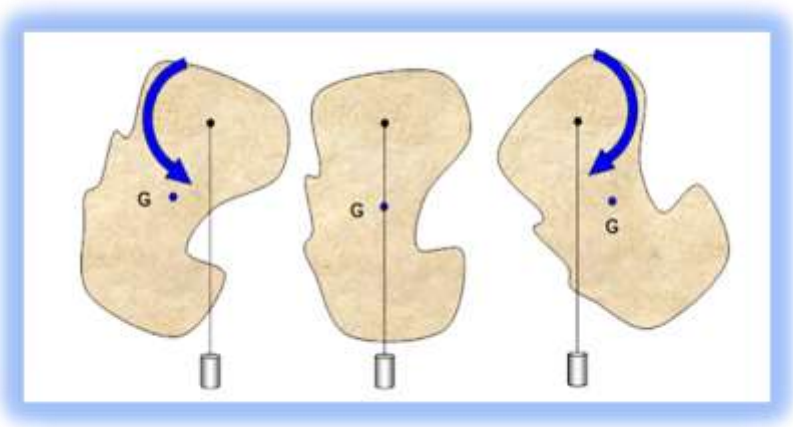
2020

EQUILIBRIUM AND C.O.G



TEACHERS OF PHYSICS

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9/10/2020

1. **Define** the term centre of gravity of an object. (1mk)

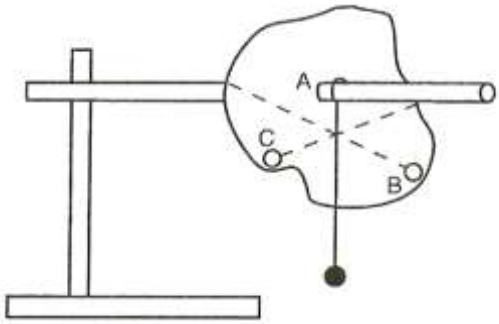
Refers to the point where the whole weight of a body acts from

2. Differentiate between a body in a stable state of equilibrium and one in an unstable state of equilibrium.

A body is said to be in stable state of equilibrium if it returns to its original position after being displaced slightly, while a body is said to be in an unstable state of equilibrium if on being displaced slightly does not return to its original position

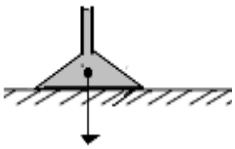
3. With the aid of a diagram, describe an experiment to determine the cog of an irregular lamina. (6mks)

Set the apparatus as shown below,

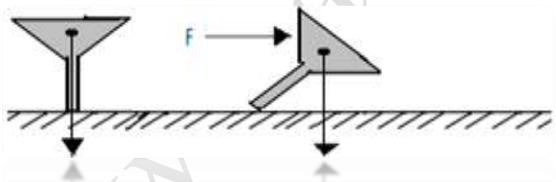


- Remove the cardboard and balance it on the tip of a pencil.
- The suspended object will always rest with its centre of gravity vertically below its point of support.
- The object balances on the tip of the pencil it placed at its centre of gravity.

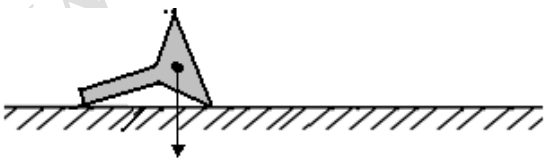
4. Use simple sketches to show the three states of equilibrium. (3mks)



Stable state



Unstable state



Neutral state

5. State two ways in which the stability of an object can be reduced. (2mk)

-Increasing the height of the object/position of C.OG
-Reducing the base area of the object

6. Explain why racing cars have wide tyres. 1mk

- Wider tires increase the base area of the race cars which in turn lowers the centre of gravity hence increase stability.
- This allows the rally cars to move around corners at relatively higher speeds without overturning.

7. State two factors that determine the stability of a vehicle
- height of the vehicle/position of C.O.G
- base area the vehicle is resting on

8. A bus carrying standing passengers has a higher chance of overturning than one with sitting passengers. Explain. (1mk)

Standing passengers each raise the center of gravity of the given bus thus making it unstable thus susceptible to overturning

9. The stability of a body can be increased by increasing the base area and lowering its centre of gravity. State **one** way of lowering its centre of gravity.
- reducing the height of the given body
- Having more weight on the lower part of the body.

