Questions

How many Centers are there in every body?

A. Three, the center of Gravity, Center of Motion, and center of magnitude.

Q. What is the center of Gravity of any body?

A. It is that point round which all the parts of the body are in equilibrio.

Q. What is the center of Motion?

A. It is that point round which a body moves.

Q. What is the center of magnitude?

A. It is a point taken as equally distant as possible from the extremities of the body.

Q. Can these centers all coincide?

A. Yes.

Q. When the center of gravity and center of Motion coincide what follows then?

A. The body will remain at rest in any position it can because, by the definition, if the center of gravity be supported, the whole body, which is as it were attached in that point, will also be supported.

Q. Has every body a center of Gravity?
A. Yes.
Q. Does the center of gravity of every body always fall in some point of that body?
A. No. for in many bodies as tongs, compasses and vessels of almost all sorts, the center of G. does not fall in the body at all but in some point within the body round which all the parts are in equilibrio.
Q. How is the center of Gravity found?
A. The center of Gravity may be found either Geometrically or Mechanically. For the first way see Galileo. It may be found Mechanically thus. assume any point in the body for a center of motion, if the body will remain at rest in any position on that center then that point is the center of Gravity. but if it do not remain at rest, then the center of Gravity will revolve about the center of motion, untill it get unto a line passing vertically thro' that center draw that line. then assume another center of motion and let the body revolve untill the center of Gravity get into the vertical then draw that vertical and the center of Gravity must be in both these lines

that is in the point where they cut each other.
If two equal bodies be suspended by two threads having a rod between them as the center of Gravity will be in the vertical passing thro' the point of suspension it will be found equally distant from either body, that is, in the middle of the rod. If the bodies are unequal then the center of Gravity, being still in the line passing vertically thro' the point of suspension, will be found to be distant from either body inversely as the Intensities or quantities of matter.
The common center of Gravity of two bodies is in a line joining their respective centers of Gy. and is a point whose distance from either body is always reciprocally as their weights.
The common center of Gravity of any number of bodies may be found thus, find the center of G. between any two of them, then find the center of Gravity between the center last found and a third body, and between this last center and a fourth, and so on to any number of bodies.
Q. By what experiments are these things proved
A. By a wheel moveable on its center of Gravity. Since the center of Gravity and motion coincide

the wheel remains at rest in any position. If a weight
be applied to one side of the wheel, then the center of
Gravity no longer coincides with the center of motion
but falls in a line joining the center of Gravity of
the Wheel and the center of Gy. of the body, and its
distance from the center of Gravity of the body is to
its distance from the center of Gy. of the wheel as the
quantity of matter in the wheel is to the quantity
of matter in the body. The body will not therefore re=
main at rest but will ~~move~~ revolve about the center
of motion untill the center of Gravity get into the verti=
cal line. If a body equal to the former be applied
to the wheel in a contrary direction then the wheel
will ~~be~~ remain at rest because since the bodies are equal
their common center of Gy. will fall in the middle of a line joining
their respective centers of Gravity that is in the middle
of the diameter of the Wheel and that is in the center of
Gy. of the Wheel. Unequal weights will ballance each
other provided the are applied at distances from the Cente
of Gy. of the wheel inversely as their weights. Thus
if a body be attached by a thread to the circumference
of the wheel and a body of Double the quantity of

matter be attached to any part of a line cutting the Radius
into 2 equal parts they will ballance. The same thing
will happen altho' the upper part of the wheel be cut
away provided the same quantity of matter be taken
from the opposite side. If we suppose the wheel cut
away all to line hence the transition from the wheel
to the ballance is easy.

Q. What is the ballance?

A. It is a line moveable upon an axis for its center
of motion which is in the middle of the line, having
its center of Gravity either coinciding with its center
of motion or falling above or below in the vertical.

In the Ballance as in the wheel, if equal weights
be applied at equal distances from the center they
will be in equilibrio, or if unequal weights be
applied at unequal distances provided the distances
be reciprocally as the weights they will also ballance
each other. If any number of weights be applied;
they will be in equilibrio if the sum of the products
of the weights into their respective distances from the center
on each side the center be equal to one another.

