CHAPTER 3 GRAVITATION

Page No:100

Solution 1:
Value of gravitational constant G on the earth and the moon is = 6.67×10^{-11} Nm^2/kg^2
Note that the value of G always remains constant irrespective of the location.

Solution 2:
Gravitational force is responsible for the moon revolving round the earth.

Solution 3:
No, the acceleration produced in a freely falling body is independent of the mass of the body.

Solution 4:
Johannes Kepler gave the three laws of planetary motion.

Solution 5:
Newton explained the motion of planets on the basis of gravitational force between the sun and planets.

Solution 6:
Kepler's law of periods states that: The cube of the mean distance of a planet from the sun is directly proportional to the square of time it takes to move around the sun.

Solution 7:
Kepler's third law of planetary motion led Newton to establish the inverse-square rule for gravitational force between two bodies.

Solution 8:
Extremely large mass of the earth.

Solution 9:
Acceleration produced in a freely falling body, irrespective of its mass, is $9.8 m/s^2$

Solution 10:
Gravitational force of the earth.

Solution 11:
The gravitational force F between two bodies of masses M and m kept at a

distance d from each other is :

The gravitational force F between two bodies of masses M and m kept at a distance d from each other is :

$$F = G \times \frac{m \times M}{d^2}$$

Here, Gravitational constant, $G=6.7 \times 10^{-11} Nm^2 kg^{-2}$

Solution 12:
Gravitational force is responsible for the earth revolving round the sun.

Solution 13:
Gravitational force causes two objects lying apart attract each other.

Solution 14:
Gravitational force (exerted mainly by the moon and to some extent by the sun) is involved in the formation of tides in the sea.

Solution 15:
Gravitational force of the sun holds the solar system together.

Solution 16:
Weight, W = m x g
= 1 kg x $9.8 m/s^2$=9.8 N

Solution 17:
The weight of a body is directly proportional to its mass. It also depends on the acceleration due to gravity which varies from place to place.

Solution 18:
Weight of the body varies with altitude; mass of an object is constant.

Solution 19:
Its weight varies; mass of an object is constant.

Solution 20:
Weight, W = m x g = 10 x 9.8 =98 N

Solution 21:
Weight, W = m x g

Solution 22:
Its weight will be zero as value of g is zero at the centre of the earth.

Solution 23:
Weight, W= m x g =50 x 9.8=490N

Solution 24:
Weight of the body on the surface of moon will be 1N approx. as the value of g on the surface of moon is one-sixth that of the earth

Solution 25:
(a)True
(b)False
(c)False
(d)False
(e) False

Page No:101

Solution 26:
(a) One-sixth
(b) Mass
(c) Six times
(d) One-sixth
(e) Six times
(f) 36N

Solution 27:
This is the acceleration produced by the earth. It is also called acceleration due to gravity.

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$$g = G \times \frac{M}{R^2}$$

where, G= gravitational constant
M= mass of the earth.
R=radius of the earth

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M= mass of the earth.
R=radius of the earth

Solution 28:
(a) The falling of a body from a height towards the earth under the gravitational force of the earth (with no other forces acting on it) is called free fall.

(b) No, acceleration is independent of the mass of the body during free fall.

Solution 29:
Yes, Newton's third law of motion holds good for the force of gravitation. This means that when earth exerts a force of attraction on an object, then the object also exerts an equal force on the earth, in the opposite direction.

Solution 30:
The force of gravitation between two bodies is directly proportional to the product of their masses.

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$F \alpha m \times M$

Since the mass of cricket balls is very small as compared to that of the earth, so the force of gravitation between two cricket ba
small while that between a ball and the earth is extremely large.

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Solution 31:
The gravitational force F between two bodies of masses M and m kept at a distance d from each other is :

The gravitational force F between two bodies of masses M and m kept at a distance d from each other is :

$$F = G \times \frac{m \times M}{d^2}$$

The force between two bodies is inversely proportional to the square of the distance between them. That is,

$$F \alpha \frac{1}{d^2}$$

Therefore , if we double the distance between two bodies, the gravitational force becomes one-fourth and if we halve the distance between two bodies, then the gravitational force becomes four times.

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Solution 32:
(a) If we double the distance between two bodies, the gravitational force becomes one-fourth.
(b) If we halve the distance between two bodies, then the gravitational force becomes four times.

Solution 33:
(i) Universal law of gravitation is used to determine the masses of the sun, the earth and the moon accurately.
(ii) Universal law of gravitation helps in discovering new stars and planets.

Solution 34:
This is because the earth exerts a force of attraction (called gravity) on the stone and pulls it down.