10. A person carrying a heavy luggage using one hand leans away from the luggage. State the reason for this. (1mk)
-He/she leans in the opposite side in order to adjust the position of his centre of gravity until a state of balance is achieved.

11. State the necessary conditions for equilibrium of body which is acted upon by a number of forces

-The sum of clockwise moments about any point is equal to the sum of anticlockwise moments about the same point.
-The sum of forces in one direction on a body is equal to the sum of forces acting on the body in the opposite direction.

12. State the modification introduced in the modern buses so as to enhance stability
- The heaviest parts (engine, luggage compartments) are located at the lower most end of the bus.
-The uppermost parts of the busses are made of lighter materials.

13. Tall buildings are built with lighter materials at the upper part. Explain.(2mk
This is to reduce weight exerted at the top of the building, thus ensures the center of gravity of the building is low thus the building becomes stable.

14. A tight rope walker carries a pole to maintain stability. **Explain** how he used it to achieve it.
The pole adds more weight below the center of gravity of the walker, hence increased stability

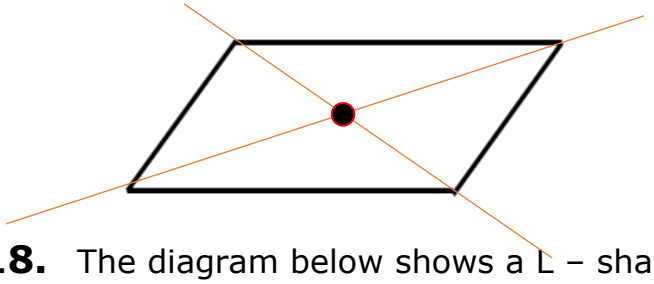
15. State two factors that may be considered when designing the body of a racing car to enhance stability. (2mk)

-Height of the car.
-base area of the car

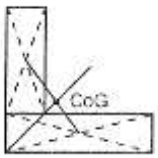
16. State two conditions necessary for a rigid body to be in equilibrium. (2mk)
-Should have a lower centre of gravity
-Should have wider base area.

17. The figure below shows a uniform cardboard in the shape of a parallelogram.

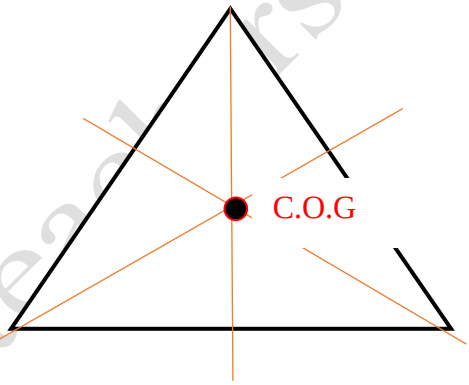
Locate the centre of gravity of the cardboard. **(1mk)**



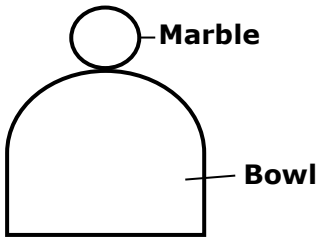
18. The diagram below shows a L – shaped solid Identify the position of centre of gravity. **(2mks)**



19. Locate the centre of gravity of the figure below. **(3mk)**



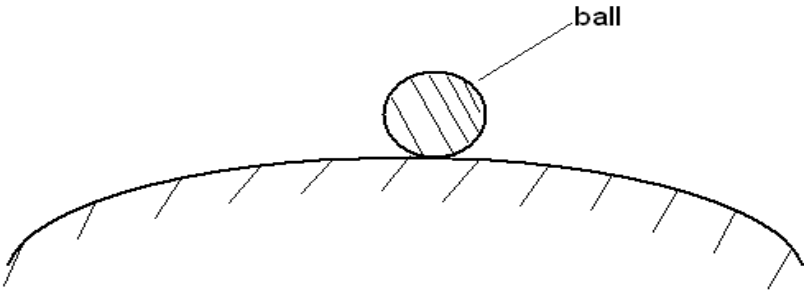
20. Figure below shows a marble placed on an inverted bowl.