Thus let the Ballance be divided into any number of equal parts for instance each arm into 12. If two equal weights be applied, one at any division on the one arm, & the other at the correspondent division on the other they will be in equilibrio but not in any other situation. Again if two unequal weights be applied one at the 8th division, another double to that, at the 4th Division they will ballance, for, as in the wheel, their distances from the center are inversely as their quantities of matter. and the product of the quantity of matter on one side, into ~~the~~ its distance from the center, is equal to the product of the quantity of matter on the other side into its distance from the center. If on one arm be appended at the 4th division 2 pounds at the 6th.. 4 pounds, and at the 8th.. 3 pounds; if on the other be appended at the 2d division 3 pounds and at the 12th 4 pounds, the ballance will be in equilibrio. Because all the quantities of matter on the one side multiplied into their respective distances are equal the quantities ~~of~~ on the other side multiplied into their respective distances.

Q. Why do some bodies stand and others fall

A. A body will stand when a line passing vertically through the center of Gravity falls within the ~~body~~ base, and most firmly when it falls on the center of the base. But if the vertical line fall without the base the body will fall.

Q. Why do some bodies roll and others slide down an inclined plane?

A. A body will roll down an inclined plane when the center of Gravity falls without the base, because the point of contact of the body and the plane ~~=~~ being the center of motion, the center of G. will not fall in a vertical passing thro' the center of motion, It will therefore endeavour to descend untill it get unto the vertical. but the center of motion immediately changes its place and goes along with the center of Gravity. A body slides down an inclined plane when the center of G.y falls within the base. Because since the center of G.y in both cases must descend, if we suppose a solid body in form of a bar of square &c to be laid on an inclined plane then it must slide down, for if it should roll then it must sometimes have its angular points for a center of motion round which if the body revolved its center of Gy. must necessarily ascend which is impossible ___

Q. Why does a double cone &c roll upwards on two rulers inclined to each other

A. Because the center of Gr. really descends altho' it appears to ascend. In like manner a Cylinder of wood will roll up a plane Because, a piece of lead being inclosed near the circumference, the center of Gy. really descends ___

1 m

m

Q. What is Mechanics? A. ______

Q. What is the scope of Mechanics?

A. To assign a power that will ballance a weight on a given machine, Or conversely the power and weight being given to construct a machine on which they will ballance each other. ______

Q. How many kinds of machines are there?

A. Machines how various soever are reduced to 2 sorts, Simple and compound.

Q. How many simple machines are?

A. Principally two, the Lever and inclined plane

Q. Are there not others reduced to these?

A. To the Lever are reduced, Wheel and pinnion pully, Barrels and handspikes, axis in peritrochio. To the inclined ~~plain~~ are reduced, Screw, Wedge.

Q. What is the Lever?

A. An inflexible line used for the raising of weights to a small distance.

Q. How many things are to be considered about the Lever.

A. Three, the weight to be raised, the power applied to raise that weight, and the fulcrum or prop that supports both the power and the weight.

Q. How many kinds of Levers are there?

A. Three. When the fulcrum is placed betwixt the power and the weight it is called a lever of the first kind; when the weight is placed between the fulcrum and the power, it is a lever of the second kind; and when the power is applied be=tween the fulcrum and the weight, it is a lever of the ~~second~~ third kind.

Of the first kind are Iron crows, scissar, pincers &c

Of the second kind are doors turning on hinges, rudders of ships, oars &c.

Of the third kind are, the bones of our legs and arms a ladder reared against a wall &c.

Q. How is the advantage of the power ~~of~~ over the weight in levers of the first kind calculated?

A. From the same principles as the ballance, that is if the power and weight are to one another reciprocally as their distances from the fulcrum, or the spaces moved thro' by the weight and power be to one another ~~[illegible]~~ inversely as their forces then they will ballance.

Q. How are the second kind calculated?

A. In the same manner as the first, that is as the distance of the power from the fulcrum is to the distance of the weight, so is the weight to the power. Or as the space moved through by the power, is to the space moved through by the weight so is the weight to the power. Thus if a weight be placed on the middle of the Lever it may be raised by a power equal to half the weight &c.

Q. How are the third kind calculated?

A. From the same principles, but here the power acts at disadvantage, for the power being applied between the weight and the fulcrum, it must exceed the weight, as much as the distance of the weight exceeds that of the power. that is as in the former cases, ~~[illegible]~~ the power and weight are inversely as their distances from the center of motion or fulcrum.

