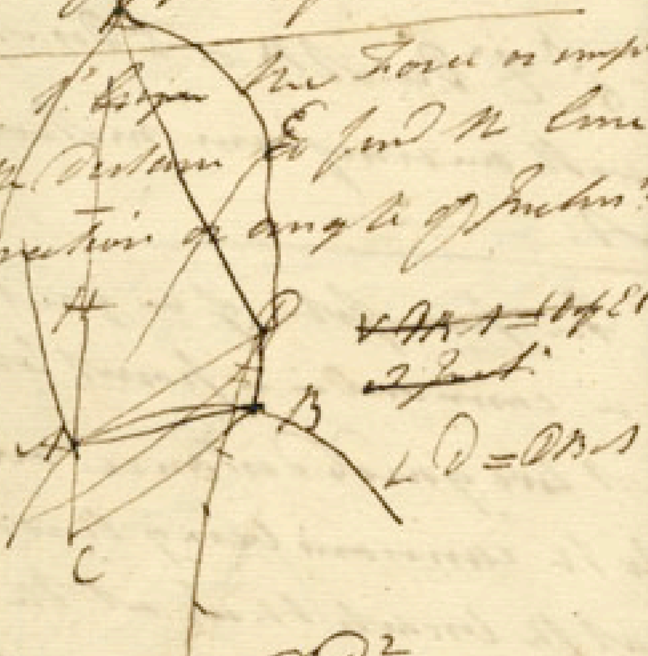
Weight of Shells

1 Q^n Z^{12} ad D^t = Line of Direction

11 Q^t. D^n D^n = Force or q^y

111 Q^n Qm Q^r b/r Time

Case 1st Given the Force or impe[tus] and the Distance to find the line of Direction or angle of Inclination



~~∠ AK = 11° 8'~~
~~2 feet~~

∠ D = DBS

$DK \times AK = AD^2$

DK . AD = AD : AK

!

Mr. Vauban first introduced the method of throwing cannon balls parallel to the Horizon with small charges of powder, chiefly designed to kill men along the trench. — Besiegers begin batting upon the out works n— when them about 4 or 500 yards distance. — They approach nearer & so — till the arrive at the ditch about 80 yards from the foot. — As the besieged are un— nearly secure from horizontal shot it is necessary to be able to hit them in another direction.

Hence the invention of bombs, wh. are thrown so as to fall nearly perpendicular to break roofs of houses powder magazines &c.

The whole business of Gunnery
may be reduced to three probl.s

1.st Having given the Force and
Distance to find the line of
Direction; or angle of inclin.n

II. Given the Direction and ~~Dist.~~ Imp.t
to find the ~~force~~ Range

III. Given the Horizontal Dist.
and Direction to find the Impuls.

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Greatest range when when the angle
of Elev.n is [illegible] that they be
placed in their situation by means
of a mirror and a plummet. When
the object reflected in a horizontal
when the angle of Elev.n must be 45°;
Horizontal ranges at diff.t are ::
sines

It is difficult to trace the path
of a single body because it leaves
no trace — but this can be
done by other contrivances —

Exp:- Fountain — ~~Curve~~ line more
curve near the place of fall – This
very remarkable in a shell —
time of the rise of a shell to its
fall, at Woolwich is as 5 to 3

range above 45 should then
the corresponding ranges below

Horizontal range more than
twice the Projection by experiment —

12°	448 (780)	
10	330	should be 6 times
8°	690	
4°	600	= about [illegible]

To find the Projection
by recoil of the piece — To yds

ball 3/4 Inch Elev: 45 with 5 out of 35 parts fine powder		1700
24 .. 16 " 45	"	1650
Elev: 16 miles		400
19°		
[illegible] 450		700

8° [illegible]
1400 ([illegible])
1690

Causes of the difference between
the Theory and experiment —
the Resistance of the air greater
in great velocities in proportion
than in smaller — i.e. each square
of the velo: until 1066 feet p. sec
between [illegible] 1100 feet the resistance
increases very fast it is doubled

II. Gravity of the projectile body

according to its resistance

[illegible] [illegible] more than

[illegible] from shot more than

wood &c.

---

1. Exp: A ball at a [illegible] of [illegible]

[illegible]

25	1670	}	velocities $\frac{1}{32}$ second
75 :	1527	}	127 as a medium
125 :	1429	}	

& its weight

[illegible] $\frac{1}{121}$: 1 weight $\frac{1}{12}$ = 10

at leaving the piece

III. Difficulty of directing the

piece — windage — [illegible]

it leaves the piece it may not

go in a straight line. This

remedied in mortars by wedges

The properties of a jet of water

may be easily measured it

is equal to the perpendicular height

which should by the theory be

= ½ horiz: range at 45° by Exp:

however it turns out little less

than the whole range.

By the theory the time of rise

should be equal to the time of

fall, in small projections this

is nearly the case, but in mortars

it is very different. Exp: At

the time of the rise of a shell

thrown to the distance of

to its fall was nearly as to

By the theory the horizontal

ranges above 45° degrees should be

equal to the correspondent ranges

below, but they are found by

experiment to be much shorter.

The imperfection of a piece of
Ordnance cannot be so exactly
measured as that of a Set —
It may however be determined
pretty nearly by the recoil —
The recoil of a piece will be ~~in~~
in :: to the force impressed on the
bullet, as the weight of the bullet
to the weight of the piece. By
knowing the recoil in small arms which
may be found by suspending the
we ~~can find~~ know tolerately exact
the imperfection.

