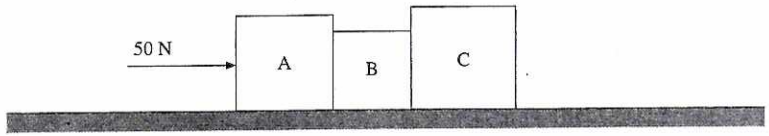
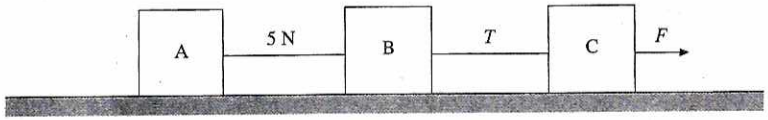
✪3. Three cubes, A, B and C, of mass 20 kg, 5 kg and 10 kg respectively are lying on a smooth horizontal surface. The cubes are in contact with each other as shown in the figure. Initially, the cubes are stationary. A horizontal force of 50 N is then exerted on cube A.



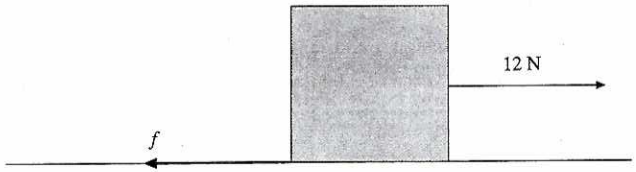
(a) Determine the acceleration of cube C.
(b) Determine the force exerted on cube C by cube B.

✪4. Three identical cubes, A, B and C, each of mass 5 kg, are connected together with light inextensible strings. The cubes are placed on a smooth horizontal surface. The cubes are dragged across the surface by a horizontal force of F applied to cube C. Given that the strings are taut and the tensions in the strings are 5 N and T respectively, determine

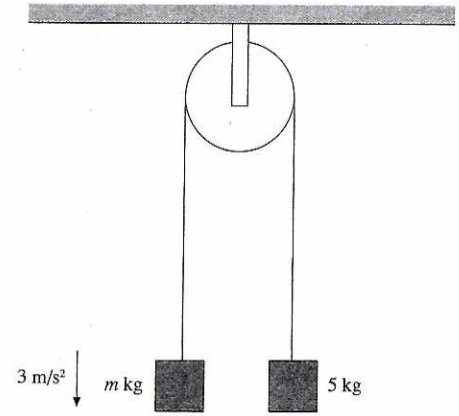


(a) the acceleration of the cubes,
(b) the values of F and T.

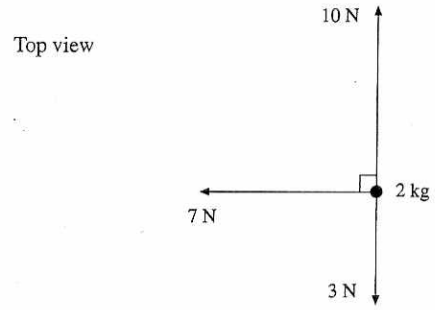
5. An object with a mass of 5 kg lies on a rough horizontal surface. When a constant horizontal force of 12 N acts on the object, the acceleration of the object is 2.00 m/s^2. Determine the frictional force, f, acting on the object.



6. In the pulley system shown in the figure, the two blocks, m kg and 5 kg, are connected by a light inextensible string. The pulley wheel over which the string is run over is frictionless. When the blocks are released from rest, the m kg block falls downward with an acceleration of 3 m/s^2. Determine the
(a) tension in the string,
(b) value of m.



7. A 2 kg point mass lying on a smooth horizontal plane is acted upon by 3 horizontal forces as shown below.



Using graphical method or otherwise, determine the resultant force on the point mass. Hence determine the acceleration of the point mass.

10. Which one of the following statements about gravitational field is false?

A. All masses have gravitational fields.

B. The gravitational fields of masses with charge are stronger than that of neutral masses.

C. The gravitational field strength of the Earth is greater than that of the Moon because the Earth has a larger mass than the Moon.