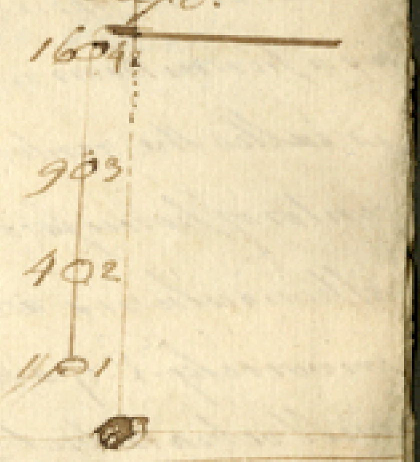
I am an [illegible]

thus if the power be applied to a point in the Lever equally distant from the fulcrum and the weight, the power must be double the weight to make an equilibrium But Levers of this kind have their advantage for as the other two serve to produce a slow motion of the weight by a quick motion of the power; this produces a quick motion of the weight by a slow motion of the the power. It is by this kind of Levers that the muscular motions of animals are performed; the muscles being inserted much nearer to the center of motion, than the point where the center of Gravity of the weight to be raised is applied; so that the power of the muscle is many times greater than the weight which it is able to ~~lift~~ to sustain. It is found that the distance between the elbo and the finger tops is twenty times greater than the distance of the muscle from the center of motion in the elbo, thus I can lift a weight 20 times greater from my foot than I can hold out in my hand.

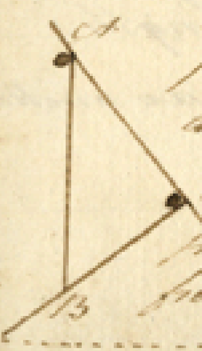
Of the Descent of heavy bodies in vertical lines &c

The spaces moved thro are directly as the squares of the times consequently the times are as the square roots of the spaces proved by suspending 4 bodies on one thread whose distances from the Horizontal plain are to one another as their □s that is if the 1st be 1 from the ground, the second must be 4, the 3, 9, the 4th 16, if they are all dropt at the same time, they will fall in equal times that is the space of time between each stroke of ~~time~~ will be equal

Exp:



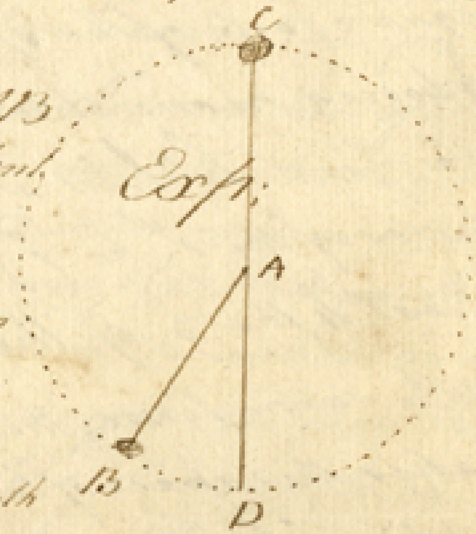
The time of the descent of any body in any chord of a circle is equal to the time of its descent through the diameter of the circle in a vertical line



proved by placing the right angled triangle ABC in such a manner that AB shall be ~~parralel~~ perpendicular to the horizon. if a ball be dropt from A and C at the same instant they will at the same instant reach the bottom point B

In small arcs of circles the chords nearly coincide with the arcs, the time of ½ a vibration therefore will be equal to the descent through a vertical line equal twice the length of the pendulum

If the ball C and the pendulum AB be both dropt at the same instant they will at the same instant reach D

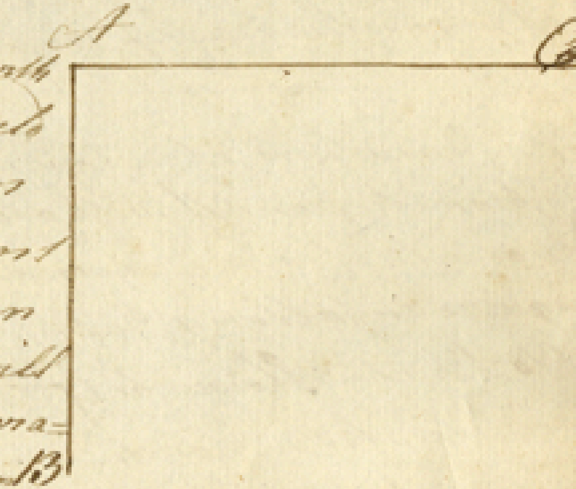


Hence a pendulum will perform one vibration in the same time that a body will fall vertically thro' 4 times the ~~diameter~~ the length of the pendulum.