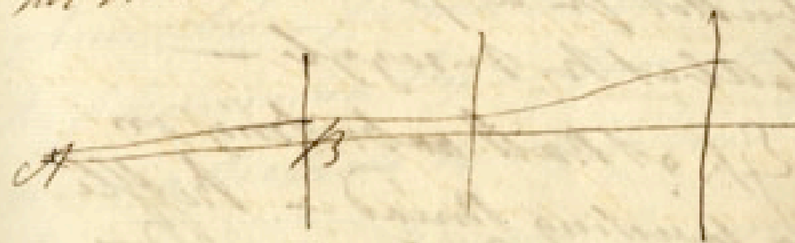
Since the results of experiments
are so different from those of the
theory, the theory is of little use
to direct the practical Gunner —
The causes of this deviation are
1st The resistance of the air
this increases as the square of
the Velo:y nearly, consequently
the greater the range, the gr:
will be the deviation, In experi:
made in a room the deviation is
small, but very great in Shells
The deviation will also be much
greater in light than in heavy
bodies, because the resistance of the
air ~~will be~~ bears a greater ::
to the former than the latter. —
hence the deviation of water is more than
an iron bullet. &c.

11. Another cause ~~cause~~ of deviation
is the difficulty of directing the
piece to the object, or to any angle
of elevation, this arises from the
shape of the cannon or mortar
It is thicker at the breech than
at the muzzle. Besides the windage
may occasion a considerable
deviation. This last cause may
be partly remedied by putting

into the mortar pieces of wood
in the form of wedges very thin
at the upper end between which the
shells is kept in the middle of the
chase. —

The Impulse may also be
found tolerably exact by making
a bullet strike some obstacle
that may be carried along with it
such as a piece of lead. By this
means the impulse may be de-
termined within $\frac{1}{40}$ of the truth.
In this manner Mr Robins tried
the following experiment —
A bullet $\frac{1}{12}$ lb weight was thrown
25 Distance its velocity pr second 1670
Again it was thrown 75, its vel.
was then found to be 1527. It
was again thrown to the distance
of 125 / its velocity was then found
the resistance to the weight was found to be as 121:1
that is the resistance at leaving the

piece was about ten pounds —
Whether or the flight of a project.
it should still move in the plane
of that figure. In this respect there
are great deviations are observed
flight neither in a horizontal
nor in a vertical plane —



Mr Robins shows the cause
A bullet has not only a motion
of progression but also a motion
of rotation. This is evident in
bodies thrown by the hand
also in shells as seen by
the grooves in the weight
the last stroke which the
bullet receives on leaving the
piece determines the axis of

24 Jan. 1776

rotation. Exp. by A Motion

the fire bullets were prosper

screws from a Gun fix'd firmly

to a block of wood – this

was confirmed by finding a

bullet for a Gun bent a

tilt at the muzzle –

Exp. A Ball oscillating on

a twisting thread – Riffle

Gun. Screwd chase remedies

this deviation

What is the cause of Gravity

Descartes Vortices – Other Phil.

attribute G.y to the action of

a fluid – Action of Grav. by

as familiar as percussion &

the two sets of facts are equally

observable – In order to explain

the phenomena by a fluid we

must attribute to this fluid

properties unknown to every

other fluid.

Of Motion communicated by Impulse

Forces of bodies in :: not to the squares of their velocity[?] tho' this was attempted to be dem: by Leibnitz by three sorts of experiments I. bodies thrown upwards. II. Bodies striking against soft bodies. III. Bodies bending springs. —

When two bodies have the same Q. & the same velocity the forces will be equal. — Expt. two equal pendulums of soft clay let fall from the same hight will destroy each others motion, of the directions are opposite. — The destruction of motion by opposite motion is a proper test of the equality of forces

Expt. — A ball of Clay let fall from 2 another half the quan: from 2 in opposite direction destroy each others motion here the V. are inversely as the quantity of matter

Hence the forces are :: velocities

To examine Leibnitz Expt. —

it is true that a body projected with 4 times the force will rise to 2 distance — three kind of obstacles objects that are immoveable with regard to the striking body. II. A resistance which the body can just overcome and no more. III. A resistance from an obstacle which a striking body can carry along with it.

25 Jan.y 1796

Huygens Mariotte Graves: Leibnitz
maintain forces are :: to the V.2 the
end of their action —

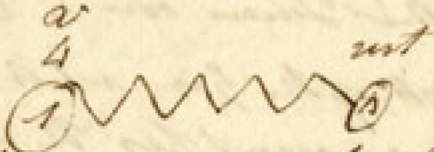
Phil: Hist. they are speaking of the
moving power whereas the [illegible] in reality
speaking of the effects. Hist for
is Defined [illegible] dispute is vain, this
cannot be done abstracted from
quantity. Only a conception
of force a good definition i.e. the Vel.y
is a proper measure of force. If
the German ph. mean by the sq Vel:
a definition there can be no Error
but he is not content with this
they attempt to prove that the
forces :: V.2 They take for granted
that the heights are the measures struck
of the force, this is not the whole effect
effect, the time must also be taken
into account. ...

steady progress 32 feet in a sec
with [illegible] from [illegible] the force [illegible]
64 feet but then it takes 2 seconds
therefore the Forces are :: V.2
by the Hyp: of the Ger: it is im-
possible to account for the collision
of hard bodies

A body striking a soft body with
double the vel: makes 4 times the im-
pression — this does not prove the F. :: V.2
because each particle of the soft body
acts but for one half of the time.

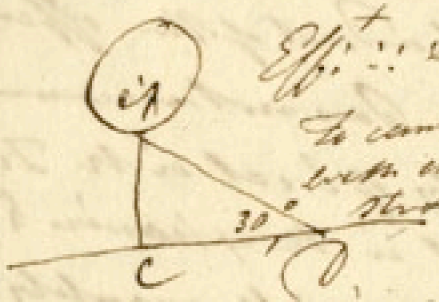
We have sometimes a measure of
force independent of the effects
Thermometer does not measure
the quantity of heat in the Fire
but its effect in the expansion be-
tween the Ther: the quantity
of heat independent of the effects
a pint of [illegible] water a pint of Do:
[illegible] double the heat —

A non elastic body 2. B goes on
with 2. — But other El: Above
its whole motion. that of both



El.t B will move backwards
[illegible]: Effect is that by [illegible]
with interchanged V.