State and explain the type of equilibrium the marble is in. (2 mk)

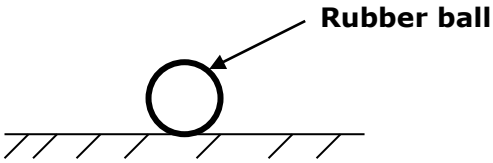
-Unstable state; position of the cog shifts when the ball is slightly displaced

21. In which state of equilibrium does the ball in the diagram below posses?



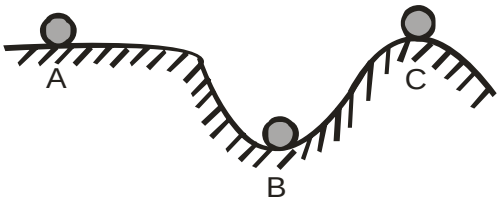
Unstable Equilibrium

22. State the type of equilibrium for a rubber ball placed on a horizontal table (1 mk)



Neutral Equilibrium

23. The figure below shows spherical balls placed at different positions on a surface. Name the state of equilibrium of the ball in each position. (3mk)

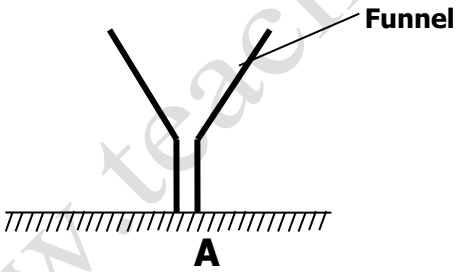


A...Neutral Equilibrium

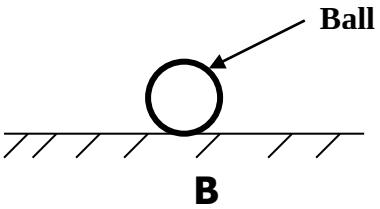
B...Stable Equilibrium

C...Unstable Equilibrium

24. State the type of equilibrium represented by each of the objects **A** and **B** below. (2mk)



Unstable Equilibrium

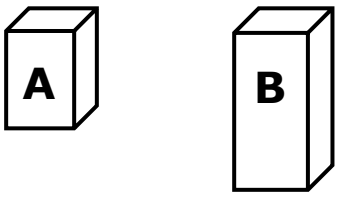


Neutral Equilibrium

25. A tight rope walker carries a pole to maintain stability. Explain how he used it to achieve it

He used the pole to increase base area hence increased stability.

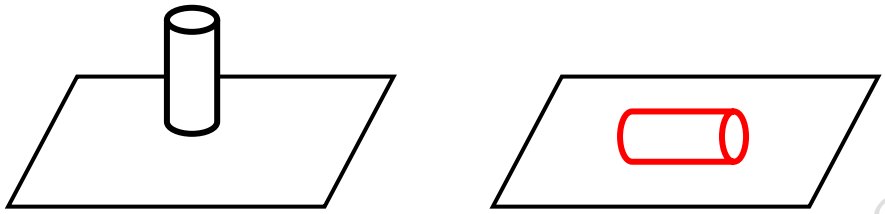
26. Two iron bars A and B with the same cross section area stand on a horizontal table as shown.



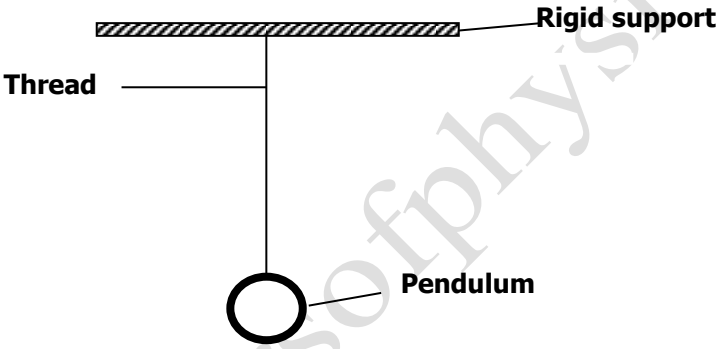
State and explain which of the bars is more stable. (2mks)

A is more stable than B. The position of C.O.G of A is lower than that of B.