Solution 35:

$$F = G \times \frac{m \times M}{d^2}$$

m=50kg
M=120kg
Distance, d=10m
$G=6.7 \times 10^{-11}\ Nm^2/kg^2$

$$F = 6.67 \times 10^{-11} \times \frac{50 \times 120}{10^2}$$

$$F = 6.67 \times 60 \times 10^{-11}$$

$$F = 4.02 \times 10^{-9}\ N$$

Solution 36:

Force due to gravity, $F = G \times \frac{m \times M}{d^2}$

$$F = 6.7 \times 10^{-11} \times \frac{6 \times 10^{24} \times 150}{(6.4 \times 10^6)^2}$$

F=1472N

Solution 37:
Distance d=1.5 x 10^8km= 1.5 x 10^{11} m
Mass of the sun, m=2×10^{30}kg
Mass of the earth,

Distance d=1.5 x 10^8 km= 1.5 x 10^{11} m
Mass of the sun, m=2 x10^{30} kg
Mass of the earth, M= 6 x 10^{24}kg
Force of gravitation, $F = G \times \frac{m \times M}{d^2}$

$$F = 6.7 \times 10^{-11} \times \frac{2 \times 10^{30} \times 6 \times 10^{24}}{(1.5 \times 10^{11})^2}$$

$$F = \frac{6.7 \times 10^{-11} \times 12 \times 10^{54}}{1.5 \times 1.5 \times 10^{22}}$$

$$F = \frac{6.7 \times 12 \times 10^{21}}{1.5 \times 1.5} = 3.57 \times 10^{22} N$$

Solution 38:
Initial velocity of the stone, u=?
Final velocity of
stone, v=0
Acceleration due to gravity, g= -9.8m/s^2
Time, t=3 sec
Using relation, v=u + gt
0 = u -9.8 x 3
u =29.4m/s

Solution 39:
Initial velocity,
u=0m/s
Acceleration due to
gravity, g=9.8m/s^2
Time taken to reach
the ground, t=2.5 sec
Height, h=?
Using relation,

Initial velocity, u=0m/s
Acceleration due to gravity, g=9.8m/s^2
Time taken to reach the ground, t=2.5 sec
Height, h=?
Using relation,

$$s = u\,t + \frac{1}{2}gt^2$$

$$s = 0 \times 2.5 + \frac{1}{2} \times 9.8 \times 2.5 \times 2.5$$

$$s = 0 + 4.9 \times 2.5 \times 2.5$$

$$s = 30.625 \text{ m}$$

Solution 40:
Height, s=20m
Initial velocity, u=0
Acceleration due to gravity, g=10m/s^2
Final velocity, v=?
Time taken, t=?
(i) Using relation,
(ii) For a freely falling body:

$v^2 = u^2 + 2gh$

Height, s=20m
Initial velocity, u=0
Acceleration due to gravity, $g=10m/s^2$
Final velocity, v=?
Time taken, t=?

(i) Using relation,

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

$$20 = 0 \times t + \frac{1}{2} \times 10 \times t^2$$

$$20 = 0 + 5t^2$$

$$t^2 = \frac{20}{5} = 4$$

$$t = \sqrt{4} = 2s$$

(ii) For a freely falling body:

$v^2 = u^2 + 2gh$

$= (0)^2 + 2 \times (10) \times (20)$

So, $v^2 = 400$

$v = \sqrt{400} = 20 m/s$

The speed of stone when it hits the ground will be 20m/s.

Solution 41:

Initial velocity, u=20m/s
Final velocity, v=0
Acceleration due to gravity, $g=-9.8m/s^2$
Height, h=?
Using relation, for a freely falling body:
$v^2 = u^2 + 2gh$
$(0)^2 = (20)^2 + 2 \times (-9.8) \times h$
$0-400 = -19.6\ h$
$h= 400/19.6 = 20.4\ m$

Solution 42:

Initial velocity, u=?
Final velocity, v=0
Acceleration due to gravity, $g=-10m/s^2$
Height, h=5 m
(a) For a freely falling body:
$v^2 = u^2 + 2gh$
$(0)^2 = u^2 + 2 \times(-10)\times 5$
$0= u^2 -100$
$u^2= 100$
So, u=10m/s

(b) Using relation, v=u + gt
0 = 10 + (-10) t
-10= -10 t
t=1sec

Solution 43:

Mass	Weight
1. The mass of an object is the quantity of matter contained in it.	1. The weight of an object is the force with which it is attracted towards the centre of the earth.
2. SI unit of mass is kilogram (kg).	2. SI unit of mass is newton (N).
3. The mass of an object is constant.	3. The weight of an object is not constant. It changes with the change in acceleration due to gravity.
4. The mass of an object can never be zero.	4. The weight of an object can be zero.