If the impulse is made obliquely
the whole force is not employed
in producing the stroke



Eff.t :: Sine ∠ [illegible]
To compare direct
with an oblique
stroke: multiply
the vel.y into the sines of the incid-
-ence angles i.e. radius, and the
angle of incidence — Useful —
a ship sails, [illegible]

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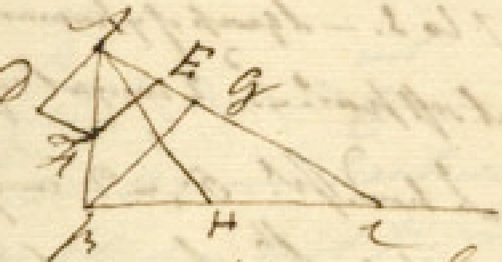
[illegible] will rebound with a vel.y
:: to 7 to 8. — Square of ½ [illegible] —

1. 2 equal soft bod.s — 3. 2 unequal soft bo.
4. [illegible] equal hard bod.s 5. — 2 unequal
[illegible] bod.s 6th — 2 equal El: bo.
— [illegible] to [illegible] [illegible]
[illegible] — When the V.s are
small not above 70 F.t per s.d
it will :: nearly as V^2

Gen. applied to motion on -- inclinations



AC : AB :: Wt. plane : Long plane

Wt. force along the plane is constant. therefore all the equations of perpend. ascents and descents are applied here A B and G

AC : AB -- times of descending as the length of the plane to the height

, Cort.

Then the motion along an incl. plane is uniformly accelerated as it always was descending

5th

1 A : III : V 0
K : IV : VI : 0 ch

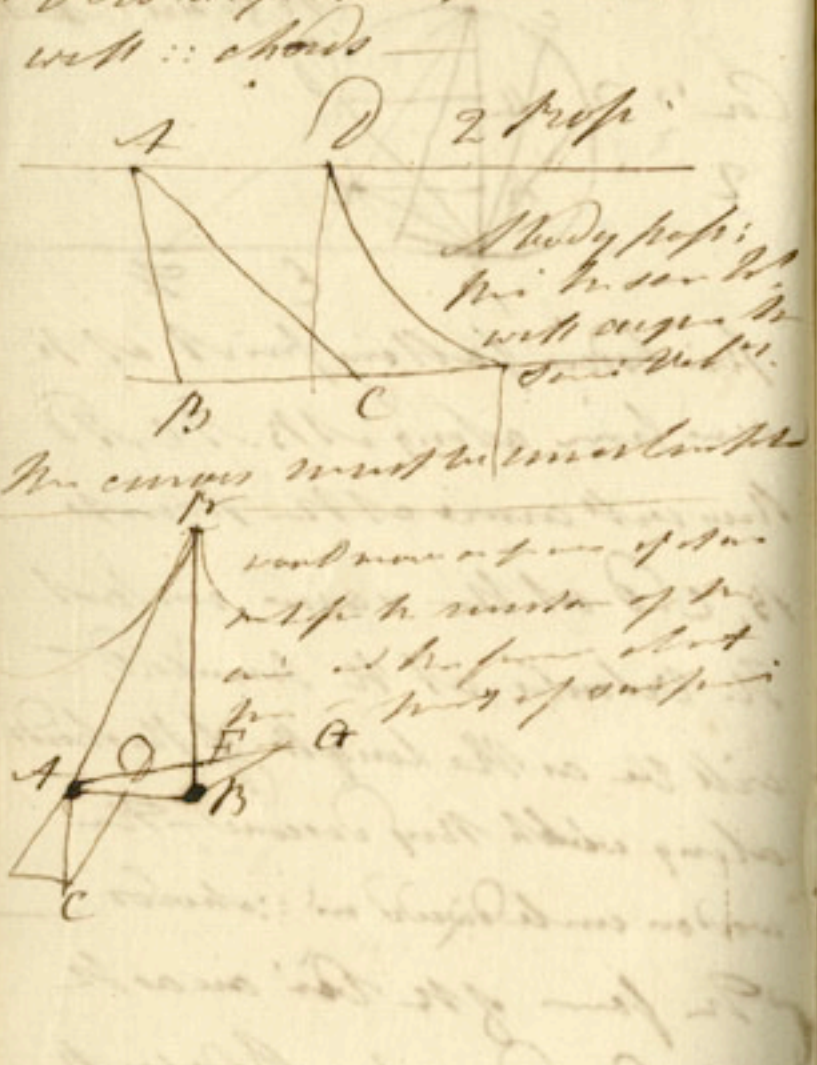
A : 3 : V : 0
K : IV : 6 : 0 met.

