CHAPTER 10

Gravitation

ONE MARK QUESTIONS

1. Write SI unit of G.

Ans :

We know $F = \frac{Gm_1m_2}{r^2}$

or $G = \frac{Fr^2}{m_1m_2}$

In SI system, force F is measured in N, distance r in m and masses m_1 and m_2 in kg, therefore

$$\text{SI unit of } G = \frac{Nm^2}{kg.kg} = Nm^2kg^{-2}$$

2. Why is G called 'a universal gravitational constant'?

Ans :

The value of G is same for any pair of objects in the universe. Also its value does not depend on the nature of the intervening medium. That is why constant G is called 'universal gravitational constant'.

3. Why should we be sent flying in space if the force of gravity somehow vanishes today?

Ans :

The centripetal force required to keep us rotating along with the Earth would not be available in the absence of force of gravity. We would then fly off along the tangent to the Earth into the space.

4. Give difference between `g' and 'G' in a tabular form.

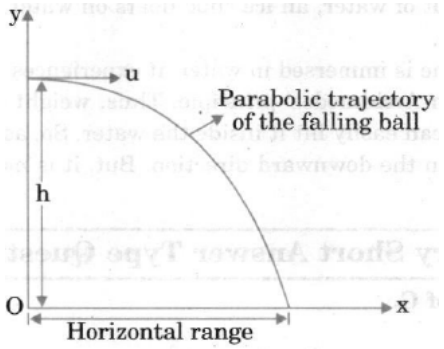
Ans :

	Gravity (g)	Gravitational constant (G)
1.	Acceleration acquired by a body due to Earth's gravitational pull on it.	Numerically equal to the force of attraction between two masses of 1 kg each apart of 1 m.
2.	Not a universal constant. Different at different places.	G is a universal constant. Value is 6.67 $\times 10^{-11}$ N-m^{2}kg^2
3.	Vector quantity	Scalar quantity

5. A ball moving on a table reaches the edge and falls. Sketch the path it will follow while falling.

Ans :

As the ball falls, it has a horizontal velocity and a vertical downward acceleration due to gravity. Under the combined effect of these two motion the ball moves along a parabolic trajectory as shown in figure



6. What is weightlessness?

Ans :

A body is said to be in a state of weightlessness when the reaction of the supporting surface is zero or its apparent weight is zero.

7. Is value of "g" same at all places on the Earth? Give reason for your answer.

Ans :

No, the value of "g" is maximum at the poles and minimum at equator. This variation is because to the oblong shape of the Earth and its rotation about its own axis.

8. Define the weight of an object on Moon.

Ans :

The weight of an object on the Moon is the force with which the Moon attracts that object.

9. What is the relation between gravitational force of the Moon with the Earth.

Ans :

The gravitational force of the Moon is about one-sixth of what it is on the Earth.

10. Name the scientist in whose honor the SI unit of pressure is named.

Ans :

The SI unit of pressure is named after Blaise Pascal.

11. Why does a mug full of water feel lighter inside water?

Ans :

A mug of water appears lighter inside the water because a buoyant force acts on the mug when placed inside the water.

12. What is the importance of universal law of gravitation?

or

Write four phenomenons which were successfully explained using universal law of gravitation.

Ans :

Many unconnected phenomenon can be explained by gravitational law successfully.

(i) Force bind us with Earth
(ii) Motion of Moon around Earth
(iii) Motion of planet around Sun
(iv) Tides due to the Moon and Sun

13. Name the force which accelerates a body in free fall.

Ans :

Gravitational force of Earth.

14. What is the unit of "g"?

Ans :

The unit of "g" is ms^{-2}.

15. Why value of "g" more or less constant on or near the Earth?

Ans :

Radius of Earth does not change much; "g" is more or less constant on or near the Earth.

THREE MARKS QUESTIONS

16. Derive a relationship between "g" and "G".

Ans :

Let a body of mass m be dropped from a distance R from the centre of the Earth.
Therefore, F exerted by the Earth on the body is,

$$F = \frac{G \times M_e \times m}{R^2}$$

Where, M_e is the mass of the Earth then, the acceleration of the body (a) is given by

$$A = \frac{\text{Force}}{\text{Mass of the body}}$$

$$= \frac{F}{m} = \frac{G \times M_e \times m}{R^2}$$

Thus, a is independent of the mass of the object falling towards the Earth. This acceleration "a" developed by a falling object is called the acceleration due to gravity. It is denoted by "g".

$$g = \frac{G \times M_e}{R}$$

17. Discuss the variation of weight of a body with the Latitude of Earth and Altitude of Earth.

Ans :

(i) Earth is not a perfect sphere.
(ii) Its radius at equator is longer than at the poles.
(iii) The acceleration due to gravity is inversely proportional to the square of the radius.
(iv) Therefore, the value of "g" at the poles is higher than that at the equator.
(v) As a result, the weight of an object increases if it moves from the equator to the poles.

