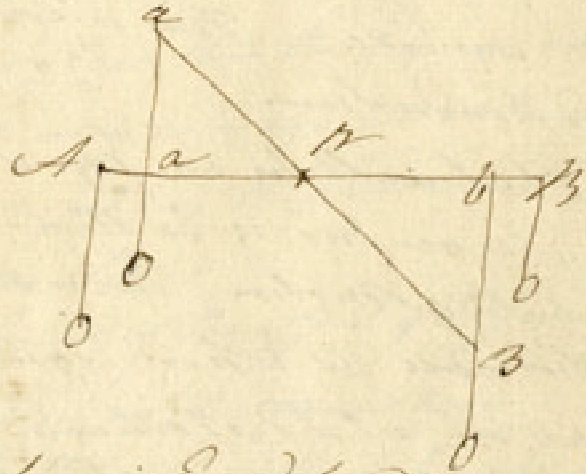
E.

12 Feby 1776.

Levers in Eq. when the resultants of any forces on one side are in Eq. with those on the other



A lever in Eq. loaded with a weight below if put out of its horizontal pos. will return to that again

It will return with a force :: load & weight & obl. dist. of the c. m.

when the weight is
applied above the lever

It will not rest but in a hori-
zontal position – the points
of suspension above –

Exp:

1 Bal: having its C of G
on the conside — this is a com-
-pound pendulum

2. The bal: will be in Eq: when
the weights are Inv: :: to their dista
fr the Centre of motion – Here the
simplest case is when equal
weights are at = Distances.
– unequal weights at Dist:
Inv: :: as the weights –

3. A number of weights will
be in Equil: when the produc
of the 2 of the wts & the Dist on each
side are equal.

4 A number of weights may be
put in Eq: with one weight which
is not equal to their sum.

5 A number of wts may be put in
Equ: with a number of weights
when the sums are not equal

In every case that the Eq: of any n°
of wts may always be obtained
by making the products on each
unequal –

Centre of the effort of different bodies
applied on the same side —
Rule to find this Centre is the
same as in a system of bodies —
Sails of a Ship, of a wind mill –

Then the weight is

13th Feby 1776

Expt. A perfect lever should rest in any situation, this is very difficult in practice — Bal. is an instrument to determine the weight of bodies

Axis must stand at right angles to the plane of motion or a straight line — two points of support made like the axe edge turned up. Hers — bead — 1st the Bal. must again get self in Horizl position — the scales of an equal weight — Arms exactly of the same length — found by changing the weights — to find the difference of the arms — 11 : 11+1 : as the one arm is to the other. The whole of the Bal. ought to be very easily moved — this depends upon a great many circumstances. The oblique position of the B.

alters the ::: of the Arms — Center of Gy. must be very near its center of motion — the near the axis of motion the better the nearer it is to the Axis to take off the [illegible] and set the Bal. in vibratory state — the slower the vibrations are, the nearer the two centers coincide whether the vib. are very slow it is a proof that it is very delicate matter should not be carried away in the middle — Assay Bal.: the nicest — Arms need not be very exact as to length, for its use is to determine the ::: of Gold & Silver for the Assay Bal.: the weights must be very exact — common way to adjust the weights, to begin with the least weight — better at the largest —

St^d Mom:^m advantages – it is easier to shift the axis than the weights – Axis sustains a less pressure than the common Bal: – They have usually two or three centers of Mo: – Useful for weighing very small weights – Steelyard and two moving parts of wire acting

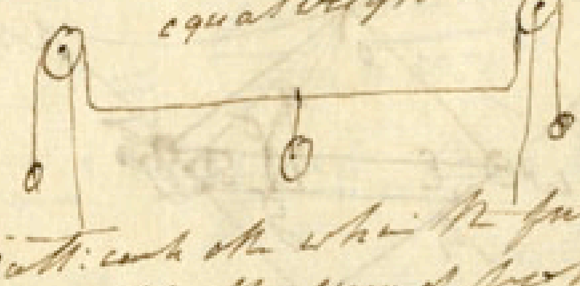
Ball for very small weights a slip of Mahogany – A needle for the axis and another –

14 Feb^y 1776

Center of the mass also be considered as a prop or support – It may be considered as a lever acted upon by two forces – A man lifting a stone with a lever – A man does not exert a greater power by the lever or by any machine, he only transfers the power to a point, & where it sustains the whole

Effect is the same whether the power acts upwards or downwards —

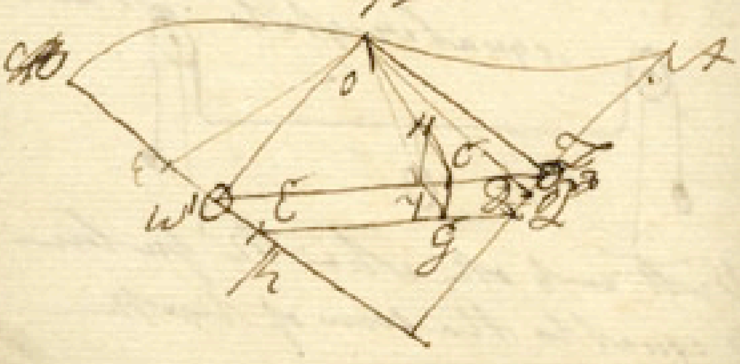
equal weights &c



Vertic: each other while the fulcrum is equal to the sum of both

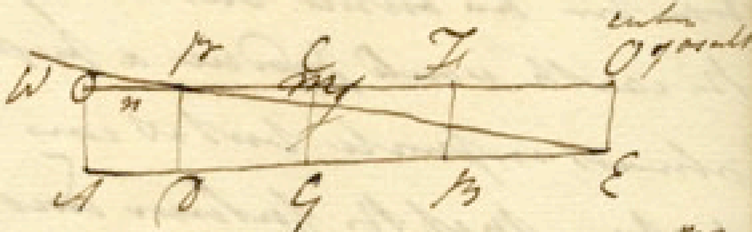
If one end is double the other the
weights must be in :: the length
and the fulcrum weight equal to
both. – Pressure of a machine must
depend upon support – if it is
weak the m: – the bank of two
strings this is an addition of weight of
machine.

To determine the force on the
fulcrum – consider the quantity
& direction of the pr of the two
weights, when unconnected, then
the friction of the centre of G when
connected with the machine



quant of pr on the fulcrum of
found by x' ~~f+w~~

$F+W \times CG$ = force of the syst



PO : CO :: F+W : pressure at P

$$\frac{fm^2+wn^2}{fm-wn} : \frac{fm^2+wn^2}{fm-wn} \; \frac{fm-wn}{f+w}$$

$f+w : P$

$$P = \frac{fw \times \overline{m+n}^2}{fm^2+wn^2}$$

$$\frac{f+w \times 4}{f+w} = \frac{12}{4} = 3 \text{ pressure}$$

on the centre of rotation

1 m + m3 when the weights are for: that the press sust: a pressure equal to the sum of the two forces. this will happen every case of equilibrio. but will not take place in other. of this was an ounce balancing the earth would produce a pressure almost infinite but it can be shewn that the fulcrum would sustain a pressure only 4 times [illegible] by fractions or reductions 4 th Lu

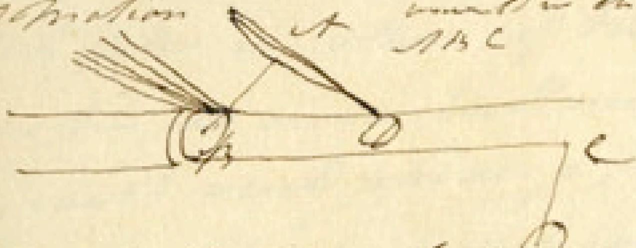
Beams of fire engines — pumps Scissars pincers - toys the first kind —

Of the second kind - Oars of a boat - bodies of animals

The maximum sum of pressure on the fulc is when the beam is in equilibrio

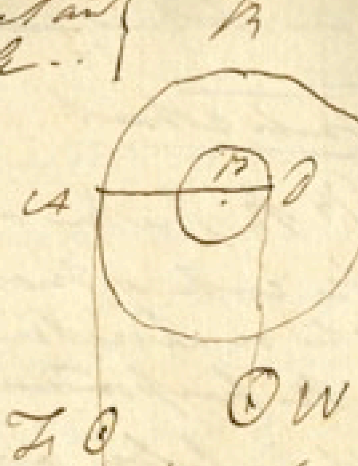
Thursday 15 Feby

Limbs of Animals are levers of the third kind — an Insertion of the muscle near the joint or centre of motion — muscle is the lever ABC



Most of the muscles placed much near the centre of motion — hence the greater exertion of power in the muscle and the greater m[illegible] of the limb — Contraction probably owing to the vital [illegible] of the animal, not to ether or any other fluid

wheel and axle —



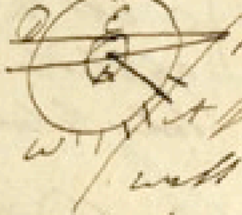
$F \times AB - W \times BD$ = effect

all the formulae applied to the lever takes place here

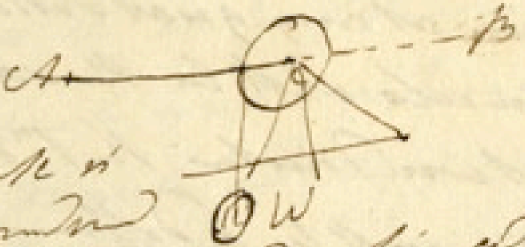
only differs in that the lever becomes perpetual — whereas the lever is not suited for a motion at any great distance. The formula will be the same in whatever direction the P acts — There will be a difference here — with regard to pressure on the centre of motion — it is always diminished or directed to a different point — sometimes it is annihilated —

as if a pulley were below ... directly above

Treadle wheel



the pressure on it at the centre of motion will be in direction oblique between the perpendicular and horizontal line below on the other side from the weight —



effect is caused by both the direction and quantity of pressure continually changing

— Horse gins smaller ... pulled in every direction by two beams at right angles

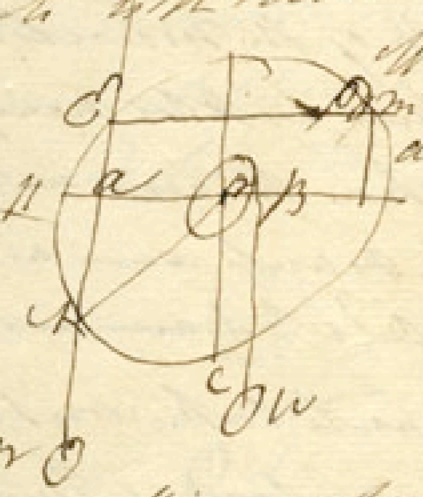
Effect of the wheel and axle —

~~16 Feb 1796~~

The effect of the muscles to raise a weight is inconceivable. A man of ordinary strength can hold out 20 pounds in his hand. The strength of the muscles to sustain this will be near 700 lb. Above when he runs on his hind legs the muscles raise an effect of 47 — and it is remarkable the same muscle takes ... not suffer it above 3 hundred wt. — small people are stronger than large ones, because the articulation of the muscles ... — Borelli de Motu Animalium. Bernoulli in acta Erud.