If a rod be suspended it will vibrate in the same time as a pendulum $= \frac{2a}{3}$ (its length a) ∴ the point $\frac{2a}{3}$ from the point of susp.n is called the center of Oscillation, which is also the center of percussion. The times of the vibrations of pendulums are as the ~~squares~~ roots of their lengths inversely. E.G. a pendulum 4 times as long as another will vibrate but ½ so fast.

Every body projected on the surface of the earth describes a parabola unless it be projected in a vertical

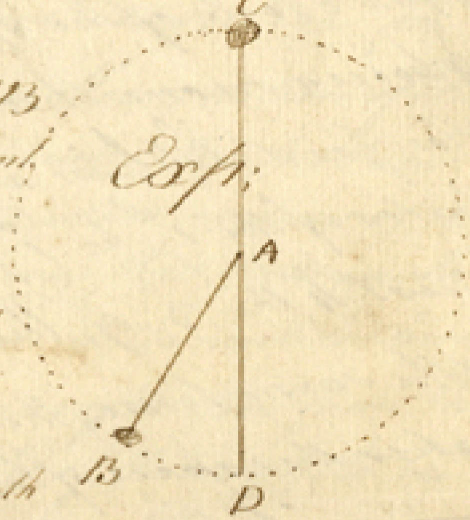
If a body be projected from B with the same velocity that it would have acquired in falling from A to B then AB will represent the impetus and AB drawn parallel to the Horizon will be the directrix of all the parabolas at any given elevation



A body projected in a line parallel to the Horizon, and a body dropt from the same height on the Vertical will at the same instant reach the Horizon.

In small arcs of circles the chords nearly coincide with the arcs, the time of ½ vibration therefore will be equal to the descent through a vertical line equal twice the length of the pendulum

If the ball C and the pendulum AB be both dropt at the same instant the[y] will at the same instant reach D



Hence a pendulum will perform one vibration in the same time that a body will fall vertically thro' 4 times the ~~diameter~~ the length of the pendulum.

If a rod be suspended it will vibrate in the same time as a pendulum $= \frac{2}{3}$ of its length ∴ A point $\frac{2}{3}a$ from the point of susp^n is called the center of Oscillation, which is also the center of percussion. The times of the vibrations of pendulums are as the square roots of their lengths inversely. E.G a pendulum 4 times as long as another will vibrate but ½ so fast.

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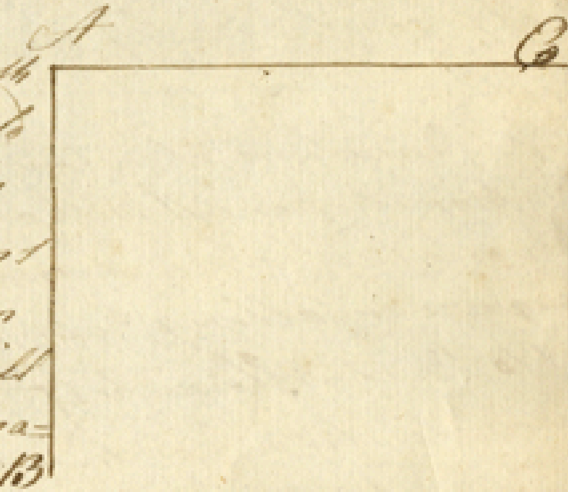

A body projected in a line parallel to the Horizon and a body dropt from the same height on the Vert[ical] will at the same instant reach the Horizon.

Of Central forces

If a body be projected round a ~~curve~~ point to which it is continually pressed it will describe a curve

If a pendulum at rest over B is projected from A with a force equal to that which it would acquire in falling from A to B it will describe a circle if it be projected with a force greater than the afore said it will describe an elipse whose lesser axis will be AC drawn from the point A perpendicular to DE the line of the projection. If it be projected with a lesser force it will describe an elipsis whose greater axis is AC. Now to project the body with any given force let the pendulum which rests over B be brought to A and there supported in such a manner that the least force will strike it off. let there be another pendulum of equal length which rests over A if this last be removed to ~~to~~ D so that DA be equal to AB and there let go it will strike the other at A with the same velocity that it would acquire in