18. Why are the ends of tools like knives, pins and nails pointed?

Ans :

The ends of tools such as pins, knives and nails are made pointed to increase the effect of the force. Because the pointed ends have much smaller areas. As result for a certain amount of force applied, the pressure becomes very large. That is why sharp edges needs very small force to cut fruits or vegetables.

19. Why the value of 'g' decreases when we move from the poles to the equator?

Ans :

The shape of Earth is an ellipse so when we move from the poles to the equator the radius of the Earth R increases. Hence, the value of 'g' decreases because value 'g' is inversely proportional to the radius of Earth.

$$g = \frac{GM}{R^2}$$

20. Explain : Centrifugal force and Centripetal force.

Ans :

A force which is required to move a body uniformly in a circle is known as centripetal force. This force acts along the radius and towards the centre of the circle, centrifugal force arises when a body is moving actually along a circular path, by virtue of tendency of the body to regain its natural straight line path. This force acts along the radius and away from the centre of the circle.

21. A certain particle has a weight of 30N at a place where the acceleration due to gravity is 9.8 m/s^2 (a) What are its mass and weight at a place where acceleration due to gravity is 3.5 m/s square (b) What are its mass and weight at a place where acceleration due to gravity is 0?

Ans :

(a) Weight of the body, W = 30, W = mg,
Mass of the body,

$$m = \frac{W}{g} = \frac{30}{3.5} = 8.5 \text{ kg}$$

New weight of the body,

$$W' = mg'$$

$$= (3.06)\ (3.5)\ N = 10.71\ N$$

(b) Mass remains the same but weight becomes zero.

22. How does the force of gravitation between two objects change when the distance between them is reduced to half?

Ans :

When the distance between the objects is reduced to half the gravitational force increases by four times the original force.

23. The gravitational force acts on all objects in proportion to their masses. Why, then, a heavy object does not fall faster than a light object?

Ans :

Acceleration due to gravity does not depend on mass of object. Hence, all bodies fall with the same acceleration provided there is no air or other resistance.

24. What is Gravitation?

Ans :

Gravitation is the force of attraction between two objects in the universe :

(i) Gravitation may be the attraction of objects by the Earth.
Example : If a body is dropped from a certain height, it falls downwards due to Earth's gravity. If a body is thrown upwards, it reaches a certain height and then falls downwards due to the Earth's gravity.

(ii) Gravitation may be the attraction between objects in outer space : Attraction between the Earth and Moon. Attraction between the Sun and planets.

25. Two objects of masses M_1 and M_2 are dropped in vacuum from a height above the surface of Earth (M_1 is greater than M_2). Which one will reach the ground first and why?

Ans :

Since acceleration is the rate of change of velocity, and velocity is the rate of change of position, objects dropped from the same height will feel the same acceleration, and so move with the same rate of increasing velocity, and so hit the ground at the same time, independent of their masses.

26. How does the force of gravitation between two objects change when the distance between them is reduced to half?

Ans :

When the distance between the objects is reduced to half the gravitational force increases by four times the original force.

27. The gravitational force acts on all objects in proportion to their masses. Why, then, a heavy object does not fall faster than a light object?

Ans :

Acceleration due to gravity does not depend on mass of object. Hence, all bodies fall with the same acceleration provided there is no air or other resistance.

28. Match the column :

	Cloumn I		Column II
(A)	Attraction between two planets	(1)	gravity
(B)	Attraction between a body and a planet	(2)	weightlessness
(C)	Free fall	(3)	gravitational force
(D)	Weight	(4)	gravitation

Ans :

(A - 4), (B - 1), (C - 2), (D - 3)

29. Why are objects in free fall weightless?

Ans :

An object falling freely is accelerated downward by gravity. Due to the downward acceleration, it experiences an upward inertial force. This upward force cancels the downward gravitational force. Hence, the object is weightless.