14

Velocities along AB AC are :: AD AB

Cor 4 2

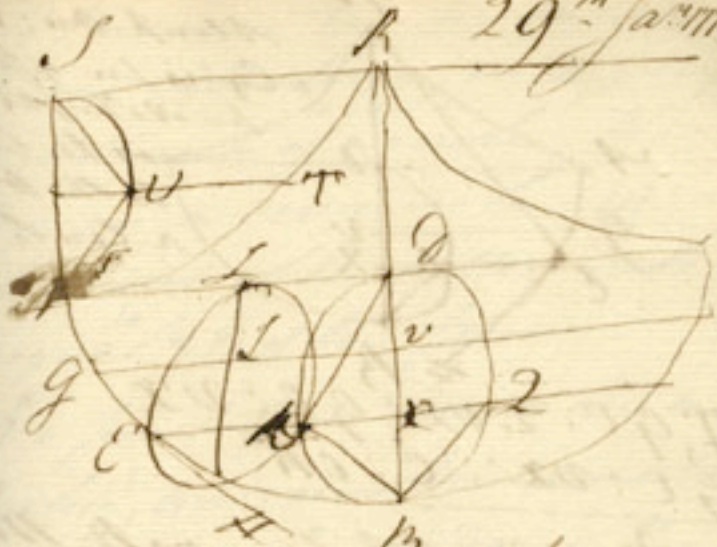
The bodies falling from A at the
same time along AB. AC. AD
they will arrive at the points
B, C, D at the same instant
The velocities at the points B. C
will be as the lengths of the chords
along which they descend — the
momentum acquired are :: chords
The forces of the bodies are as the
chords of descent — Bodies will
descend along the diameter in the same time
along any chord.



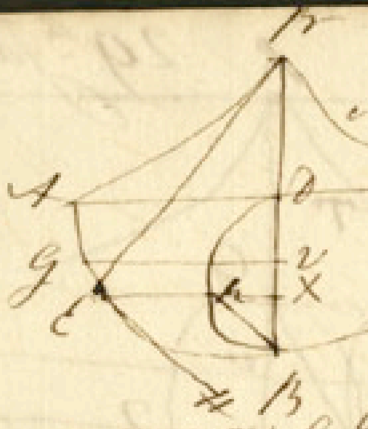
Saturday – 27th Jan.y 1776

A Lecture upon Comets —

29 Jan. 1776



AC = circumf. of Cond.
AG = GE
EH = KB ch.
EB = 2 ch. KB Gen. Cond.
hence
AB = 2 OB
GE : VX :: PK : KZ
& AB betw. AK and KC in KC



Mark: Arc: in
Cyc: is twice of the
ditto
as the Arc:
to the D. of
a circle

T, GC : T, VZ :: GC : VZ
GC : VZ :: C : Ch

times^2 in diff. Cy: are as the
heights of the Cycloids — or the
times as the square roots of Heights ~~squared~~

Times of any vibrations in a
Cycloid are all equal

$T^2 = \frac{S}{F} = \frac{S}{S}$

If the vibration of a circular
pendulum are in a smaller
they are equal nearly.

v : v
29 : 34

Cy { 86400
arch { 86401. $\frac{2}{3}$

If there are two pendulums
the one vibrating in a very
small arch of a ~~circle~~ cycloid, the
other in a semicircle 29
vibrations of the latter will
be equal to 34 of the former.

If a pendulum moves in a
Cycloid, and another describes
an arch of 1° 86400 of the
vib. of the latter will be =
86401$\frac{2}{3}$ of the former.

Time of a small Vib. will be nearly
as the circumference of a circle to
the D. —

Very small V. are in the sub-
duplicate ratio of the length
i.e. a pendulum to vibrate
twice as slow must be 4 times
the length.

This foundation is made to describe two different curves, by supposing an object [struck through] at the string, it will notwithstanding rise to the same height on both sides.

31st Jany 1776

Experiment found: with [struck through] ascend the same height whatever is the nature of the curve of Descript

Application

[redacted] Glass—wt Glass—Carm—

Tenbrun

— of Also a curious to G— Sun Dials by Anaximander—Acct brought to Syr to Rome—

Inaccurate from the equation &c

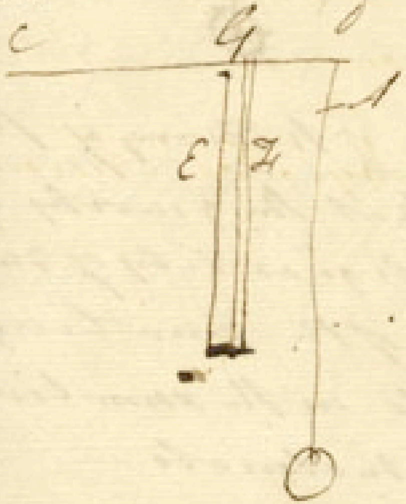
About the 7th & Century water clock a curious one by Tenbrun, where the vessel was so shaped that the water run out equally— Some was made with a wheel turned by a spout of water. First clocks were regulated by a fly like a Jack— Imperfections— Afterwards it was

improved by changing the pro-
gressive motion into a recipro-
cating Mo. – Balance — Dr.
Hook greatly improved this Mo.
by adding a spring to the verge
of the Bal: – Watch – the quicker
watches move so much the better
they are. common ones about 5
beats in a second. – Harrison's
watch — his improvements
cannot be introduced into a com-
mon watch on account of its size

N.B. this day Far: Thermometer
at 14°, –

1st Feb.y 1770 –

Either increase the anchor or the
quantity of Mo. in the pend:, in order
to increase the momentum. The first
method seems the best – common
A Clock kept time within a second
p. Annum – Heat expands the rod –
Mr. Graham's Merc:l pend:m wo–
Mr. Harrison's compound pen–
dulum –



Harrison's pendulum

Another use of the theory of pend.^m is to prove that the gravity of any body is :: to its quantity of matt. pendulums of the same length will vibrate in the same time whatever the materials —

Hence we can very accurately determine the time of the descent of heavy bodies - which cannot

be don accurately any other way.

22 : 7 :: TV ~~the~~ time fall $\frac{1}{2}$ pendul.

22 : 7 1 : .315 time $\frac{1}{2}$ the pendul.