16 Feb.y 1776

The proportion of the P. to W on the wheel & axle obtains only when the P. & W are at right angles to the radius which which act there



the walking wheel. The farther from c the greater is the force. The reason why we [illegible] to [illegible] the most advantageous point of appl.n is that it [illegible] to walk [illegible] to walk

then a [illegible] always on the outside — sometimes he is made to push a stake by which he pushes the wheel back in an opposite direction — then a bullock cannot climb up so steep — A Goat found very convenient in Sweden to raise water &c — Greater work done when the man walked about 42° from the vertical line

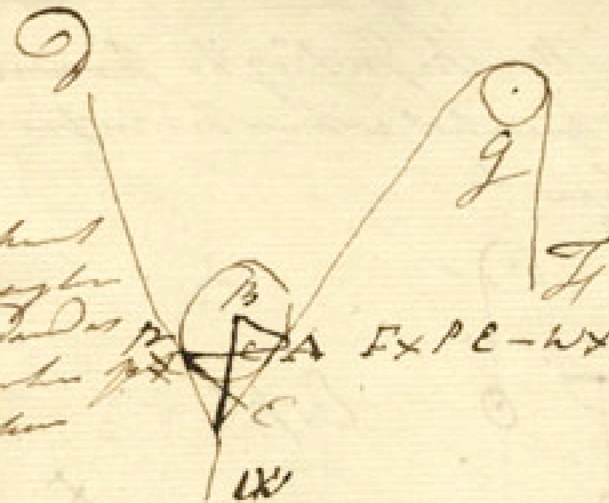
There is no way of performing so much work by a man, as in walking — coalheavers do more work by carrying up stairs than by the most perfect machine

Undershot, Breast and Overshot Wheels

The overshot wheel moves by the weight of the water in the buckets on one side of the wheel —

To find the effect — multiply the quantity of water by the perp: distance of the centre of gravity from the centre of M.n — If we cons the ver: perp: to C. G will cut the radius about $\frac{a}{2}$ for the C. M but when loaded about $\frac{3}{4}$ —

A pulley — greatest advant is when the weight is $\frac{3}{5}$ of the power or $\frac{414}{1000}$. Whole effect produced by a single pulley is a change of direction —



Suppose the whole constituted except the lever AP and lever of Pulley

intensity of the power $P \times \text{Cos} \frac{1}{2}$ perpendicular to power | Int: of the weight $- W \times \frac{1}{2}$ Radius

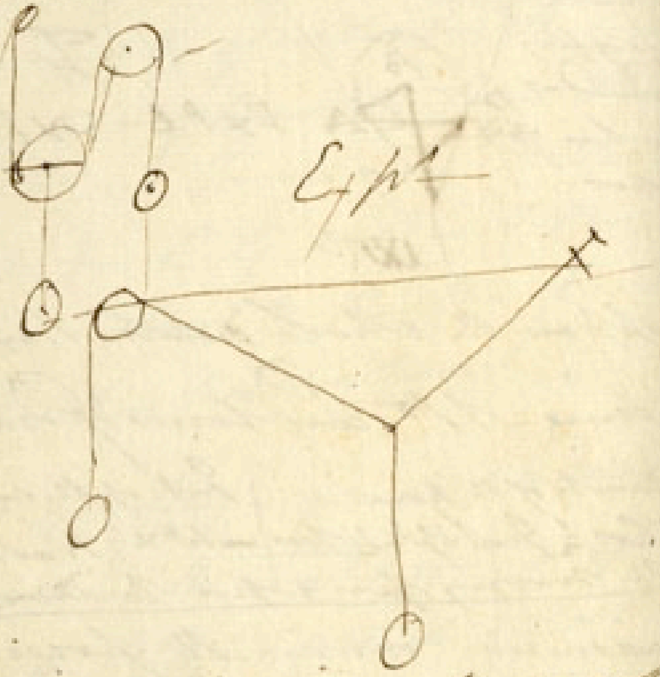
is the moving force upon the machine

Maximum is when the power is to the W. as the Sq Root of 2 to 1. or nearly $\frac{2}{5}$ this being to a fixed pulley —

But if the pulley can move & it allows the ...

19th Feby 1776

Cor: then the Intensity of the power
is the greatest when the weights
are equal!



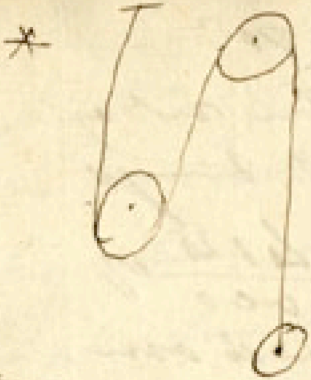
powers will produce the greatest
effect when the weight

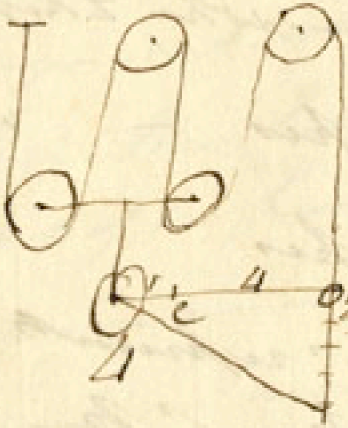
$w = \sqrt{m^4 + m^2} - m^2$ *

wt pro 1000 —

$\sqrt{\frac{16+8}{24}} - 4 = 599 = 1000$ —

*





Maxm when —

F = 1 something less than
w = 1.59 what will be it:

Gen: :: when the power is
to the weight as 1 to the
number of pulleys by which the
weight is raised —

$w = \sqrt{n^4+n^3} - n^2$

the n represents the no. of
ropes the weight hangs
weight must be $\frac{412}{1000}$ of
the [illegible] when there is one
[illegible] — $\frac{899}{1000}$ when 2 ropes

$\frac{140}{100}$ 3 ropes —

$\frac{189}{100}$ 4 ropes

the the Demo: represents
the power the Mach: the
weight — then it is evident
that the mechanical [illegible] of
is not true i.e. that so great
a [illegible] is lost in the [illegible]
of working the machine —

The [illegible] of the
[illegible] is found [illegible] two con-
[illegible] — other combination
have been [illegible] —

Exp: two [illegible] each block
along side each other — Dead-
[illegible] — when [illegible] of the [illegible]

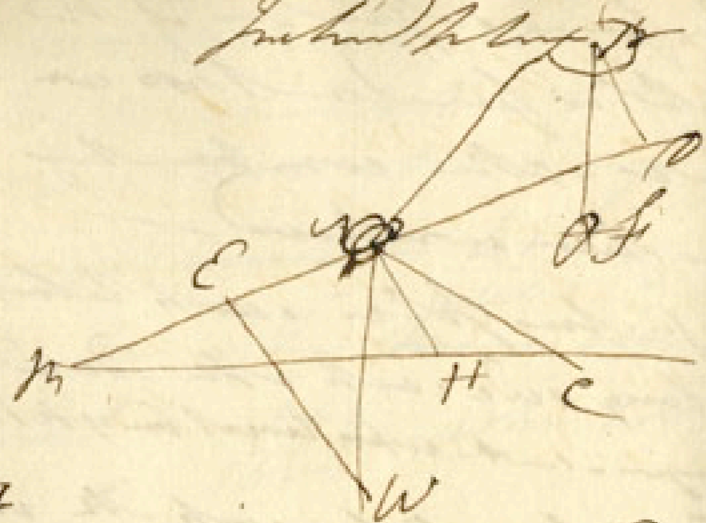
Exp: three below each other in
each of the frames — Small

movement —

Exp: [illegible]

20 in four rows — or any no.
which will divide by 4 or by
an odd number

Inclined Plane



B : S.El :: abs weight : tendency to descent - or

$1 : S.E = W : E$

$W \times S,E$

fr. C, S.In: Ab.t Tendency

the plane

$F \times C,S$ Incl. effect up the plane

$F \times C.In - W \times S,El$ = moving force of the machine

20 Feb: 1776

Equil: when

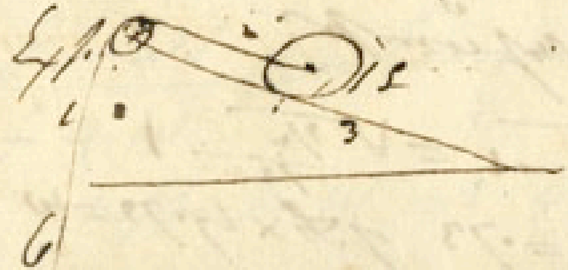
$F \times C.S.In = W \times S,$ Elev.

hence the power will be most effect. in making a body move along an inclined plane when it is in a direction parallel to the plane.

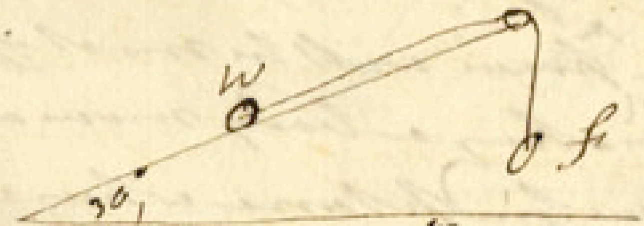
$E : W :: S.El : C, S\ Incl :$

Equil: when the power is to the weight as AC to BC i.e. when the power is to the W. as the height of the pl. to the length of the plane.