30. How can a person lie on a bed of nails without getting hurt?

Ans :

Weight is spread out over them all making the pressure on each individual nail just about equal to a pinch if there are many nails. The greater the number of nails the lesser will be the pressure per square inch. If there are a large number of nails, it will be almost like lying on a solid surface.

NUMERICAL QUESTIONS

31. Let us find force of attraction between two blocks lying 1 m apart. Let the mass of each block is 40 kg.

Ans :

$$F = ?$$
$$m_1 = 40 \text{ kg}$$
$$m_2 = 40 \text{ kg}$$
$$d = 1 \text{ m}$$
$$G = 6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$$
$$F = \frac{6.67 \times 10^{-11} \times 40 \times 40}{1 \times 1}$$
$$= 1.0672 \times 10^{-7}\text{N}$$

32. The gravitational force between two objects is 49 N. How much distance between these objects be decreased so that the force between them becomes double?

Ans :

Let 'r' be the distance between the object of mass m_1 and m_2

$$F = G\frac{m_1 m_2}{r^2}$$
$$49 = G\frac{m_1 m_2}{r^2} \quad \text{...(i)}$$

Now, the distance is reduced to 'x' so that the force become twice, then

$$2F = G\frac{m_1 m_2}{x^2}$$
$$98 = G\frac{m_1 m_2}{x^2} \quad \text{...(ii)}$$

Dividing eq. (i) by (ii)

$$\frac{G\frac{m_1 m_2}{r^2}}{G\frac{m_1 m_2}{x^2}} = \frac{49}{98}$$

$$\frac{x^2}{r^2} = \frac{1}{2} = x = \frac{r}{\sqrt{2}}$$

So, the distance must decrease by $\frac{1}{\sqrt{2}}$ times the original distance.

33. Two bodies A and B having masses 2 kg and 4 kg respectively are separated by 2 m. Where should a body of mass 1 kg be placed so that the gravitational force on this body due to bodies A and B is zero?

Ans :

Mass of body a is $M_a = 2$ kg

Mass of body b is $M_b = 4$ kg

Mass of body c is $M_c = 1$ kg

Separation between a and b = 2 m

Let the body C be placed at a distance d from body A

Gravitational force between A and C

$$F_{AC} = \frac{GM_aM_c}{d^2} = \frac{G \times 2 \times 1}{d^2}$$

$$= \frac{2G}{d^2} \quad ...(1)$$

Gravitational force between B and C is

$$F_{BC} = \frac{GM_bM_c}{d^2} = \frac{G \times 4 \times 1}{(2-d)^2}$$

$$= \frac{4G}{(2-d)^2} \quad ...(2)$$

For body C the gravitational force is 0.

Hence, $F_{AC} = F_{BC}$

$$\frac{2G}{d^2} = \frac{4G}{(2-d)^2}$$

$$(2 - d)^2 = 2d^2$$

$$2 - d = \sqrt{2}\, d$$

$$(\sqrt{2}+1)\, d = 2$$

$$d = 0.83$$

34. Calculate the force of gravitation due to a child of mass 25 kg on his mother of mass 75 kg if the distance between their centres is 1 m from each other. Given $G = (20/3) \times 10^{-11}$ Nm^2 kg^{-2}.

Ans :

Here $m_1 = 25$ kg; $m_2 = 75$ kg; d = 1 m;

$$G = \frac{20}{3} \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$$

Using $F = G\frac{m_1 m_2}{(d)^2}$

$$F = \frac{\frac{20}{3} \times 10^{-11} \times 25 \times 75}{(1)^2}$$

$$F = 12{,}500 \times 10^{-11}$$

or $F = 1.25 \times 10^{-7}$ N

35. A boy drops a stone from the edge of the roof. It passes a window 2 m high in 0.1 s. How far is the roof above the top of the window?

Ans :

Let a stone be dropped from the edge of the roof A. Let it passes over B with a velocity say u. Consider motion BC.

u = ?, a = 9.8 ms^{-2}; s = h = 2 m; t = 0.1 s

Using $s = ut + \frac{1}{2} gt^2$, we have

$$2 = u(0.1) + \frac{9.8}{2}(0.1)2$$

$$2 = 0.1u + 0.049$$

$$0.1\ u = 2 - 0.049$$

or $u = 19.51$ ms^{-1}

This initial velocity at B in motion BC is the final velocity in motion AB.