1^2 : $.315^2$ :: 19.6 : 193.3 = 16.11 feet

.315 : 1 19.6 : 193.3 = 16.11

this gives us a very accurate meas. of the accelerating power of gravity

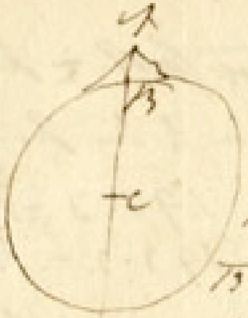
If we find the same pendul. makes a greater n.^o of swings in a day we may conclude the power of G^y is increased

M^r Condamine

Vib.

98770 } in a day near the
98740 }
98720 }

M^r Bouguer { 1^st B 439.7
438.9
438.7 = 24.4 feet ~~24.4~~ about the ...



1348 = BC
1349 = AC

that is the hill is $\frac{1}{1348}$ of BC —

1348 : 1349 :: 439·7 : 439·1

$1348^2 : 1349^2$ :: 439·9 : 440·3

hence the gravity as we ascend from the surface does not diminish so fast as the D² — Here the deflection of the plummet was not taken into account.

These experiments will also shew in what :: the gravity decreases in diff: Lat! This has been done but the calcul: shew that grav! does not decrease :: centrifugal force situation of observatories must be enquired into

In order to increase the momentum of a pendulum we must either make the pendulum very heavy or make it vibrate in large arches: this last seems to be the best method. Because when the pendulum is very heavy it communicates a mot! to the case or supports of the clock which alters the vibrations of the pendulum —

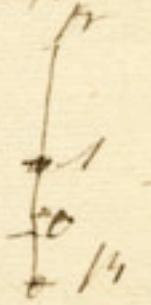
By the pendulum we obtain a very accurate measure of the time of falling bodies. For the space of a second is so short that we could not observe within $\frac{1}{5}$ or $\frac{1}{4}$ of the truth. but by knowing the :: of the times of vib. to those of falling bodies &c. we can find the time of descent in a second. By making the pendulum to perform 86400 vib. in a day we get one vib. in a second very accurate. —

2. Feb.y 1776

Matter of pendulums not at rest has a point of Oscillation in a power not in the center of the power but $\frac{2}{3}$ from the point of suspension

Eg. A prism and a ball $\frac{2}{3}$ of the power are Isochronous —

Two equal balls one at the middle and the other at the end of a power, will be Isoch: with a pendulum $\frac{5}{6}$ of the power, and not $\frac{3}{4}$ —



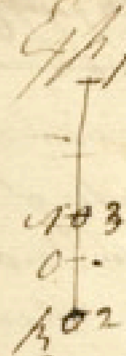
$1 \times 1 = 1$
$1 \times \frac{1}{4} = \frac{1}{4}$

$1 \times 1 + 1 \times \frac{1}{4} = \frac{5}{4}$
$1 \times 1 + 1 \times 2 = 3$

$\frac{5}{4} \div 3 = \frac{5}{12}$

$N.B.$ This afternoon a thaw —

2d. Expt: Calculation



PA. = 2   2×4+1×9=17

PB. = 3   2×2+1×3=7

$PO. = \frac{17}{7} = \frac{17\,PB}{21}$

divide PB into 21 p.

PO will be 17 of them

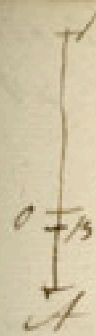
3d Expt

PA = 1   1×1+1×4=5

PB = 2   1×2−1×1=1

$PO = \frac{5}{1} = \frac{5}{3}\,AB$

The Centre of Oscill. is found by a fraction whose num. is the product of each part of the matter into the square of its dist: from the point of suspension and the Denom.



Moment of any particle

$x^2 \times \dot{x}$ fluent is $\frac{1}{3}x^3$

$x\dot{x}$ $\frac{\frac{1}{3}x^3}{\frac{1}{2}x^2} = \frac{\frac{1}{3}x}{\frac{1}{2}} = \frac{2}{3}x$

Therefore $PO = \frac{2}{3}AP$

In this calculation the thickness of the rod is not taken into account this will make some alteration in the Vib.

Expt: If a triangle vib: about its vertex the centre of Oscil: will be 3/4 from the point of Sus: this is more accurate when the triangle moves edgewise.

Expt. Triangle with a great base moving edgewise slower than otherwise —

Exp. A pyramid Δ about its vertex the Cent. of Oscil. at $\frac{4}{5}$ whole length

To find the Centre of Os: of a sensible pendulum

2a = radius of the ball

d = dist. Centre of the ball & the point

$$pO = d + \frac{2a}{5d}$$

i. e. a Second pendulum —

$$d = 39 + \frac{2}{195} = 39 + \frac{1}{92} \text{ of an}$$

Inch from the centre of the Ball

This difference will cause a difference only of 1 Vibration in 24 hours.

3. Feb.y 1776

Hardness softness Elasticity and Ductility

A body perfectly hard is that whose parts cannot be changed as to situation — Particles separated by fire — Phil. apost that the constituent particles of all bodies must be perfectly hard, this is a hasty conclusion. the various appr may be accounted for by the change of the laws of nature

2 kinds of hardness 1 a resistance to change of figure, 2 Resistance to a separation of parts. Example Soft Iron and hardened Steel —

Soft bodies are such whose parts separate, or those parts change with the least force impressed

Soft bodies are ductile, & pliable

If a body is said perf.y hard or soft but requires a constant quantum of power to change its figure, it is said to be elastic or springy — no body perfectly so Glass 15 & 16 parts. Ivory as 14 to 13 next hardned steel next. Imperfectly Elastic bodies will not always recover their figure — a piece of wood modately bent will recover its position nearly, but bent further

Monday 5. Feb 1776

No Lecture this day — Professor indisposed — — — — — —

Tuesday 6th Feby 1776

Math[illegible] abstract of Eqm. [illegible]

the Body — [illegible] ought to be [illegible]

[illegible] working state — [illegible]

[illegible] easy [illegible]