27. The figure below shows a solid cylinder standing on a horizontal surface. The cylinder is in stable equilibrium. On the horizontal space provided, sketch the cylinder in neutral equilibrium. (1mk)



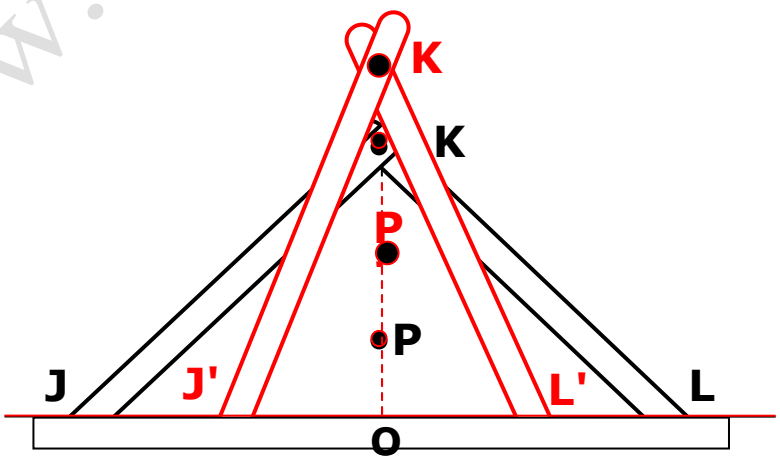
28. Figure shows how a freely suspended simple pendulum settles.



State and explain the type of equilibrium of the pendulum. (2mks)

Stable Equilibrium

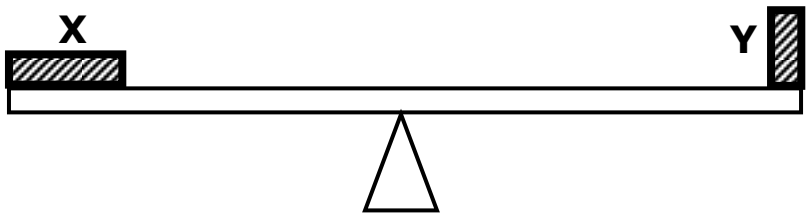
29. The figure below shows two identical rods **JK** and **LK** connected with a hinge at **K**



The position of the centre of gravity for the system is at **P**. The arrangement is now adjusted so that **J** and **L** move equal distances towards **O**. Sketch the new

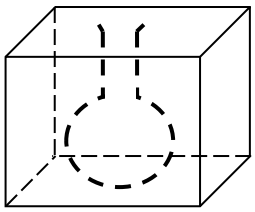
arrangement on the same diagram and mark the new position of the centre of gravity. (1mk)

30. Two identical solid cuboids **X** and **Y** are placed on a uniform metre rule pivoted at its centre as shown below. State and explain the observations made. (2mk)



The metre rule moves in clockwise direction. The C.O.G of Y is higher making it less stable.

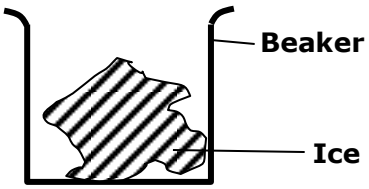
31. The figure below shows a rectangular block of wood with a hollow section (inside) at the position shown. The block is resting on a horizontal bench.



State the effect on the stability of the block when the hollow section is filled with water. (2mk)

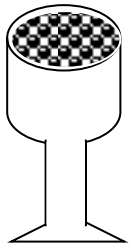
Stability is increased/more stable. Lower section is heavier/more massive on the bottom when filled with water lowering the C.O.G of the block.

32. Fig shows a beaker placed on a bench. A block of ice is placed in the beaker as shown. State and explain the change in the stability of the beaker when the ice melts.



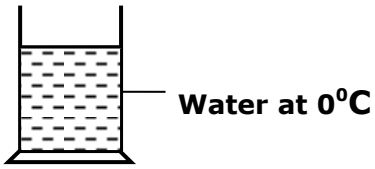
The stability of the beaker is increased because the position of C.O.G is lowered on melting since water is denser than ice.