Considering motion AB, we have

u = 0; v = 19.51 ms^{-1}; s = ?; a = 9.8 ms^{-2}

Using $v^2 - u^2 = 2as$, we have

$$(19.51)^2 - (0)^2 = 2 \times 9.8\ s$$

or $s = 19.4$ m

Roof is 19.4 m above the window.

36. A ball thrown up is caught by the thrower after 4 s. With what velocity was it thrown up? How high did it go? Where was it after 3 s ? (g = 9.8 ms^{-2})

Ans :

Since, the time of going up is the same as that of coming down, therefore, time of going up = 4/2 = 2 s.

Let it starts upward with velocity u.

Here u = ?; a = – 9.8 ms^{-2}; t = 2 s; v = 0 (at the top); s = h

Using $v = u + at$

or $0 = u - 9.8 \times 2$

or $u = 19.6$ ms^{-1}

Again $v^2 - u^2 = 2as$

$$0 - (19.6)^2 = 2\ (-9.8)\ h$$

$$h = 19.6 \text{ m}$$

After 2 s, it starts coming downwards (starting with u = 0). Considering downward motion,

u = 0; a = 9.8 ms^{-2}; t = 3 – 2= 1s;

s = ?

$s = ut + \frac{1}{2}at^2$

or $s = 0 \times \frac{9.8}{2}(1)^2 = 4.9$ m from top.

37. Coconut is hanging on a tree at a height of 15 m from the ground. A boy launches a projectile vertically upwards with a velocity of 20 ms^{-1}. After what time the projectile pass by coconut? Explain the two answer in this problem.

Ans :

Here u = 20 ms^{-1}; a = – 10 ms^{-2}; s = 15 m; t = ?

Using $s = ut + \frac{1}{2} at^2$, we have

$$15 = 20t + \frac{1}{2}(-10)t^2$$

Dividing throughout by 5, we have

$$3 = 4t - t^2$$

or $t^2 - 4t + 3 = 0$

or $(t - 1)(t - 3) = t - 1 = 0$ or $t = ls$

or $t - 3 = 0$ or $t = 3$ s

After 1 s, it will cross coconut while going up and after 3 s while coming down.

38. A sealed tin of Coca Cola of 400 g has a volume of 300 cm^3. Calculate the density of the tin.

Ans :

Here, mass of tin, M = 400 g

Volume of tin, V = 300 cm^3

Density of tin, $D = \frac{M}{V} = \frac{400\text{ g}}{300\text{ cm}^3}$

$D = 1.33\text{ g cm}^{-3}$

39. A sealed can of mass 600 g has a volume of 500 cm^3. Will this can sink in water? Density of water is 1 g cm^{-3}.

Ans :

Here, mass of can, M = 600 g

Volume of can, V = 500 cm^3

Density of can, $D = \frac{M}{V} = \frac{600\text{ g}}{500\text{ cm}^3} = 1.2\text{ g cm}^{-3}$

Since, density of the can is greater than the density of water, so the can will sink in water.

40. A force of 200 N is applied perpendicular to its surface having area 4 square metres. Calculate the pressure.

Ans :

Thrust = 200 N

Area = 4 m^2

Pressure = ?

$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}} = 200\ \frac{\text{N}}{4}\ \text{m}^2$

$= 50\text{ Nm}^{-2} = 50\text{ Pa}$

41. The density of water is 1000 kg m^3. If relative density of iron is 7.874, then calculate the density of iron.

Ans :

Density of water = 1000 kg/m^3

Relative density (R.D.) of iron = 7.874

Using, R.D. of iron we get

Density of iron = R.D. of iron × density of water

$= 7.874 \times 1000\text{ kg/m}^3$

$= 7874\text{ kg/m}^3$.

42. A plastic bottle of 500 g has a volume of 450 cm^3. Will the bottle float or sink in water? Density of water is 1 g cm^{-3}? Also calculate the mass of the water displaced by the bottle.

Ans :

Mass, M = 500 g

Volume, V = 450 cm^3

Density of bottle, $D = \frac{M}{V} = \frac{500\text{ g}}{450\text{ cm}^3} = 1.11\text{ g cm}^{-3}$

Since, density of bottle is greater than the density of water (1 g cm^{-3}), so the bottle will sink in water.

Mass of water displaced by the bottle

= Volume of water displaced × Density of water

= Volume of bottle × Density of water

= 450 cm^3 × 1 g cm^{-3}

= 450 g.