Ex.



but in Motion not a state
of Eq.m



$w \times s \quad \frac{f - w\, s, \text{ mot}^n}{f + w}$ = Velocity

$\frac{fw - w^2 \times s \text{ Cl}^n}{f + w} = E$ —

$\frac{w - w^2 \times s}{w + 1}$

result of the operation which

$w = f \times \sqrt{\frac{1}{s} + 1} - 1 =$

$= w = f \times \sqrt{\frac{1+s}{s}} - 1$

result of work

$\sqrt{\frac{1 + .5}{.5}} - 1 = \sqrt{\frac{1.5}{.5}} - 1$

$= \sqrt{3} - 1 = .73$ of $f \times$ by $.73 = w$

Eq.m on a inclin.d plane is the
same as in the common pulley
It often happens that the
:: f, w are given, to determine
the inclination of the plane
to produce the Eq.m quantity
of work —

In the case

$\frac{w - w \cdot s}{w + 1}$ = Velocity

but it is not the velo.y
alone that we want, for
this would be greater on
a horizontal plane

$\frac{fs - ws^2}{f + w}$ = work done

suppose the W.t = 1 then

$$\frac{FS - S^2}{F+1}$$

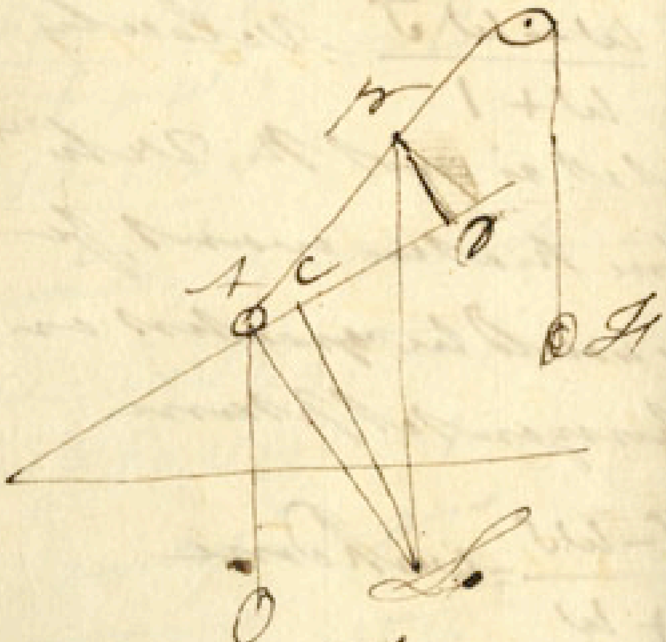
resultant will be

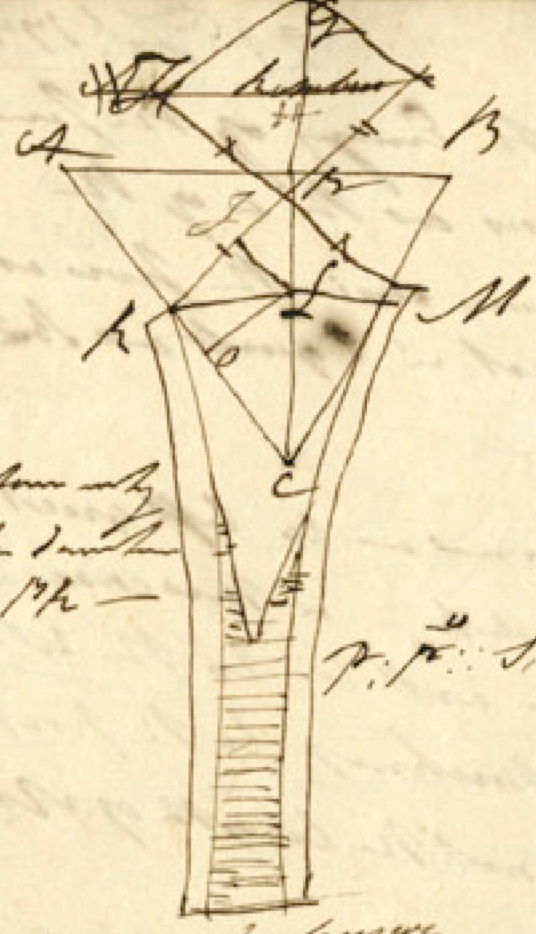
$S = \frac{F}{2}$ or $2W : F :: R : S$ &c

Divide the num by 2 the quot

will represent :: S &c when

the Radius is 1





resistance only

in the direction

PM, PK —

$P : F :: S\frac{1}{2}C : R$

Resistance

$\frac{P}{S\frac{1}{2}C}$ = energy of the power

$\frac{Res}{S, L\,sint} \quad \frac{P}{S\frac{1}{2}C} - \frac{W}{Sint}$

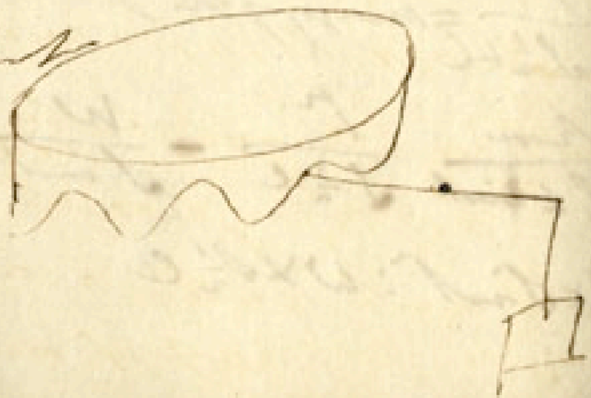
$P \times Sint : W \times S\frac{1}{2}C$

21st Fl. 1776

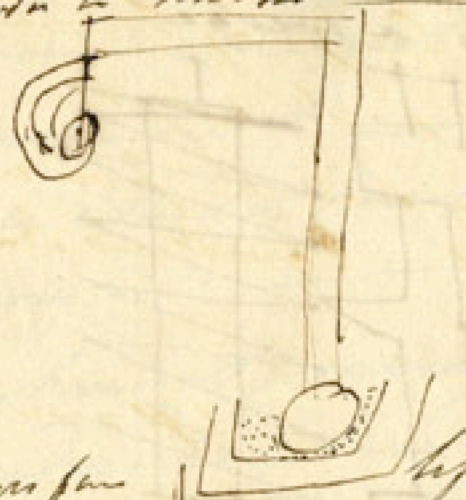
Then the Energy of the force
increases as the ∠ of the
in every case the power is
to the resist. in Equilib. as KL
to LC —

Wedges used to lift great
wt. or stakes — in this case
the power will be to the W.
of the thickness to the point:
length, not the length of its
side

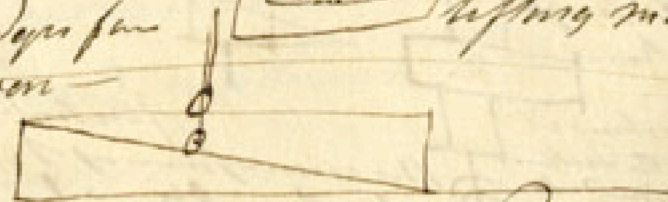
Spout



Circular wedges for stamping
powder in mills

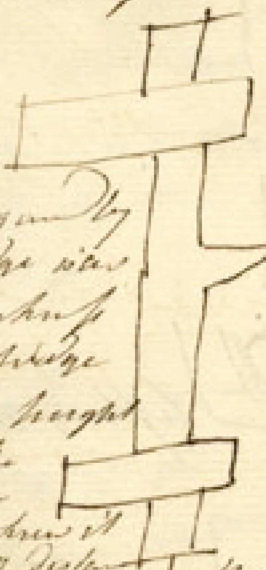


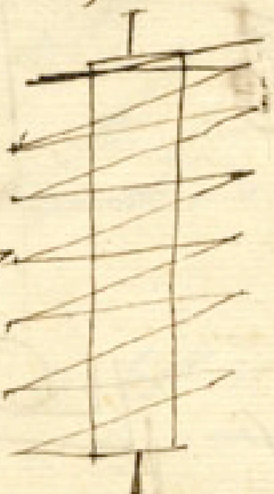
wedges for lifting mass
of iron —



Suppose two wedges
rapt round the convex side
of a Cyl. and one round the con
concave side, the lifting wedge
which can move only per-
pendicularly upwards &
this is exactly [illegible] & there
it is exactly suppd. an

inclined plane but it is
evidently a wedge





power gained by the wedge is as the thickness of the wedge to the length [illegible] in the [illegible] as the distance of the [illegible]

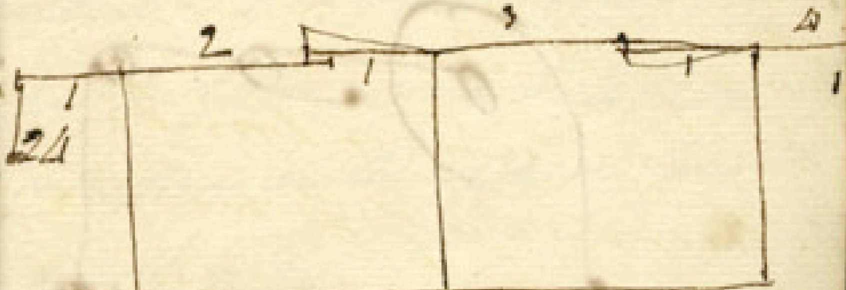
[illegible] the circumference of the [illegible]

Eg. in the screw the P is to the weight as the distance of the threads to the circumference of the Cylinder – there seems to be no bound to the increase of power for the threads will be equally strong whether