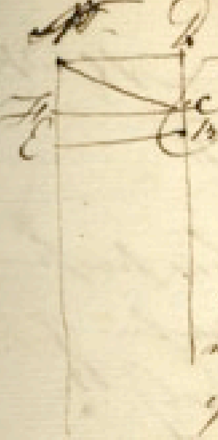
Mathc. [illegible] [illegible]

on the subject of Mechanics

considered as [illegible]

of Hydr. Hydraulic & Pneumatics

Gravity is supposed to act in parallel lines



$B \times BD$ = effect [illegible]

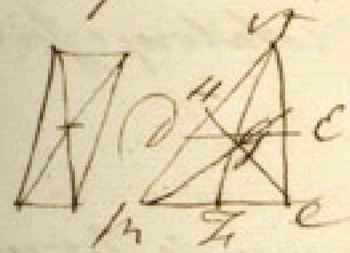
$B \times BC$ &c $= M \times P$

$$\frac{B \times BC \&c}{M} = P$$

Center of grav. [illegible] will be same with the center of the body [illegible] near the earth

But this is not sensible in all bodies we can [illegible] any experiments on —

To find the centre of Gr.



$gT = \frac{1}{3} AT$

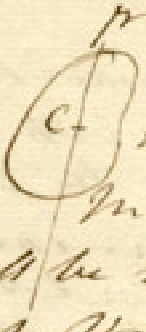
$$x = \frac{bx^3}{\frac{1}{2}x^2} = AG$$

or $\frac{bx}{\frac{1}{2}} = AG$ i.e. $AG = \frac{2}{3}x$ [illegible]

of a Cone

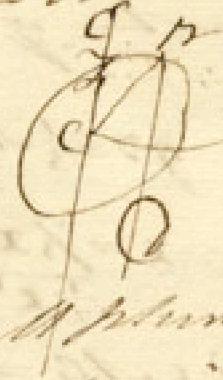
$\frac{\frac{1}{4}\pi x^4}{\frac{1}{3}\pi x^3} = AC = \frac{3}{4}x$

$AC = \frac{3}{4} AH$



where a line passes thro' the Centre of motion and of G^y there will be no motion

But if the V L does not pass thro' the Centre of M^n and G^y there will be a motion

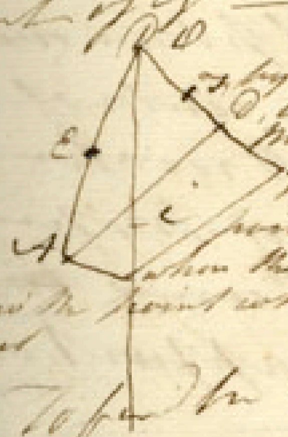


rotatory effect

From all phenomena there every irregular will be in the direction of Gravity: this affords another method of finding the centre of Gravity

hang the body up by two different points

This may also be found by laying the body on a table the line V the pressure gives the centre of G^y



If a body be suspended by two threads at the point D, it will rest when the V line passes thro' the C.G of the body. If susp^d from two points E & F it will rest when the line thro' C.G passes thro' the point where AE, DF produced would meet

To find the Centre of G^y

multiply all the

7th Feb. 1776

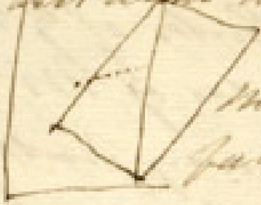
Mr. Properties of the Cent. Gy

When the Center of Gy. is supp.
the body will be at rest —
If the Vertical plane does
not pass thro' the center of
Gy. the body will revolve
round the center of Motion
till the Cent. of Gy. comes to
under point of support or
in per. line

Exp. A triangle suspended
as above will shew that
the center of Gravity is 1/3 of
the ~~perth~~ of the base &c as
shewn in last lecture.
The triangle may be susp.
also by one or two points

3d. Mr. Pr. of the C. Gy. is that
when the Center of Gy. coincides
with the center of Mo. the body
will rest in any position
Any body upon a plane will
not rest unless the vertical ^the perp. contact
passing thro' the C. Gy. is ^or be
perpendicular to the plane
~~If the~~ ^of the body will always rest
when the Vertical line thro'
the C. G. ~~before~~ falls within
the base — When it touches the
plane in two points — axis
of — Strikes but not stable
When the C. G. falls above
the center of the Cyclone? Circle
it will not rest — but when under
it will — an egg will not rest
on one end, but cut off the eggs shell

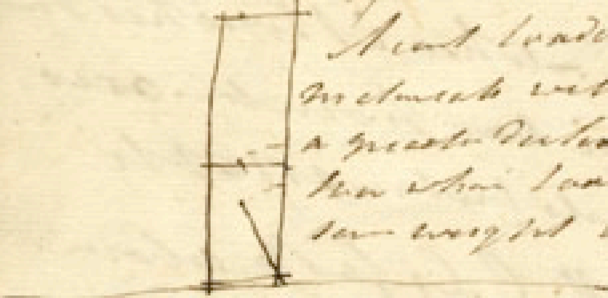
A body moves a little way out of its place ~~without~~ back from out with the C.G. it gets beyond the body will



upwards. when the vertical line fall

Pisa **towers**
130 feet high 15 feet beyond
Bol. 170 feet h. 9 feet beyond

Hence tall bodies are more easily pushed down than short ones Ex:

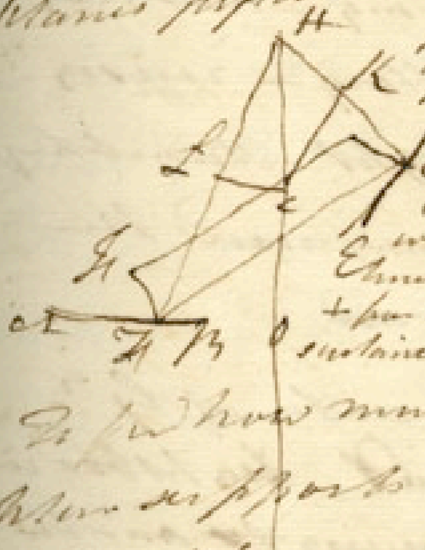


A cart loaded with hay or straw will go over in a greater declivity than when loaded with the same weight of [illegible]

No body will rest on an incl. plane if there was no friction. was this the case even a ball would slide down an incl. Plane

A body slides down an incl. plane when its C.G. falls within the points of support and rolls when it falls without

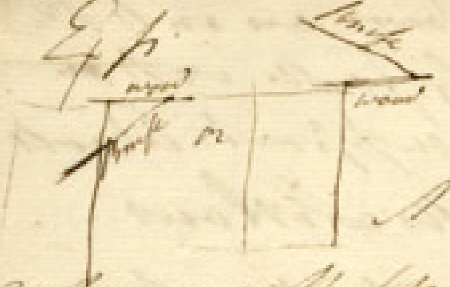
If a body rest upon two incl. planes it will not rest until a line from each of the [illegible] cross at the Vert. plane perpen.: meet in the Vert.



If the lines LH, GH are drawn perpen. from the points of support and meet in the V. line HO pass. C.G. of the beam, then the beam will rest and if the lines CL, CK are drawn + from the C.G. C. each pt. sustains a pressure :: HL : HK

To find how much each plane supports it is as HL to HK

If the [illegible] of bodies joined by inflexible line at the V. line the C.G. ~~[illegible]~~ within the points of supp. [illegible] body will remain ~~[illegible]~~ at rest



A scaffold for repairing the Ch: of St Pauls room

C.G in animal bodies — of man — standing — walking wading — sitting — rising — carrying a weight — stumbling skating or turning round the body them inward

Sometimes the center of Gy seems to ascend — light bodies in water — this owing to another cause — Double cone will either roll up or down as the angle is great or small —

8 Feby 1776

A Mc is an instrument inter- for transferring the action of the power to the weight — commonly defined an instrument whereby [illegible] the power, but this is not always the case as in Clocks &c — Mech: is the science of motions — Generally like Dynamics is the science of motions — Work to be performed gives resistance to the Mech. powers — Gravity commonly substituted for the moving power or the resistance of the weight

Mc either Simple Com or inter- mediate

Simple Machines, Cords,
Levers and Inclined planes

of the Lever

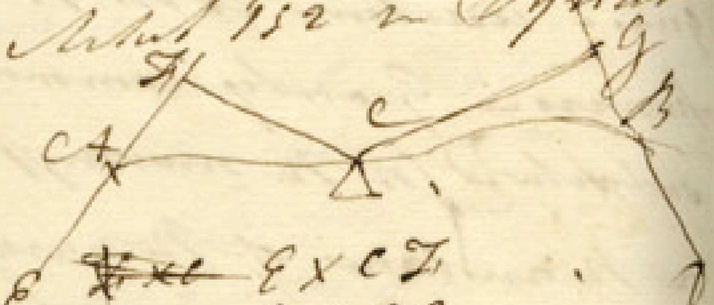
A lever is any inflexible rod of any shape moveable in one plane round a fixed point

I Fixed is where the fixed point is the middle thing

II. Weight is the middle

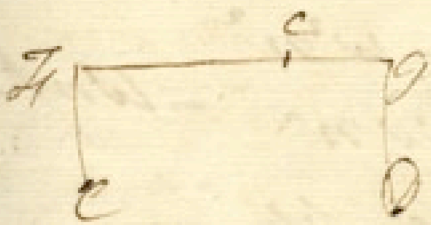
III. Power is the middle

Properties of the Lever deri: from Article 152 in Dynamics



$\frac{E \times CF}{D \times CG}$

E and D act as if applied to FC and CG at F and G. We may substitute any other lines equal to the former hence we may convert the above 2 into a straight one



Tis indifferent where the weight is attached whether at F. G or at E D.

Three things to be considered in the Mo.ⁿ of the Lever

I Leng. V.ʸ of the Lever

II. V.ʸ of the weight

III. Work performed, or momentum

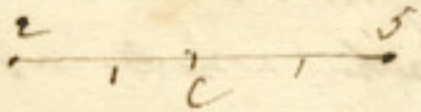
m = Dist of the Power
n = Dist of the Weight

1° $\frac{pm - wn}{pm^2 + wn^2}$ = Ang. Velocity

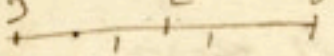
2 $\frac{pmm - wn^2}{pm^2 + wn^2}$ = Vel of w $1 \times wn =$

3 $\frac{pwmn - w^2n^2}{pm^2 + wn^2}$ = Work

Example



$\frac{5\times2 - 2\times1}{5\times1 + 2\times1} = \frac{8}{7}$ work done by the Power



$5\times1 - 3\times1 = 2$ ang. $\times 1 = \frac{2}{5}\times3 = \frac{6}{5}$
$5\times1^2 + 3\times1^2 = 8$

$1 \quad \frac{C}{1} \quad \frac{5}{1}$

$\frac{5\times1 - 1}{6} = \frac{4}{6} \times 1 = \frac{4}{6}$

Greatest quantity of work done when the weight is $\frac{2}{5}$ of the Power employed. Time is not less that the Power is applied

1° Given the proportions of the parts of the machine To find the proportion of the Power to the weight

$m^2 - 2m^2w - w^2 = 0$
$m^2 = w^2 + 2m^2w$
$w^2 + 2m^2w = m^2$
$w^2 + 2m^2w + m^4 = m^2 + m^4$
$w + m^2 = \sqrt{m^2 + m^4}$
$w = \sqrt{m^4 + m^2} + m^2$

9th Feb. 1776

Eg.