43. What is the force of gravitation between two point masses of 1 kg and 2 kg kept 1 m apart?

Ans :

$m = 1\text{ kg}, m_2 = 2\text{ kg}, r = 1\text{ m}$

$F = G\frac{m_1 m_2}{r^2}$

$F = \frac{6.67 \times 10^{-11} \times 1 \times 2}{(1)^2}$

$= 13.34 \times 10^{-11}\text{ N}$

This is an extremely small force.

44. A particle is thrown up vertically with a velocity of 50 m/s.

(a) What will be its velocity at the highest point of its journey?

(b) How high would the particle rise?

(c) What time would it take to reach the highest point?

Ans :

At the highest point the velocity will be zero. Considering activity A to B

Using $v = u + at$

$0 = 50 - 9.8 \times t$

$t = 5.1$ sec

Also $v^2 - u^2 = 2as$

$0^2 - (50)^2 = 2\ (-9.8) \times s$

$s = 127.5$ m

45. A ball is dropped from the top of a tower 40 m high. What is its velocity when it has covered 20 m? What would be its velocity when it hits the ground? Take g = 10 m/s^2.

Ans :

Let the point B be at a height of 20 m.

Activity from A to B :

$u_1 = 0, a_1 = 10\text{ ms}^{-2}$,

$s_1 = 20\text{ m}, v_1 = ?$

$v_1^2 - u_1^2 = 2a_1s_1$

$v_1^2 - 0^2 = 2\ (10)\ (20)$

$v_1^2 = 20^2$

$v_1 = 20$ m/s

Activity from A to C : C is a point on the ground

$u_2 = 0$, $a_2 = 10\ ms^{-2}$, $s_2 = 40$ m,

$v_2 = ?$

$v_2^2 - u_2^2 = 2a_2s_2$

$v_2^2 - 0^2 = 2\ (10)(40)$

$v_2^2 = 800$

$v_2 = 28.28\ ms^{-1}$

46. A body is thrown up with a speed 29.4 ms^{-1}.

(i) What is its speed after (a) t = 1 s, (b) t = 2 s and (c) t = 3 s.

(ii) What is its height after (a) t = 1 s, (b) t = 2 s and (c) t = 3 s.

Ans :

(i) (a) $u = 29.4\ ms^{-1}$, $a = -9.8\ ms^{-2}$, $t_1 = 1$ s, $v_1 = ?$

$v_1 = u + at_1$

$= 29.4\ (-9.8) \times 1 = 19.6\ ms^{-1}$

(b) $u = 29.4$ ms, $a = -9.8\ ms^{-2}$, $t_2 = 2$ s, $v_2 = ?$

$v_2 = u + at_2$

$= 29.4 + (-9.8) \times 2 = 9.8\ ms^{-1}$

(c) $u = 29.4\ ms^{-1}$, $a = -9.8\ ms^{-2}$, $t_3 = 3$ s, $v_3 = ?$

$v_3 = u + at_3$

$= 29.4 + (-9.8) \times 3 = 0$

(ii) (a) $u = 29.4\ ms^{-1}$, $a = -9.8\ ms^{-2}$, $s_1 = h_1$, $t_1 = 1$s

$h_1 = ut_1 + \frac{1}{2}at_1^2 = 29.4 \times 1\ (-9.8) \times 1$

$= 24.5$ m

(b) $u = 29.4\ ms^{-1}$, $a = -9.8\ ms^{-2}$, $s_2 = h_2$, $t_2 = 2$ s

$h_2 = ut_2 + \frac{1}{2}\ at_2^2$

$= 29.4 \times 2 + \frac{1}{2}\ (-9.8) \times (2)^2 = 39.2$ m

(c) $u = 29.4\ ms^{-1}$, $a = -9.8\ ms^{-2}$, $s_3 = h_3$, $t_3 = 3$ s

$h_3 = ut_3 + \frac{1}{2}\ at_3^2$

$= 29.4 \times 3 + \frac{1}{2}\ (-9.8) \times 3^2 = 44.1$ m

47. What is the weight of a person whose mass is 50 kg?

Ans :

The weight of the person

$W = mg = 50 \times 9.8 = 490$ N

Note : The gravitational unit of force is kg-f (kilogram force) or kg-wt (kilogram weight) 1

g – wt = 9.8 N = 1 kg-f

490 N = 50 kg-f

48. Weight of a girl is 294 N. Find her mass.

Ans :

$W = mg$

$294 = m \times 9.8$

$m = 30$ kg

49. Weight of an object is 294 N on the surface of the Earth. What is its weight at a height of 200 km from the surface of the Earth. Radius of the Earth = 6400 km.