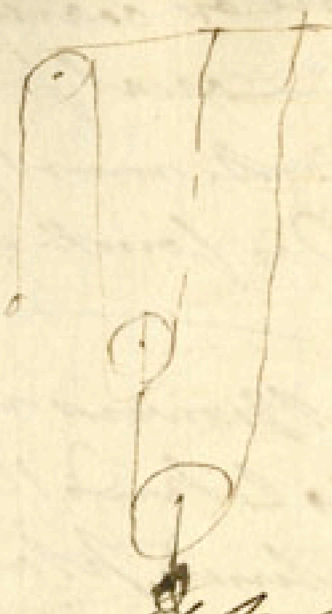
may be fine or coarse –
[illegible] in great friction
= [illegible] in the most perfect
it is a third or fourth of the
power. –

Mechanical powers may be reduced to 4 heads, 1 Cords 2 Lever 3 inclined plane & Screw –

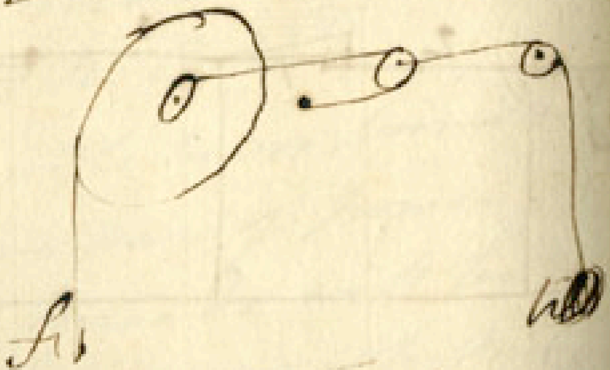
Eg. compound Lever

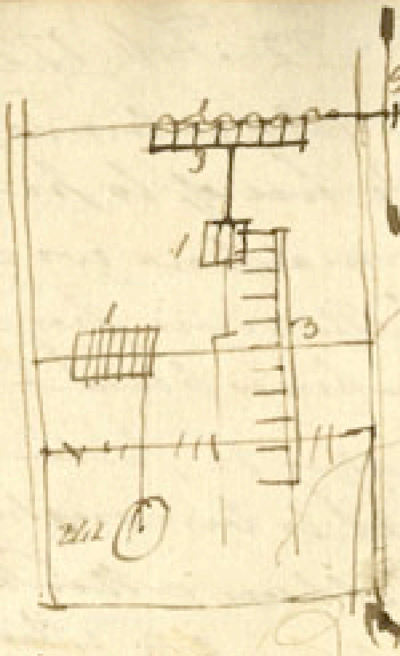


Ex:



A moveable pulley com-
municates with a lever or lets:
and axle combined with
a lever





3
3
9
3
27
9
$1 : 243 ::=$
power to the weight

A compound machine when
all the four Mechanicals
are combined. The upper
end of the above machine
and that low is constructed
as represented above, but the
a jack

22 Feb. 1776

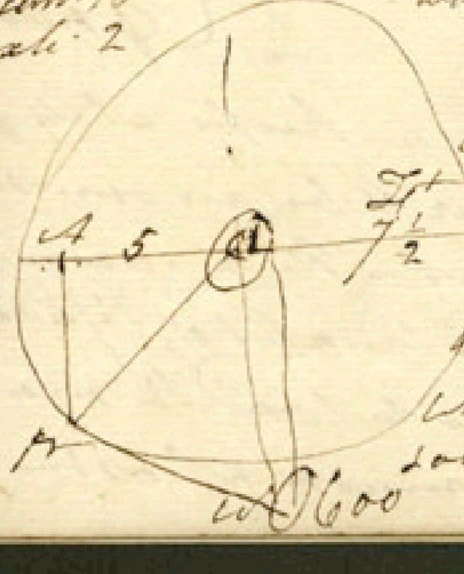
The smoke &c. intermediate
ration made use of to prevent
the effect, the machine will
be so much the more perfect.
because machines bend—

The intensity of the power
acting ought to be constant
This has not been attended
to by Engineers— i.e. wheel
and Crank— for clock &
watch work the tooth do not
act on the pinion at equal
distances from the centre, &
therefore unequally, the is nicety
is a great manner. Co re-
medied by giving the tooth
the form of an epicycloid de-
scribed by the pinion rolling
along the side of the wheel
Motions should be no stronger
than what is necessary— Cf.
Efficiency— Greater friction, great
power required to put the machine
in motion— in the steam engine
near Newcastle the quantity of
power employed to move the
engine is $\frac{2}{3}$ of the whole power
In a wheel, the advantage of
of M.r is of less in consequence
but in all reciprocating engines
it is very inconvenient.—
To determine the strength
a man of M. Sipp weighs
about 150 Lbs— He can raise
and loaded with near 3 Cwt.
four in walking 20 hours

be .. in from his knees
with a weight of about 250
pounds — A man without [illegible]
my raise 2000 pounds wt. to
an inch if he stands on a stage
with weight below it the
string thro a hole this is
fixed to a belt round his loins
— A man can push him self
up towards the ceiling by his
arms without bending his
legs, tho the strength of the
muscles of the arms being the
strongest At 160 pounds
this for the wt. of his body
and the add about 20 which
a man can support the
[illegible] of the arms when

~~perpendicularly~~ wrongly
the [illegible] forward — A man moving
with a [illegible] undulatory [illegible] to
center of support, this is prevented
by a small bending of the legs —
— this appears practicable from a
man being able to walk between
the floor and roof of a house which
less than his height — 6 : 5 ft 10.
The most adv. way of employing
a man's force is in walking

Diam: 15 ft
axle: 2



walking wheel
to produce an
Eqm. the man
must stand
at 4 ft dist.
from the perpen:
whole wheel
2000 lbs Wt.

23 Feb. 1770

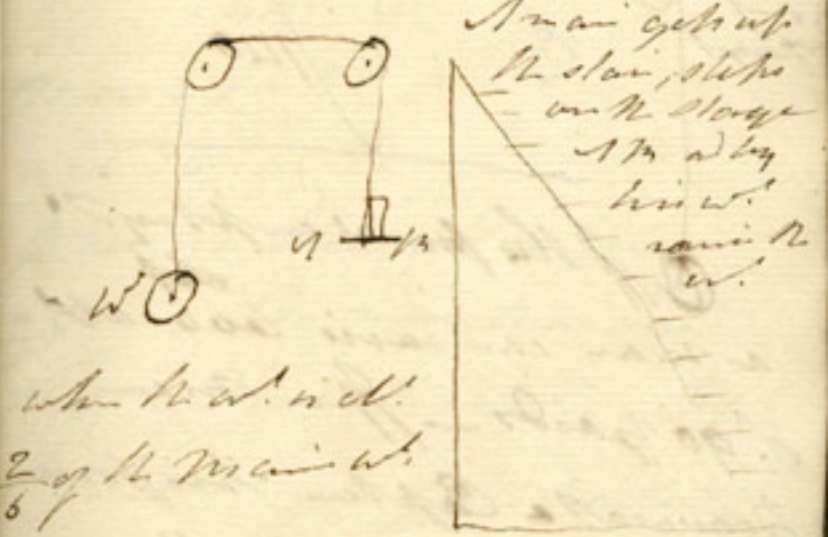
$\frac{130\times5-600\times1}{1000\times7\frac{1}{2}+600\times1^2}$ = angular velocity of 600 lb.

$= \frac{1}{3004}$

$\frac{1}{3004}\times7\frac{1}{2} = \frac{1}{400}$ velocity of the rim of the wheel which is a $\frac{1}{400}$ of the velocity of a heavy body falling in the same time —

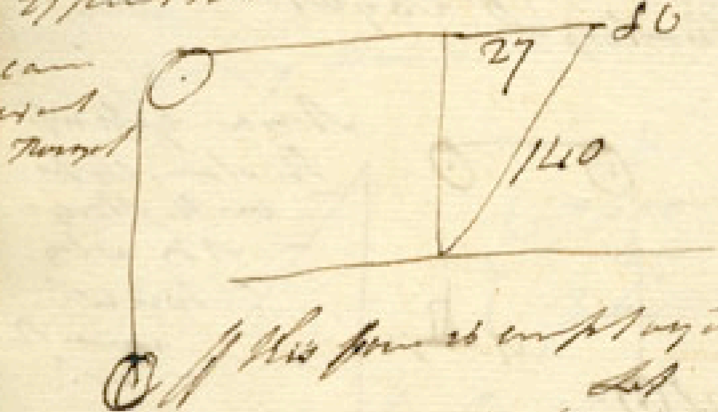
yds.
37 6000
1440
4 hours

as long as he keeps at 4 ft. distance he will be an overmatch for the wheel — He is raising 600 lb the height of $7\frac{1}{2}/400$.
Let
It is better to load the man with as much w. as the can conveniently bear & then he may keep walking nearer the center at first — Walking wheel improperly employed as a Crane — The best way of employing the strength of a man seems to be that of D'Lagny.



Let
25 the utmost a man can
continue to draw horizontally
for 8 hours a day this found
by applying a spring steel-
yard to the rope, by which the man
pulled the boat along the
Canal this [illegible]

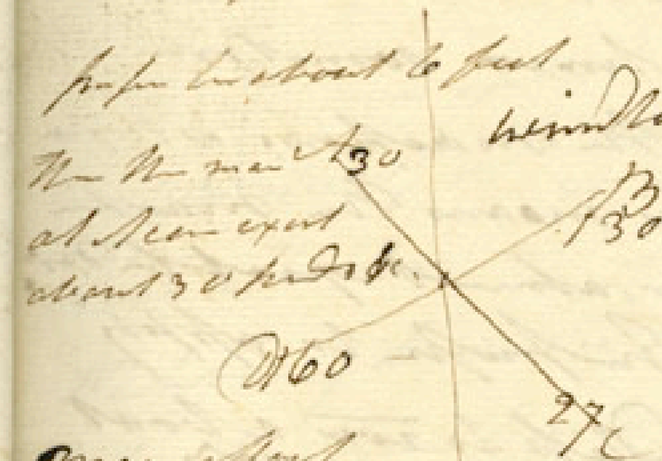
27 pounds that will which a man



Of this force is employed.
Let
a man can raise 600 at
the 90 yards — If a man
heaves at a Capstan his force
is much the same as pulling
i.e. about 27 pounds —

A man can drag backwards
more than otherwise —
A better way of employing
a man's force is by the windlass