D. The gravitational field of the Moon acts inwards towards the centre of gravity of the Moon.

11. Figure (a) shows a rubber balloon filled with helium gas at a room temperature of 30 °C and tied to the floor with a string. Figure (b) shows the same helium gas balloon at a different temperature T. Assuming no gases can enter or leave the balloon, how has the following properties of the balloon changed?

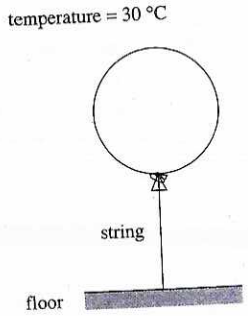


Figure (a)

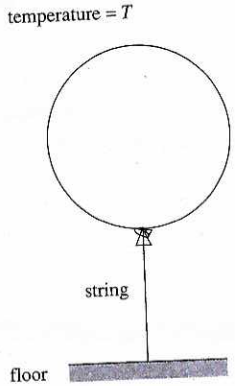


Figure (b)

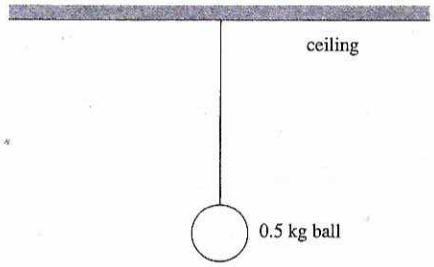
	Mass	Density	Temperature
A.	Increases	Remains unchanged	Increases ($T > 30°C$)
B.	Decreases	Increases	Decreases ($T < 30°C$)
C.	Remains unchanged	Decreases	Increases ($T > 30°C$)
D.	Remains unchanged	Remains unchanged	Decreases ($T < 30°C$)

Structured Questions

1. **(a)** State the differences between mass and weight.

(b) Explain how the mass of a body affects its motion.

2. A ball of mass 0.5 kg is suspended from the ceiling with the help of a light inextensible string as shown in the figure.



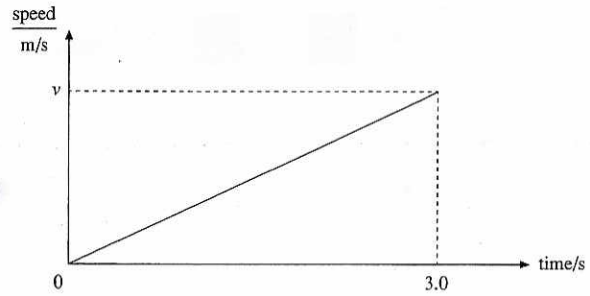
(a) State what is meant by the term *mass*.

(b) Taking the gravitational field strength to be 10 N/kg, state the resultant force acting on the ball

(i) before the string is cut,

(ii) after the string is cut.

(c) The ball takes 3 seconds to fall to the ground after the string is cut. The figure shows the speed-time graph of the ball. (Assume that air resistance is negligible.)



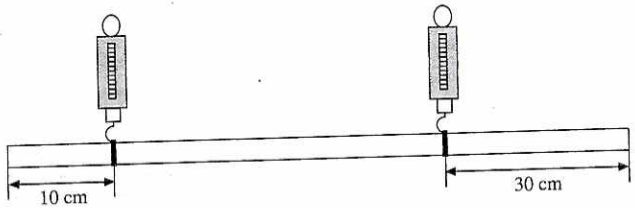
Determine the value of v and the distance travelled by the ball.

3. **(a)** Define *gravitational field strength*.

(b) A piece of irregularly shaped rock weighs 240 N on Earth. What is the weight of the rock when it is brought to the Moon? (Take the gravitational field strength on Earth to be 10 N/kg and the gravitational field strength on the Moon to be 1.6 N/kg.)