33. Figure below shows a glass filled with ice placed on a bench.



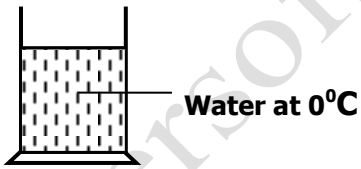
State the change on the stability of the glass when temperature increases. (1mk)
The stability reduces. The ice melts into water which is more dense. Higher density raises C.O.G, higher C.O.G reduces stability.

34. The figure below shows beaker containing water at $\mathbf{0^0}$. The beaker is placed on a bench.



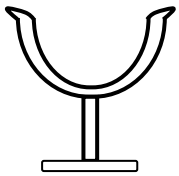
State and explain the changes in stability of beaker when water freezes
Stability lowered. The position of C.O.G when water freezes is high therefore lowering stability.

35. The diagram below shows a tall tube half filled with frozen ice at $\mathbf{0^0}$ **C**



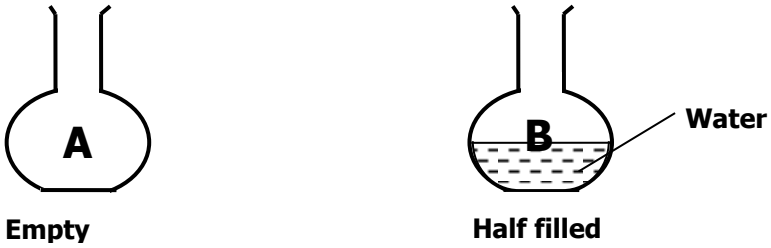
If the tube is warmed upto $\mathbf{4^0C}$, state and explain the effect of this on the stability of the tube. (2mk)
The tube becomes more stable. The volume of water being lower and denser than that of ice, the C.O.G is lowered.

36. The figure below shows a wine glass.



(i) State how the stability of the wine glass is affected if it is being filled with wine. (1 mk)
The stability lowers.
(ii) **Explain** your answer in (i) above. (2mks)
More weight/mass is being added which makes the position of C.O.G higher hence reduced stability.

37. Two flasks, A and B were placed on a horizontal surface as shown in figure 2



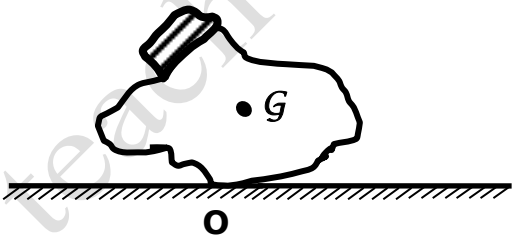
State and explain which flask is more stable (2mk)

Half filled flask B is more stable. More mass is on the lower part of the flask lowering the position of C.O.G

38. The figure below shows a wooden sphere with a nail hammered in to it at point A as shown below.

The sphere is rolled on a horizontal ground and comes to rest after some time at point Y. **Draw** the sphere after it comes to rest at point Y. (1mk)

39. Figure below represents a rock balanced at point **O. G** is the centre of gravity of the rock.

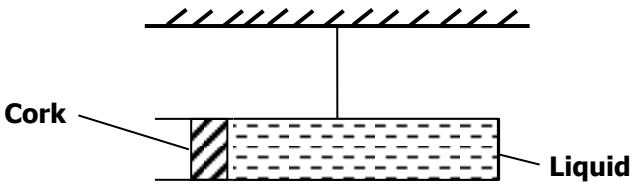


a) Draw and label on the fig the force acting on the block. **(2mk)**

b) If the portion of the rock represented by the shaded part is chopped off. Explain why the rock may topple to the right. **(2 mks)**

The rock moves to the right because the C.O.G shifts due to more weight/mass to the right. Weight will have a clockwise movement about O causing greater movement of the force towards right than left.

40. The figure below shows a liquid in a long cylindrical tube closed at one end with a cork. The cork is tight fitting but movable. The system is in equilibrium.