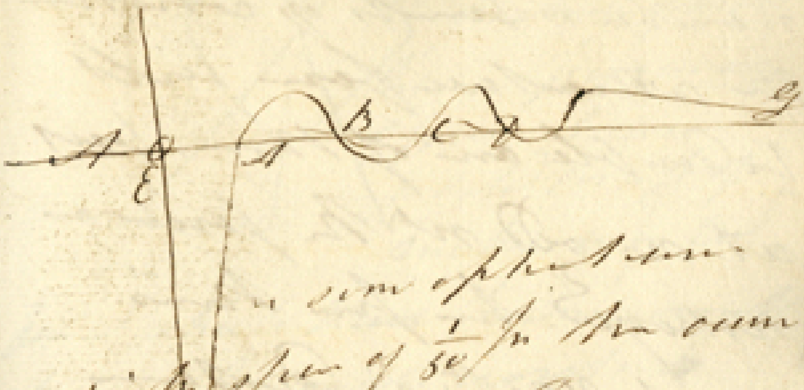
perhaps about 18 feet



mean effort
is at 26 pounds
If two handles are employ
2 men can do more than one
man can do with one handle
But position of the handle
2 men can 600 about 150 yds
an hour —

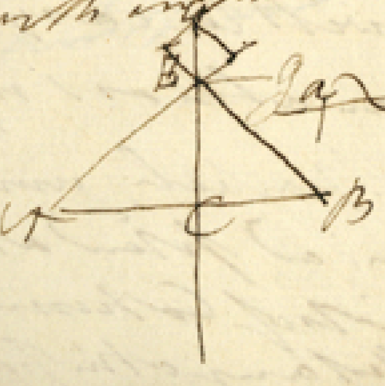
Effect of fly is to accumulate
effects of the forces in different ides —
much for coining money —
A fly requires sometimes to
come to its motion but
& continues sometimes
after the machine stops
by this means the machine
has an almost regular [illegible]
in 1 — Instances to a fly
a windlass to row a boat or
a windlass in a [illegible] the
much way of [illegible] fly [illegible]
a man [illegible].

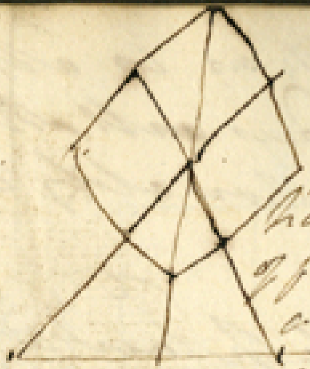
Sat. 24 Feb. 1776



[illegible] some [illegible]
in the sphere of $\frac{1}{50}$ of the [illegible]
2000 attraction or repulsion
[illegible]
different orders — particles of
[illegible] — Upon the supposition
the elementary particles are
[illegible] it will be easy to
[illegible] that an atom or [illegible]
[illegible] — Particles [illegible]
of [illegible] Elem. and [illegible]
first [illegible] Cohesion
[illegible] not affect any other particles

If they are placed at an even
number of limits of cohesion
the attraction force will
be double one of them, but
at an odd no. the force is
destroyed. The former this
single vary in distance
there may arise very
different effects from the same
particle of matter — Let
now two particles act
upon one in the same dir
line with respect

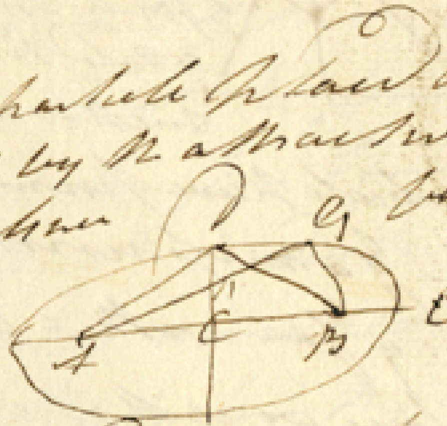




particle of which
have a permanency
of form — hence
a solid mass of
matter may be
formed which have permanent
forms — If a mass resists a
change of form with a consider-
able force we call it a hard
body — bodies will be very diff
from the kind of particles of which
it is composed — A particle
of the third order will be
with the particles of the
2d order. Whatever is changed
in the particles the system of
connected by ... may take

place at least as to all
sense. For bodies will attract
inversely proportional to the
the D²

Any particle placed at
G will by the attraction
and repulsion from

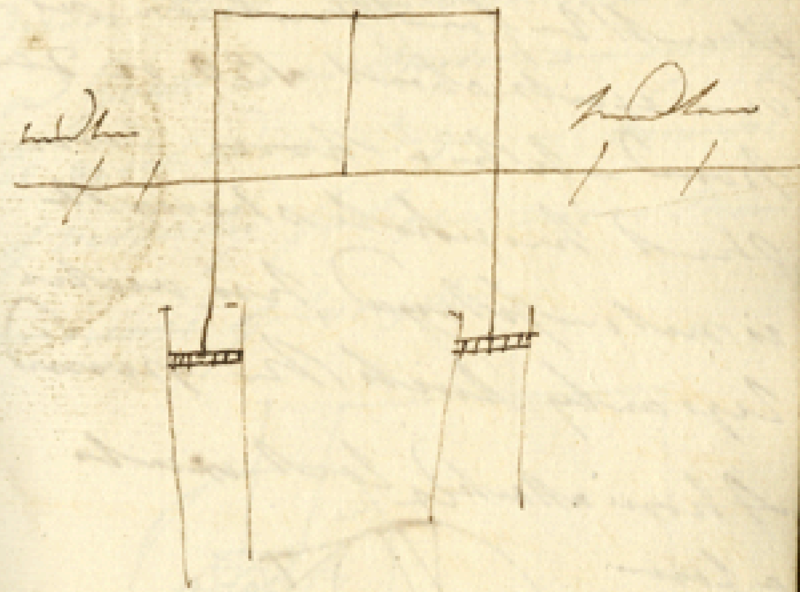


~~[illegible]~~ will
move to-
wards D

Then the body may become
a fluid -

Also the ultimate El.
of all bodies are the same
yet from the various com-
binations, an infinite V.
of effects may take place

26 Feb. 1776



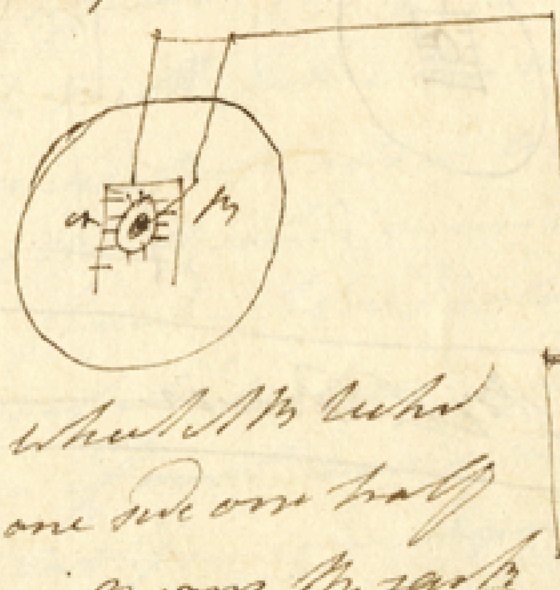
When a horse draws a boat
8 hours at the rate of two
miles an hour the resistance
must not be above 200
in the most advantageous
way

A horse will drag a very great weight up hill, but it would be found that he at- tains exerts about £50 or 200 pound - when a horse turns that his whole strength is not employed, his outer legs only touch the ground

A horse attached to A exerts a force which is not = AB but the per- pendicular BC. The best way of employing a horse is to give him a large walk, and to extend the bar

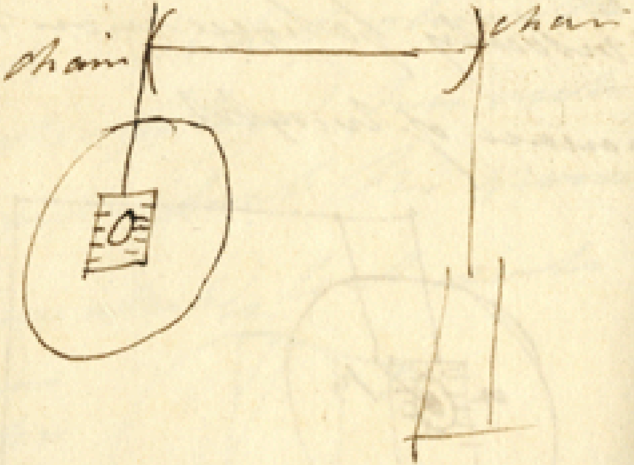
Let him exerts 170 in the sugar mill- in W. Indies - but in small

circuits about 11 ft. diam. not above 100 - Horse should never trot - Oxen better than horses and Goats, as in Sweden are employ'd to great advantage - increase of velocity fatigues more than increase of weight



The wheel AB when on one side over half by this means the axle is alternately pushed up and down

Now the action is not equall in the parts, the equality exerted. They [illegible] that there is remedied by



Pile Driver

27th Feby 1776

~~Hydrostatics~~

Of Fluids

A fluid is a collection of matter whose parts yield to the smallest impression. Sand is perhaps more easily — but sand is not a fluid properly. Imperfect fluids Blood — Milk. Ink when viewed by a microscope appear to consist of small solids swimming in a fluid. Silver dissolved in aquafortis produces a perfect fluid. — Efficient cause of fluidity not the subject of investigation here, but of the argument. It is probable that fire renders all bodies fluid — Cold, solid

That particular circumstance
in which fluidity consists
is the subject of Mechanical
investigation – not known –
Phil.^s account for fl.^y by supp:
that the particles are uncommonly
spherical – and this consists
with our phenomena – all
~~[illegible]~~ F.^s will not be in
Equil.^m unless in a horizontal
situation – If the particles
of fluids are spherical they
w^d be piled like shot –
Other Phil.^s derive F.^y ~~by~~
from the violent agitation
among the particles –
This supposes that whether the
..., the same as by their

heat in the former case.
When at rest, but put on
the head of a drum quickly becomes
the sand falls in the same &
subsides to the level of the other.
– Alabaster heated puts on
the appearance of a fluid
like milk – consists of the Carbonic
acid with the Volatile
Fluid – which heat is expelled
by the heat. – If salt is
~~[illegible]~~ put into W.^r it quan-
quickly dissolved then any
particles of the water which
could not happen without
a motion of the particles
But the argument from fire
is not conclusive because

it takes for granted the principle of Fire which is by no means known –

The Argument for Term is the same as Imp – imperfect fluid. –

The last argument for Stat. concludes against the principle

The solution of Salt &c. is owing to the nature of Chem. attract – Saturation, – A body will be dissolved in a fluid when the fluid attracts the body more strongly than the particles of the body do one another – Internal motion is inconsistent with some of the phenomena

The arguments to prove that the particles of solid bodies are not in contact, will apply to fluids. Fluid contracts by cold &c. – The florentine experiment has misled many. The ball of Gold twice elastic, it rebounded when struck on the ground – when struck with a violent blow it always recovered its form – but the blow struck & have yielded to the shock supp: the fluid not elastic, for Gold is elastic. – A more accurate experiment would have determined the matter. The Gold will contract by cold & infer the particles

of the fluid are twenty feet more to each other — Particles of fluids kept asunder by a repulsive power. as in solids — The particles of solids may be so circumstanced as to attract or repel different according to the distance and position, as explained by an Ellipse — The particles of a fluid exert the same force at equal distance in every direction. this is the Characteristic distinction between a solid and a fluid — the particles of fluids can circulate round each other, with the utmost facility. as they must

at the same distance from each other. In a case of Equil. the particles must not be at the nearest limits of cohesion — they must be brought together into a state of cohesion.