Structured Questions

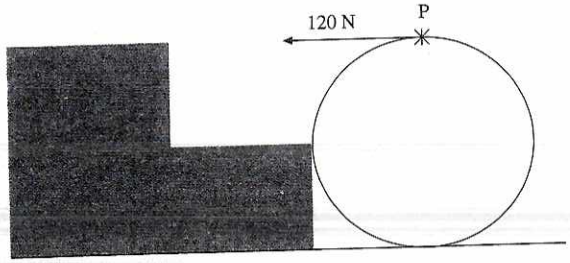
1. A 5 kg cylindrical rod of *non-uniform* density is supported by two identical spring balances. The length of the rod is 1.0 m. Given that both the spring balances show identical reading, determine the position of the centre of mass of the rod. (The gravitational field strength is 10 N/kg.)



2. The figure shows a Japanese Sumo wrestler squatting with his legs wide apart in a position ready for wrestling.

Explain how the Sumo wrestler's weight and the position he assumes (squatting) help him maintain stability.

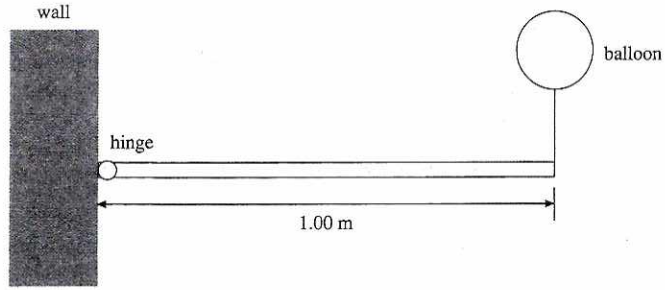
✪3. The figure shows the cross-section of a uniform solid cylinder of diameter 20 cm placed against a step. Given that the height of the step is 10 cm and that a minimum force of 120 N applied at point P is required to move the cylinder up the step, determine the mass of the cylinder.
(The gravitational field strength is 10 N/kg.)



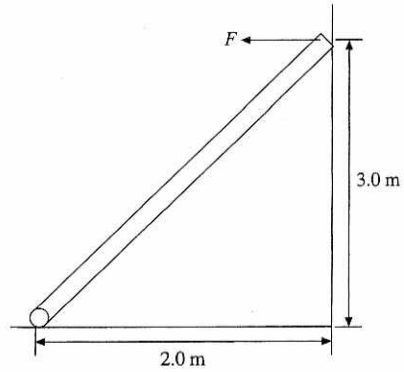
4. **(a)** A rubber balloon is filled with helium gas. If the volume of the balloon is 1000 cm^3 and the density of helium is 0.164 kg/m^3, determine the weight of the helium gas in the balloon.

(b) The balloon in part (a) is now fixed to one end of a 1 kg uniform rod with a light inextensible string. The other end of the rod is hinged to a vertical wall. Given that the rod remains in a horizontal position as shown, determine the tension in the balloon string.

(The gravitational field strength is 10 N/kg.)

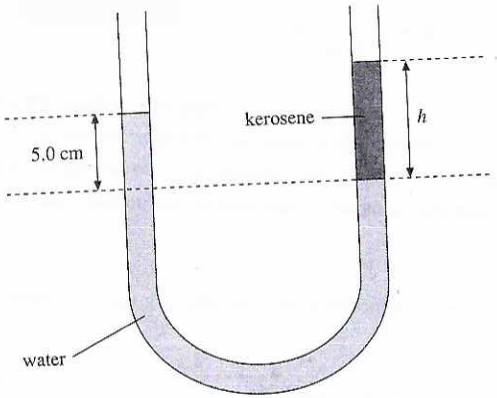


5. A uniform ladder is leaning against a smooth wall as shown. The base of the ladder is hinged to the floor. Given that the weight of the ladder is 150 N, determine the minimum horizontal force F required to just move the ladder away from the wall.