(i) State two observations that would be made when the tube is gently heated uniformly. (1mk)

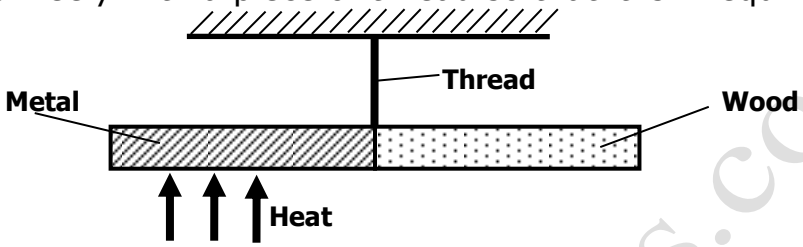
The tube becomes unbalanced/anticlockwise movement.

The cork moves towards left.

(ii) Explain your observation above. (2mk)

Liquid expands on heating pushing the cork towards left. More weight on the left shifting the C.O.G hence anticlockwise movement.

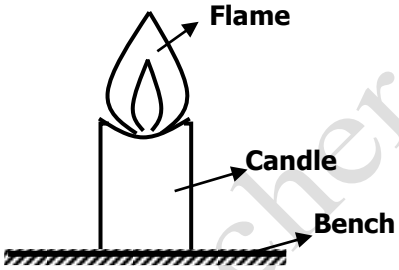
41. The figure below shows a rod made of wood on one end and metal on the other end, it is suspended freely with a piece of thread so that it is in equilibrium.



The side made of metal is now heated with a Bunsen flame. State and explain the observation made. (2mk)

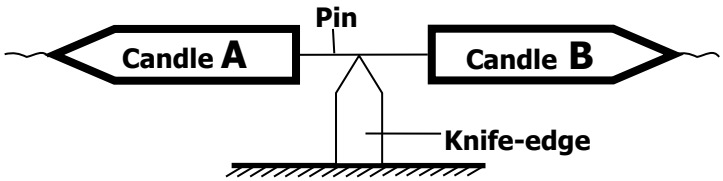
On heating, the metal expands thus making the position of C.O.G to shift to the right. The system therefore becomes unbalanced.

42. Fig represents a flaming **non-drip** candle. State and explain how the candle's stability changes as it burns. (2mk)



The stability increases as the position of C.O.G keeps on shifting downwards.

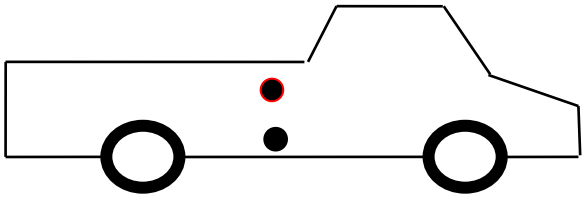
43. Two candles **A** and **B** of equal lengths and thickness are joined together and balanced horizontally as shown below.



If candle **B** is lit, what observation is made after a short time?. Give reason for your answer. (2mk)

The system becomes unbalanced/anticlockwise movement. The weight of candle B reduces with time making the C.O.G to shift from the knife edge towards candle A.

44. Figure below shows a track loaded such that its center of gravity is as shown with a dot.



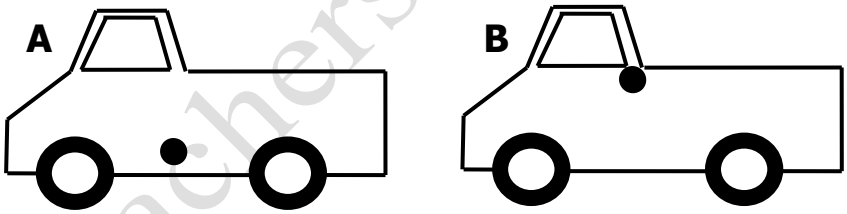
More weights are added on the top of the first load. Indicate on the diagram, the relative position of the new center of gravity. (1mk)

45. The figure below show two identical trolleys with loads A and B. The loads are identical in shape and size.

Given that the density of **A** is greater than that of **B**, state and explain which trolley is more stable. (2mk)

Trolley ii is more stable. Low density/weight/mass lowers C.O.G. Lower C.O.G increases stability.

46. Two identical pick-ups A and B are loaded such that their centre of gravity is as shown in.



State with a reason which one of the pick-ups is more stable. (2mks)

Pick up A. It's position of C.O.G is very low hence increased stability than that of B.