Another circumstance in fluids is that some fluids gather into drops — air does not — hence the distinction into attracting and repelling fluids. as air and water are most distinguished of each kind. the Subject is divided into two branches Hydrostatics, and Pneumatics —

Phil. thought that the particles of matter were round or into spheres but that cannot be the case — shot holes

28th Feby 1776

— Of Hydrostatics

If the particles of fluids are
not in contact it is true
in [illegible] what is its form.
fluids exert a repulsive force
air expands when the pressure
is taken off — the particles
of air on the surface of our
earth are 2000 times nearer
than the limits of cohesion.
This may be proved from Expt.
— All fluids are heavy bodies
every fluid in a state of Eq.
will have its particles
in a compressed state or
within the limits of repulsion

Now the compression of water tho'
it will hardly be sensible
Now the water at the bottom
of a well tho' denser than at
the surface, yet it will be diff.
to observe it

Hydrostatics, treating of the
Equilibrium of fluids — and Hydrau-
lics treating of the motion of
fluids.

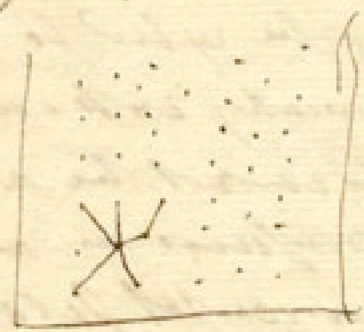
Principle of inflammability can
be the cause of the gravitation
it must be either heavy or positive
light [illegible]

suspension by the extremities of Golden Glass —

Some of the ancients assert that fluids ~~struck~~ gravitate in proportion, that a man pulling a bucket out of a well (drawing water) will feel the weight of the water till the bucket is above the surface this is false proved by weighing an empty glass in water, and when filled with water, in the latter case the water in the fluid will weigh as much as in the air —

If the particles of a fluid are incompressible the fluids particles will be nearly at equal distances, but if the fluid is compressible the under particles will be brought much nearer to each other.

If the particles are not arranged above one another but as in a vessel, every particle is pressed equally in all directions and the pressure is that of the fluid above the horizontal plane of the particles —

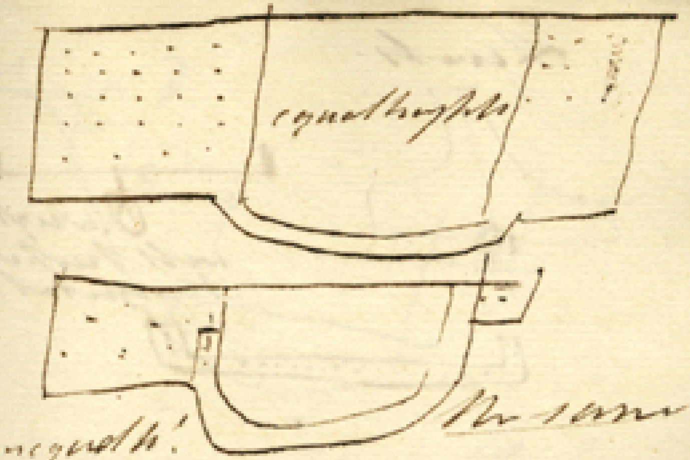


1 Cond. the base of the Vessel
is pressed with a weight = to the
fluid.

II Each particle is pressed
with a column whose base the
particle

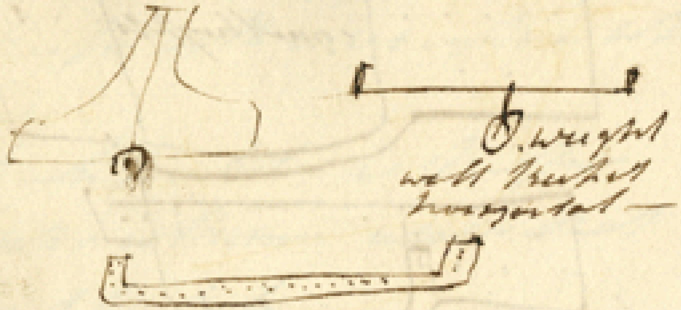
III. If any one ~~fluid~~ particle is raised above
the Horizontal plane of the
rest it cannot remain at
rest. – The same takes place
of any No. of particles —

This may be applied to 2 vessels
communicating with each other
The water cannot be at rest
till the surfaces are at the
same Horizontal plane

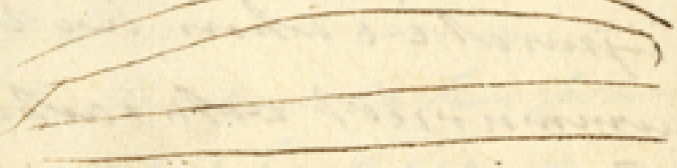


Of this the Romans were
ignorant i.e. where two vessels
communicated with each other
Their Aqueducts are monu-
ments at the same time of their
Magnificence and their inadequate
inattention to the most obvious
properties of fluids

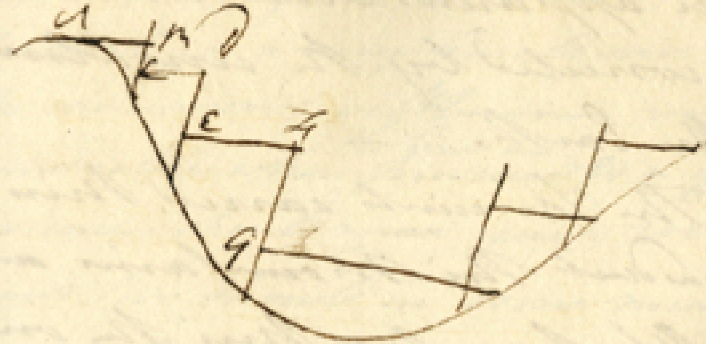
Levels.



Common [illegible]

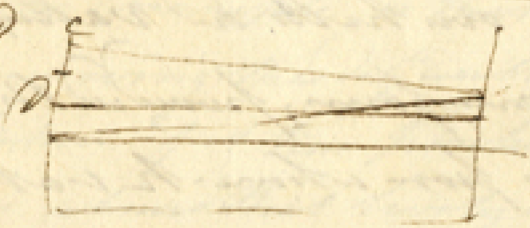


Method of bringing the tangent of the tube at the bubble parallel to the axis of the Telescope by lifting out the telescope & reversing its position —



1 Station ought not to be long not above 200 yards

11 They correct the first, by cross observations, i.e. by looking back to the last station ——



The apparent Level must be corrected by the curvature of the Earth. —

The Ancients carried their Aqueduct thro' Mountains and Valleys, by cutting thro' the one and bearing up the other — what a shocking proof is this of the Magnificence & Riches of the Romans. We conduct our Water with imperfectly less trouble by pipes over hills & valleys, and into any form, provided that the place from whence the water is to come is higher than where it is to be delivered. To find this Difference of height is the common & apparent problem, it is the business of Levelling

In Levelling the Station should be short, for a very small error at the instrument will become very considerable when produced to a great distance. should a mean exceed 200 yards, this should in some measure be :: to the goodness of the Instruments —

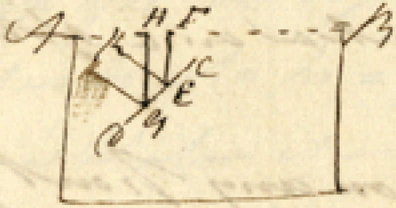
* The cause of the Gravity of bodies cannot be this, at least it is great presumption against this Assumption. If this Star has weight it must depend on some other principle so that this is but removing the difficulty a step further. If it has positive body it seems absurd that Gravity should produce gravity. — Neither can it be the principle of impenetrability for if it has no weight it has no matter, and Impenetrability is contrary to

very other kind of matter that we are acquainted with. If it has ponderability many absurdities will follow. Suppose two pendula one of Gold, the other of Glass

The Gold pendulum is composed of the principle of inflammability & the calx of Gold &c.