6. With the aid of a labelled diagram, describe a simple experiment to demonstrate the Principle of Moments.

10. The figure shows a U-tube which contains 2 different liquids: kerosene and water. Assuming that the cross-section of the U-tube is uniform, determine the height h.
(Given: density of water = 1000 kg/m^3 and density of kerosene = 810 kg/m^3)

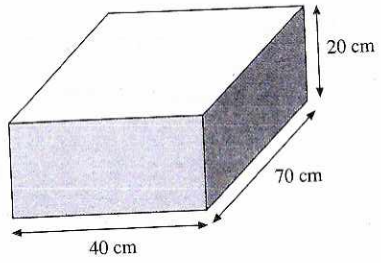


A. 1.17 cm
B. 4.05 cm
C. 6.17 cm
D. 7.34 cm

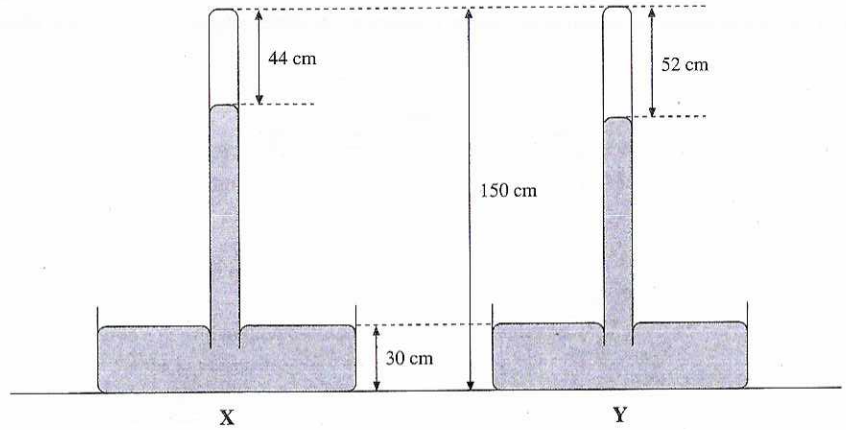
11. Given that all the wheels of the following trucks are identical, which truck is least likely to sink into soft ground?
A. Truck of mass 12 000 kg, with four wheels
B. Truck of mass 12 000 kg, with six wheels
C. Truck of mass 7000 kg, with four wheels
D. Truck of mass 7000 kg, with six wheels

Structured Questions

1. (a) State a formula that relates pressure P to force F and area A.
(b) The figure shows a rectangular block weighing 280 N. Using the formula you have stated in (a), determine the maximum pressure the block can exert when it is placed on a horizontal ground.

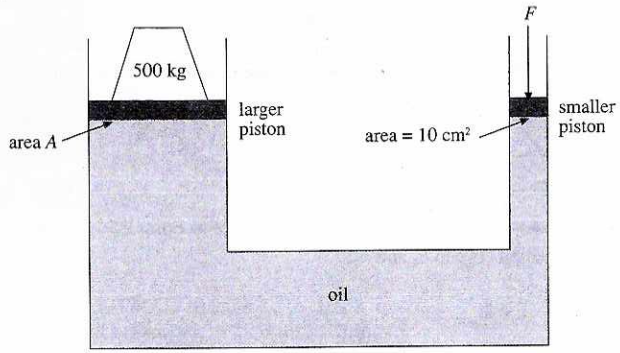


✪ 2. A student sets up two barometers, X and Y, side by side at sea level using identical glass tubes. The heights of the liquid columns are shown in the figure. The densities of the liquids used in X and Y are ρ_X kg/m^3 and ρ_Y kg/m^3 respectively.
(The gravitational field strength is 10 N/kg.)



(a) State the atmospheric pressures, in Pa, as measured by X and Y, in terms of ρ_X and ρ_Y respectively.
(b) Given that barometer X contains mercury, calculate the atmospheric pressure measured by X in terms of Pa. (Given: density of mercury = 13 594 kg/m^3)
(c) Suggest a possible reason why barometer Y has a shorter liquid column than X.

3. The figure shows a hydraulic system. By applying a force F at the smaller piston, a 500 kg load can be raised at the larger piston.
(The gravitational field strength is 10 N/kg.)



(a) If F = 100 N, determine the area A of the larger piston required to raise the 500 kg load.
(b) Using your result from (a), if the 500 kg load rises by 9 cm, determine how much the smaller piston has moved down.
(c) Suggest why oil has to be used in the hydraulic system and not air.