Ans :

Weight on Earth = $W_e = 294$ N

Radius of Earth = $R_e = 6400$ km

We have to find the weight at height 200 km from the surface of Earth

Total distance = 200 + 6400

$d = 6600$ km

Weight at height 200 km = $W_h = ?$

We know,

$$W_e = \frac{GM_e \times m}{R_e^2}$$

and $$W_h = \frac{GM_e \times m}{d^2}$$

G and M_e are constant.

$$W_e \propto \frac{m}{R_e^2} \text{ and } W_h \propto \frac{m}{d^2}$$

$$\frac{W_e}{W_h} = \frac{d^2}{R_e^2}$$

$$\frac{294}{W_h} = \frac{(6600)^2}{(6400)^2}$$

$$W_h = \frac{6400 \times 6400 \times 294}{6600 \times 6600}$$

$$W_h = 276.45\ \text{N}$$

Weight of the object at the height 200 km from the surface of the Earth is 276.45 N.

50. The gravitational, force between two objects is F. How will this force change, when :

(i) Distance between them is reduced to half?

(ii) The mass of each object is quadrupled?

Ans :

(i) According to Newton's law of gravitation, gravitational force F between two objects distance r apart is $\frac{GMm}{r^2}$

When distance between them is reduced to half, i.e., r' = $\frac{r}{2}$, the force.

Thus, F'' = 4F

i.e., force becomes 4 times its previous value.

Again, according to Newton's law of gravitation, the gravitational force F between two 'objects of masses m_1 and m_2 is $F \propto m_1m_2$

When mass of each object is quadrupled,

$m'_1 = 4m_1$

and $m'_2 = 4m_2$

The force, $F' \propto m'_1m'_2$

or $F' = 16\ F$

i.e., force becomes 16 times its previous value.

51. A sphere of mass 40 kg is attracted by a second sphere of mass 15 kg when their centres are 20 cm apart, with a force of 0.1 milligram weight. Calculate the value of gravitational constant.

Ans :

Here, $m_1 = 40$ kg, $m_2 = 15$ kg

From $r = 20 \text{ cm} = 2 \times 10^{-1}$ m

$F = 0.1$ milligram weight

$= 0.1 \times 10^{-3}$ gram weight

$= 10^{-4} \times 10^{-3}$ kg wt

$= 10^{-7} \times 9.8$ N (1 kg wt = 9.8 N)

As $F = \frac{GMm}{r^2}$

$$9.8 \times 10^{-7} = \frac{G \times 15 \times 40}{(0.2)^2}$$

$$9.8 \times 10^{-7} = \frac{G \times 600}{0.04}$$

$$9.8(0.040 \times 10^{-7}) = 600G$$

$$3.92 \times 10^{-7} = 600G$$

From $G = 6.53 \times 10^{-11}$ Nm^2/kg^2

52. Calculate the force of gravity acting on your friend of mass 60 kg. Given mass of Earth = 6×10^{24} kg and radius of Earth = 6.4×10^6 m.

Ans :

Here, $m = 60$ kg, $M = 6 \times 10^{24}$ kg

$R = 6.4 \times 10^6$ m, $F = ?$

$G = 6.67 \times 10^{-11}$ Nm^2/kg^2

$$F = \frac{GMm}{R^2}$$

$$= \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 60}{(6.4 \times 10^6)^2}$$

Thus, $F = 58.62$ N

53. A force of 15 N is uniformly distributed over an area of 150 m^2. Find the pressure in pascals.

Ans :

Here, force, $F = 15$ N

Area (A) $= 150$ cm^2

$= 150 \times 10^{-4}$ m^2

(1 cm $= 10^{-2}$ m, 1 cm$^2 = 10^{-4}$ m^2)

$$(P) = \frac{F}{A} = \frac{15}{150 \times 10^{-4}}$$

Thus, pressure, P = 1000 Pa

54. How much force should be applied on an area of 1 cm^2 to get a pressure of 15 Pa?

Ans :

Here, Area, A = 1 cm^2 = 10^{-4} m^2

Pressure (P) = 15 Pa = 15 N/m^2

As $F = P \times A$

$= (15 \text{ N/m}^2) \times (10^{-4} \text{ m}^2)$

$= 1.5 \times 10^{-3}$ N

55. A block weighing 1.0 kg is in the shape of a cube of length 10 cm. It is kept on a horizontal table. Find the pressure on the portion of the table where the block is kept.