29th Feb. 1776

The particles of a fluid exert a pressure in every direction which are proportional to their depth from the surface



To estimate the pressure upon a surface is = Wt of column of that fluid above the surface placed whose height the depth of the center of that surface under the surface of the fluid, whatever is the figure of the surface

Thus the side of a vessel is pressed [illegible] with

- face = W. Col: of whose base is the side, and whose height is a line from the centre of that surface to the surface of the fluid

Pressure outward on a hollow - Cylinder

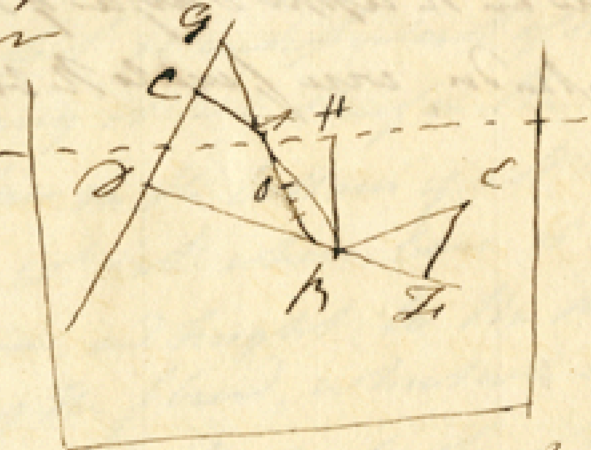
The pressure on any point of a vessel is independent of that on any other - therefore the pressure on the bottom of all V.^s is = W. Col: whose base is the bottom, and height to the surface of the fluid, whatever be the shape of the vessel. - A Cylindrical Ves: base 10 square inches and whose height 1 3/4 Ft the bottom is pressed with 6 pounds which is the W. of the

whole water - A small tube on the same bottom as the last and of the same height. Attached presses the bottom with the same force this is called the Hyd^l Paradox -

Foot of the last vessel is pressed outwards w. a pr. = C.^o of the same base and W. above it - about 6 pounds laid on the upper surface of the Cylinder, were fixed to the bottom

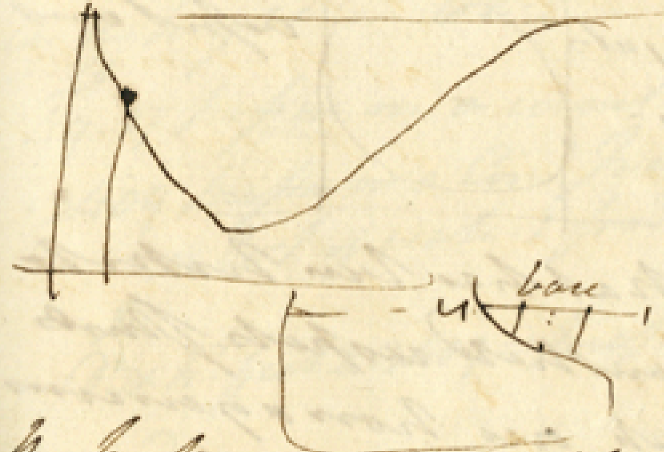
1st March 1776.

Mr. Pressre on any plane is to the perp: pressure b[y] any oth[er] plane as Radius to the Co-sine of the Inclination of the planes, or to the orthographic project on that plane



The Pressre on any surface whatever is equal W.t of the col: of whose height is the Dist: of the C:G to the surface

and the other basis is the orthographic projection

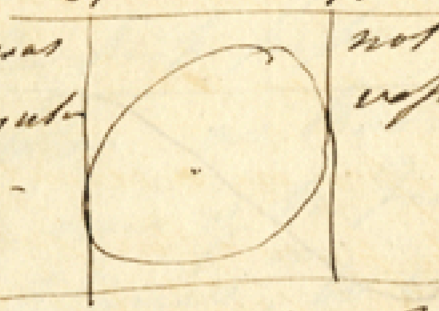


The press: on any curved surface is = col: of the incumbent fluid. The press on any surface upwards is = col: of fluid which would rest on the other side of it.

Horizontal pressure on sides
Curbings itself it is equal in
all directions.

A B

If this was a irregular mass —



not the case respects ...

All that has been stated
demonstrated respects fluids
which are homogeneous

When two vessels com-
municating with each other
have different fluids in
the lighter fluid will
stand higher

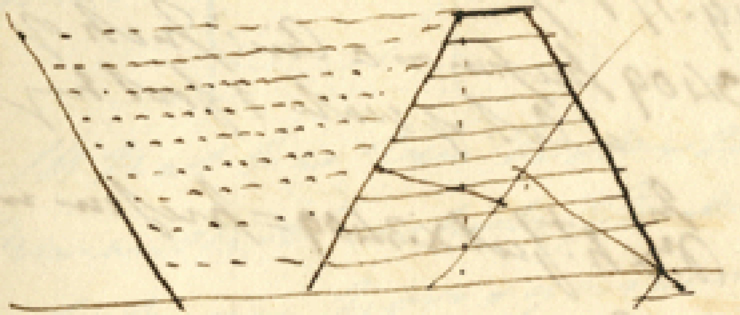
Cubic foot of river water weighs
62½ lbs of 16 ounces. To find the
pressure of water mult.y the area
by the height in 62½

49.17 lbs pressure on a circular ft.
.3409 pressure on a Circ.r Inch of
a Col. of water 1 foot long

$D^2 \times h^t$ feet $\times .3409$ = pressure in
pounds

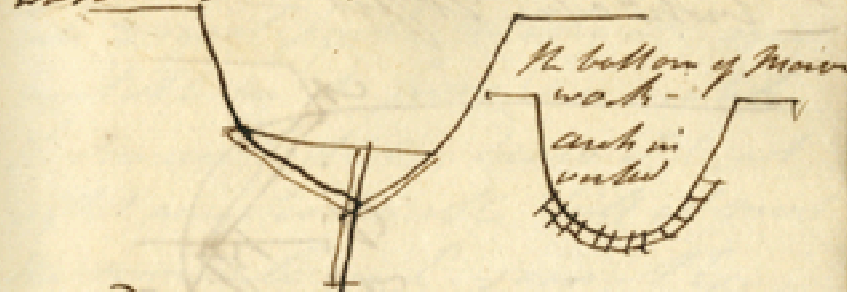
Quantity of Earth in Dams with
require a force nearly = their
weight to push it along, then
the computation is easy

The Cal. and difficult when the water is confined by a line of masonry



Great object of an Engineer in constructing Dry Docks is to prevent water getting in at the bottom, this to be done by driving a row of Piles on the sides of the Dock, or beams laid below in Mortar

Different ways of making the bottom water tight —

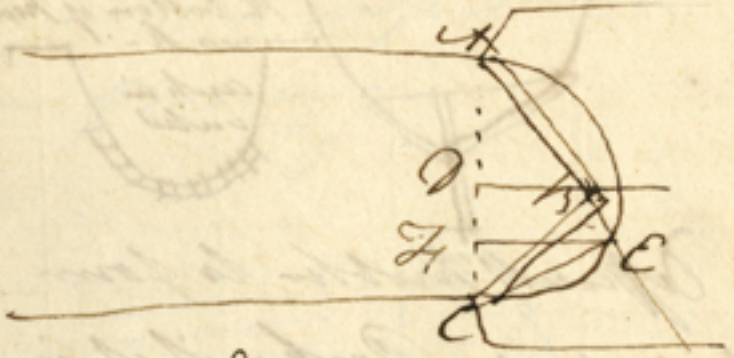


Difficult problem to form the gates of a Dock, if it is a ~~[illegible]~~ narrow dock a plain ~~[illegible]~~ Gate will do.

$S \div \frac{1}{\text{Width}}$ absolute strength of a Gate is inversely ∴ to the square of the ~~length~~ width —

As the gates are too weak they are made to sally —

Double Gates must be made use of when the width exceeds 20 feet



BA : AD :: AC : AE

AA × AE = AD × AC

AE^2 expresses the thrust of the gate AB

$AE^2 \times CE$ absolute power of the Gate. When AE^2 is double CE^2 it is a maximum

AC = 3 CF

Now it is easy to construct a gate of the above form —

Note. Divide AC the mid rib into 3 equal parts make FC one third AC on D, from D describe the semicircle AEC, draw FE at right angles to AC till it meet the semicircle in E. join AE. AB will be ½ the Gate —

In constructing dry Docks great care should be taken to prevent the water getting in at the bottom. Suppose a hole was made of the size of a goose quill if this was exposed to the depth below, the pressure upward would be equal to the weight of a Col: of water of the same height with the water without and upon base as the whole dock to prevent this some engineers drive rows of piles round the Dock two rows as necessary —

Others drive a row of piles along the bottom, to these they fix beams extending to the masonry on each side, by this means the pressure of the water on the bott^m will be resisted by the weight of the whole masonry.

Others again build the bottom of mason's work — The arch of a bridge inverted, the greater the pressure is upon this, the stronger it is

---

AE^2 is max: ; to AB^2

$a = AC$

$x = CE$

$a^2 - x^2 = AE$

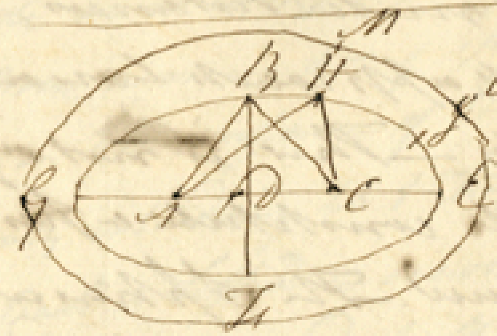
$\overline{a^2x - x^3}$ = strength of the gate

$a^2\dot{x} - 3x^2\dot{x} = 0$

$a^2 - 3x^2 = 0$

$a^2 = 3x^2$

Saturday 2 March 1776



If the original assumed curve is wrong all that follows is so the the figure of the above curve will be stronger it will be some figure different from an ellipse

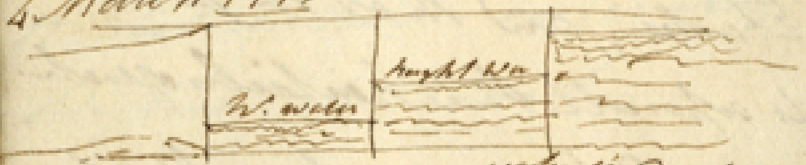
In soft bodies, the particles are not arranged at their nearest limits of cohesion but at a greater distance

When the particles are ranged
at still greater distances, the
body will approach towards
fluidity — This is not suf-
ficient to constitute a per-
fect fluid. The Sphericity
of the particles of a fluid is
not necessary because of the
smoothness, for if the particles
do not touch each other it
is no matter what is their
forms. But a spherical
form is necessary, that
the attractions on every
side may be equal —