$w = \sqrt{m^2 + m^2} - m^2$

$\sqrt{1+1^2} - 1^2$

$\sqrt{1+1} - 1$

$\sqrt{2} = 1.4148$

$\phantom{\sqrt{2} = }\underline{1}$

$\phantom{\sqrt{2} = }.4148$

n = Given the ^ power and wt. to find the ^ proportions of the ~~machine~~ arms of the Lever

$\dfrac{p \times x \times n - x^2 n^2}{p n^2 + x n^2} = \dfrac{p n - n^2}{p + n^2}$

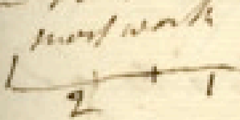
by the Thus ^ results the result with the

$n = \sqrt{p+1} - 1$

Expt.

$p+1 = \sqrt{4} - 1 = 1$

that is if the power is 3 a the wt. 1 the prop. must be ... by ... the ...



$\sqrt{9} - 1 = 2$

A particular case

in equilibrio

$\dfrac{F \times Fp - W \times Wp}{F \times Fp^2 + W \times Wp^2} - R \times p$

$F : W :: Wp : Fp$

In the Lever whether g[illegible] or
power is lost or lies, but this
proceeds upon a wrong principle
for it supposes the power applied
to move the weight whereas it is
only applied to balance the
weight

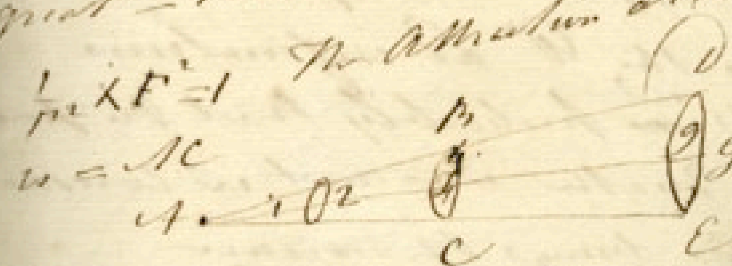
This however has its ad-
vantages in carpentry &c
when the machine is in equilib.
same states — If the power
gained in :: less of his [illegible]
the power would communicate
to the weight but half that it
that it would do without it.

Saturday 10 Feb 1776

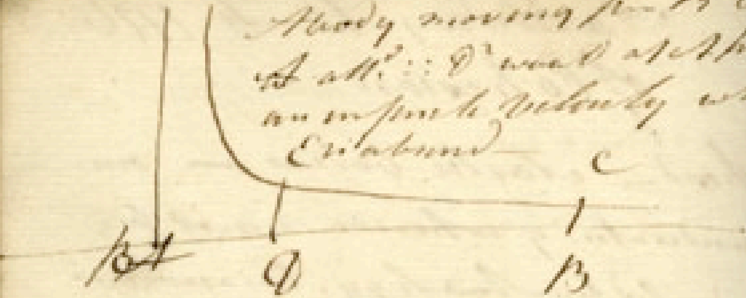
— of Cohesion —

hard — elastic bodies — our
conduct of cohesion must be
conducted by Analogy because we
cannot see the particles in contact
— At an infinitely small distance
the attraction of Gr.ty will be infinitely
great — Musket ball —

The attraction at A B C



If we suppose the particles
in contact what is not the
case

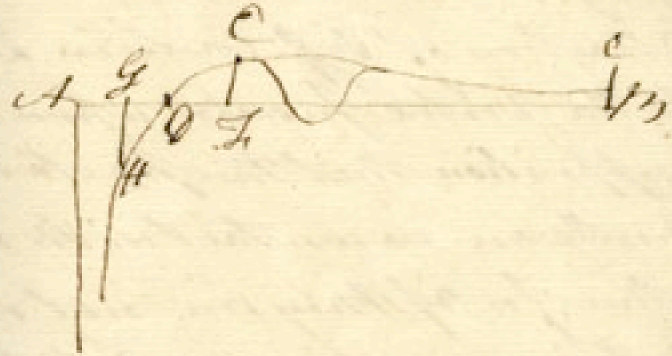


A body moving from B to A att.n :: D.n would at the start have an infinite velocity which is absurd

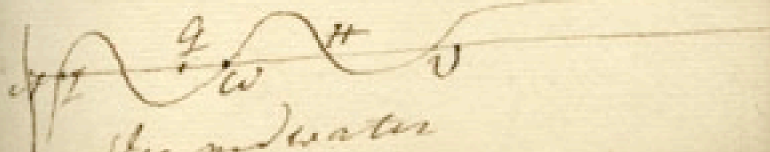
By infinite Vel.y we mean a body describing an infinite space in a finite time, hence it appears that it is absurd to suppose that G.n can increase as the D.n ad infinitum as the It and probably that the part of matter are not in contact — Space brings the same demonstrated —

The particles will be in c and C at the same time 2 E A of the particles of matter are in contact

Since we cannot bring into contact the absurdity in G.n vanishes.



The greatest force we cannot bring the particles of bodies into cohesion — two pieces of steel — hence two particles of steel are in the common boundary of the attraction and repulsion.



Ice and water

The power of Gravity does not
increase accurately ∴ D^r Bro thou
may be no sensible deviation in
the great bodies of the System.
Sir J.^s N^s Demonstration of the
Attraction of Diff. Circles in a cone
to the vertex proceeds upon the
supposition that the particles of
matter are in contact with each
other, for if they are not in con
tact, his conclusion will by no
means follow. & Many Experiments
in Electricity. Magnetism often
&c. shew that the particles of Mat-
cannot be in contact —