Ans :

Here, force acting on the table,

F = 1.0 kg = 10 N

Area of the table on which this force acts,

A = 10 cm × 10 cm = 100 cm^2

$= 100 \times 10^{-4}$ m^2 = 10^{-2} m2

(1 cm^2 = 10^{-4} m^2)

$$P = \frac{F}{A} = \frac{10}{10^{-2}}$$

Pressure on the table,

P = 1000 Pa

56. Relative density of gold is 19.3. The density of water is 10^3 kg/m^3. What is the density of gold in kg/m^3?

Ans :

Given,

Relative density of gold = 19.3,

Density of water = 10^3 kg/m^3

Density of gold

= Relative density of gold × Density of water

$= 19.3 \times 10^3$

Density of gold = 19.3×10^3 kg/m^3.

57. Mass of aluminum is 67 kg. Volume of aluminium is 0.025 m^3. Calculate the density of aluminium.

Ans :

Given,

Mass of aluminium (M) = 67 kg,

Volume of aluminium (V) = 0.025 m^3

$$\text{Density} = \frac{M}{V} = \frac{67}{0.025}$$

$= 2680$ kg/m^3

58. The mass of brick is 2.5 kg and its dimensions are 20 cm × 10 cm × 5 cm. Find the pressure exerted on the ground when it is placed on the ground with different faces.

Ans :

Given, Mass of the brick (m) = 2.5 kg

Dimensions of the brick = 20 cm × 10 cm × 5 cm

Weight of the brick (Thrust/Force)

F = mg = 2.5 × 9.8

= 24.5 N

(i) When the surface area 10 cm × 5 cm is in contact with the ground, then

Area = 10 × 5 = 50 cm^2

$= \frac{50}{10000} = 0.005$ m^2

$$P = \frac{F}{A} = \frac{24.5}{0.005} = 4900 \text{ N/m}^2$$

(ii) When the surface area 20 cm × 10 cm is in contact with the ground, then

Area = 20 × 10 = 200 cm^2

$$= \frac{200}{10000} = 0.02 \text{ m}^2$$

$$P = \frac{F}{A} = \frac{24.5}{0.02} = 1225 \text{ N/m}^2$$

59. A force of 20N acts upon a body whose weight is 9.8N. What is the mass of the body and how much is its acceleration? Given, Force = 20 N, Weight W = 9.8 N. We know, W = mg ∴ 9.8 = m × 9.8 m = 1 kg

Ans :

We know $F = ma$

$20 = 1 \times a$

$a = 20 \text{ m/s}^2$

60. An object is thrown vertically upwards and reaches a height of 78.4 m. Calculate the velocity at which the object was thrown? ($g = 9.8 \text{ m/s}^2$)

Ans :

Given, $h = 78.4 \text{ m}$

$v = 0$

$g = -9.8 \text{ m/s}^2$

Now, $v^2 = u^2 - 2gh$

$u^2 - [2 \times (-9.8) \times 78.4] = 0$

$u^2 = 2 \times (-9.8) \times 78.4$

$u^2 = \frac{2 \times (-98) \times 784}{10 \times 10}$

$u = \sqrt{\frac{2 \times 2 \times 49 \times 784}{10 \times 10}}$

$u = \frac{2 \times 7 \times 28}{10}$

$u = 39.2 \text{ m/s}^2$

61. What is the mass of an object whose weight is 49 Newton?

Ans :

Given, Weight of object $W = 49\text{N}$

$g = 9.8 \text{ m/s}^2$

Now, $W = mg$

$m = \frac{W}{g} = \frac{49}{9.8} = 5 \text{ kg}$

62. The volume of 50 g of a substance is 20 cm^3. If the density of water is 1 g cm^{-3}, will the substance float or sink?

Ans :

Mass = 50 g

Volume = 20 cm^3

Density = ?

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{50 \text{ g}}{20 \text{ cm}^3}$$

$= 2.5 \text{ g cm}^{-3}$

As the density of substance is greater than water, so it will sink.

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Science IX

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