Which should be sufficient to se-
parate as to compress —
Suppose a number of spheres
lying on the surface of the earth
gradually extending to 1 foot — when
one ball is lifted a second follow
then a third &c and still I feel
but the weight of one. here
the spheres are supposed to have
a greater attraction for each other
than for the earth — Three
great objections. that all
bodies should be perfectly
Elastic, and that the power
to separate the particles again
should be as great as that
to compress them —

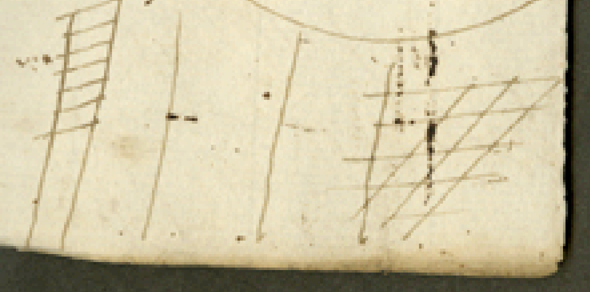
All this doctrine is founded
on an assertion that all the
particles of matter are not
in contact — Softness, Duc-
tility, and fluidity arise from
the different arrangements of
the particles of matter at
different distances. The only
hypothesis which [illegible] this
subject was that the original
Elements of all bodies are
the same this was gratuitous
but all the effect that will
arise from any alteration —

4 March 1776



sometimes when the water is very deep there
gates are made within an earth

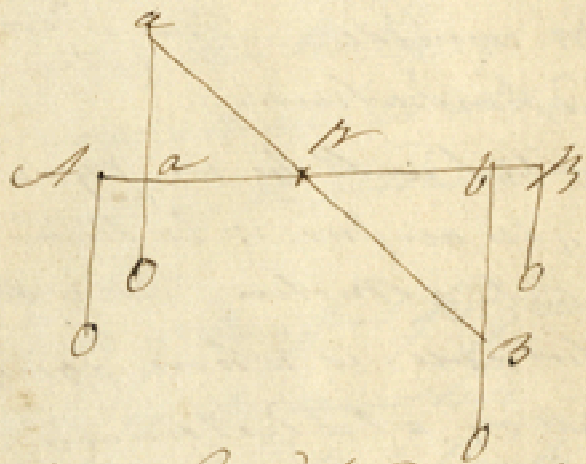
Muscle effects not a
proof of circular cause
p. 24 [illegible]
20 = man 700 pound
W. of a horse when he carri[es]
about 4 times — same
muscle will not carry
above 5 hundred W.
taken out — Small
smith stronger than
large one — because the
contraction of the fibres
finite — Borelli de
Motu Animalium —
Bernoulli in Acta Erud.
Lib. 1727 —



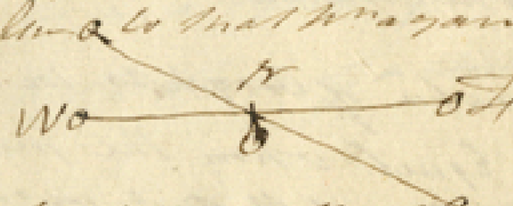
$\frac{1}{5} = \frac{1}{1000}$

12 Feb. 1776

A lever is in Eq. when the momenta of any power on one side are in Eq. with those on the other

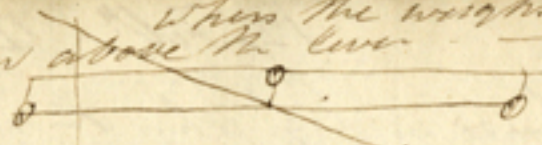


A lever in Eq. & loaded with a weight below it but out its horizontal p[ositio]n will return to that again



It will return with a force :: to ad[ded] weight & dist[ance] of its line c m

When the weight is applied above the Cent.



It will not rest but in a horizontal position. — The points of suspension above —

Cor:

1 Bal: having the C of G: on the same side — This is a compound pendulum

2. The Bal: will be in Eq: when the weights are Inv: :: to their dist: from the Cent: of motion. — Now the simplest case is when equal weights are at Dist: Inv: :: as the weights.

3. A number of weights will be in Equil: when the product of the Sum of the Weights into their Dist: on one side are equal

4 A number of weights may be put in Eq: with one weight which is not equal to their sum.

5 A number of Wt: may be put in Equ: with a number of weights when the sums are not equal —

In any case where the Eq: of any Wt: may always be obtained by making the Products on each side equal —

Centre of the effort of different bodies applied on the same side —

Rule to find this Centre is the same as in a system of bodies — Such as a Shaft of a windmill —

13th Febr. 1776

Exp. Where the levers should
rest in any situation, this is very
difficult in practice — Bal: is conven-
ient to determine the weight of bodies
Axis must stand at right angles
to the plane of motion and a straight
line — two points of support
made like the axis edge turned up.
ways — but — 1st The Bal: must
again get itself on Hor: position —
the scales of an equal weight —
Arms exactly of the same length
— found by changing the weights —
& for the difference of the arms
11 : 11+1 : as the one arm is to
the other. The whole of the Bal:
ought to be very easily moved — this
depends upon a great many circum-
stances: the oblique position of the

alters the ::: of the arms —
Center of Gr. must be very near
its center of motion — the nearer
the axis of revolution the better
Hancenter this to the off. the
scale and set the bal: a vibrating
the slower the vibrations are, the
nearer the two centers coincide
when the vib: are very slow it
is a proof that it is very delicate
but it should not be carried away
in the middle — Assay Bal:
the nicest — Arms need not be very
exact as to length, for its use
is to determine the ::: of Gold & Silver
For the Assay Bal: the weights
must be very exact — common
way to adjust the weights, to begin
with the least weight — better at
the largest —

St.d Mom.m advantages — it is
easier to shift the axis than the
weights — Axis sustains a lesser
pressure than the common beat —
They have usually two or three
centers of M.n — Useful for weighing
very small weights — Steel yard
and two most parts of thin arbitrary
Built for very small weights
a strip of Mahogany — A needle
for the axis and another —

The body B C
is pressed downward
by all the fluid
incumbent on it
and upward by a
Col. of fluid from
D to E G a body
is pressed upwards with a weight
equal to the displaced fluid.
The diff. of pressure downward and upward
is equal to the displaced fluid
this is usually expressed by
saying that a body loses as
much of its weight in a fluid
as its bulk of that fluid
weighs but this is inaccurate

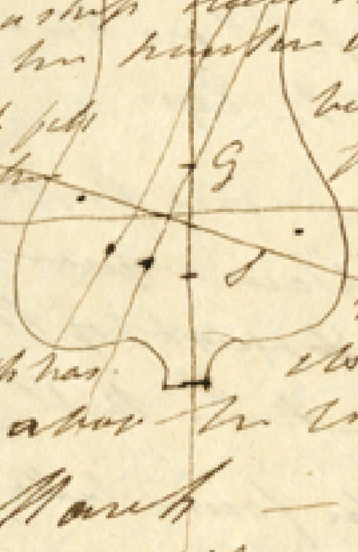
Exp! the air weighed out
of [illegible] the bulk of F: of
the weight — What the b: loses
the f: gains the press: under
bott: of the vessel is increased
by the quantity of F: in the
upper Cylinder, which the under
Cyl: filled exactly. The under
one is solid and goes into the
Fluid — That what is lost
by the solid is gained by
the F: is proved by first
counterpoising a jar filled water
water, with weights in the
opposite scale, and suspending
the brass Cyl: from a scale
placed higher, immersed
it in the Fluid: put

the both in equilibrium
then immerse the Cyl:
and the weight taken from one
scale when put on the other
will restore the Equi:

A body swimming the part
immersed displaces a quantity
of water = the weight of the
whole body — Hence the wt of a
ship may be found better than
by the common rules — small
quantity of water will float
a ship if compen[illegible]

Position of floating bodies
varies — They rest when the
Center of Gr: of the body and
of the fluid lies in the

over which it will be C. of
support or C. of the immersed
part
when a ship heels she will not
move her [illegible] unless the
Centre of G. [illegible] beyond the
[illegible] from the point



G. to [illegible] make the
move [illegible]
the ship has its greatest
angle above the water —

5 March — 1776

Of the Specific Gravities of Bodies —

If the weight of any fluid be
called 1 the : : gravity of any
body will be the No. of times
heavier than the fluid
Water is the most convenient
fluid because it can be procured

[illegible] different
in a state of the greatest purity
and is of the same weight all
over the globe — Standard Gold
the Sp: G is 19: that is it is
19 times heavier than its bulk
of water —

Exp —

1st To find the Sp: G. of Fluids —
weigh the G bubble in water
= 564 grs. | in Spirit of Turpentine
= 513 | 564 : 513 : : 1 : Specific
gravity Sp. T.

1st To find the Sp G. of a Solid
weigh it in air, and also then in
the fluid — Divide its weight
in air by what it loses in the
F: the quotient will be Sp. G.

for this purpose it is poured into a glass bucket

The bucket is first counterpoised in water taking care there be no air bubble in it —

A Guinea first weighed in without taking off the bucket

In air 105 Gr nearly
In water it lost about 6 Grains

add three cyphers to the Sp Gr and the sum is the weight of a cubic foot in ounces

6	105	$17\frac{1}{2}$
	6	
	45	
	42	
	3	
	6	

Sp G of salts cannot be found this way but they may in Spirit of Turp:

Considerable accuracy required in the Sp: and in Spirits —

Spirit proof in Hydrometer —

No 1 contains equal parts water and Alkohol
Glass bubbles

Alkohol 1 water 9 wine 19 parts i:e: to a hundred

To find the proportions of different Metals in a mixture —

m = mixture Wt
w = weight lost by Ditto
$x = h$ = Ditto lost by ye heaviest part
y l = Ditto by the lightest part

supp Gold $m : h :: x : \frac{xh}{m}$

Silv: $m : l :: y :$

$$\frac{xh}{m} + \frac{yl}{m} = w = \frac{xh+yl}{m}$$

$$w = \frac{mh - yh + yl}{m}$$

$$wm = mh - yh + yl$$

$$yl - yh = wm - hm$$

$$y = \frac{wm - hm}{l - h}$$

This is commonly called Archimedes theorem It cannot however be exact for many bodies when compounded do not preserve the same bulk as when separate