Solution 44:
Yes, weight of a body is not constant, it varies with the value of acceleration due to gravity, g.
Weight of a body is zero, when it is taken to the centre of the earth or in the interplanetary space, where g=0.

Page No:102

Solution 45:
Weight= 9.8N
W= m x g
9.8 =m x 9.8
m= 1kg
Force, F= mass x acceleration
20 N = 1kg x a
Acceleration,
a=20m/s^2

Solution 46:
Weight of the stone = Gravitational force acting on it = 20 N
Weight, W= m x g
20=m x 10
m=2 kg

Solution 47:
(i) Its mass will be 20 kg as mass is a constant quantity.
(ii)Weight, W= m x g =20 x 1.6=32N

Solution 48:
The mass of a body is more fundamental because mass of a body is constant and does not change from place to place.

Solution 49:
The weight of an object on the moon is about one-sixth of its weight on the earth. This is because the value of acceleration due to gravity on the moon is about one-sixth of that on the earth.

Solution 50:
(a) The mass of a body is the quantity of matter contained in it. The SI unit of mass is kilogram (kg).

(b) The weight of a body is the force with which it is attracted towards the centre of the earth. The SI unit of weight is newton (N).

(c) Weight, W =m x g, i.e. the weight of a body is directly proportional to its mass.

Solution 51:
(a) According to universal law of gravitation: Every body in the universe attracts every other body with a force (F) which is directly proportional to the product of their masses (m and M) and inversely proportional to the square of the distance (d) between them.

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$$F = G \times \frac{m \times M}{d^2}$$

Sir Isaac Newton gave this law.

(b) The gravitational constant G is numerically equal to the force of gravitation which exists between two bodies of unit masses kept at a unit distance from each other.

$$G = F \times \frac{d^2}{m \times M}$$

Units of gravitational constant= Nm^2/kg^2

Sir Isaac Newton gave this law.

Solution 52:
(a) The uniform acceleration produced in a freely falling body due to the gravitational force of the earth is called acceleration due to gravity of earth.

(b) Usual value of acceleration due to gravity, $g=9.8\ m/s^2$.

(c) SI unit of acceleration due to gravity is m/s^2.

Solution 53:

(a) No, the value of acceleration due to gravity (g) is not constant at all the places on the surface of the earth. Since the radius of the earth is minimum at the poles and maximum at the equator, the value of g is maximum at the poles and minimum at the equator. As we go up from the surface of the earth, the distance from the centre of the earth increases and hence the value of g decreases. The value of g also decreases as we go down inside the earth.

(b) Acceleration due to gravity,

$$g = G \times \frac{M}{R^2}$$

Mass, $M = 7.4 \times 10^{22}$ kg

Radius, $R = 1.74 \times 10^6$ m

Gravitational constant, $G = 6.7 \times 10^{-11}\ Nm^2/kg^2$

$$g = 6.7 \times 10^{-11} \times \frac{7.4 \times 10^{22}}{(1.74 \times 10^6)^2}$$

$$g = \frac{6.7 \times 7.4}{1.74 \times 1.74 \times 10}$$

$$g = 1.637\ m/s^2$$

As the value of $g = 1.637\ m/s^2$, which is one sixth the value of g on earth, the satellite could be moon.

Solution 54:

Kepler's first law: The planets move in elliptical orbits around the sun, with the sun at one of the two foci of the elliptical orbit. This law means that the orbit of a planet around the sun is an ellipse and not an exact circle. An elliptical path has two foci, and the sun is at one of the two foci of the elliptical path.

Kepler's Second law states that: Each planet revolves around the sun in such a way that the line joining the planet to the sun sweeps over equal areas in equal intervals of time. This means that a planet does not move with constant speed around the sun. The speed is greater when the planet is nearer the sun, and less when the planet is farther away from the sun.

Kepler's Third Law states that: The cube of the mean distance of a planet from the sun is directly proportional to the square of time it takes to move around the sun.

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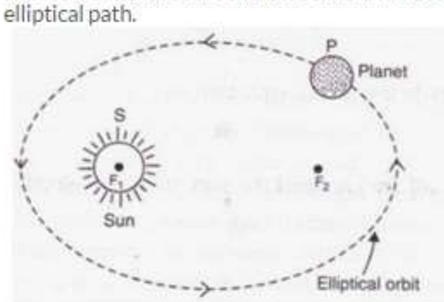

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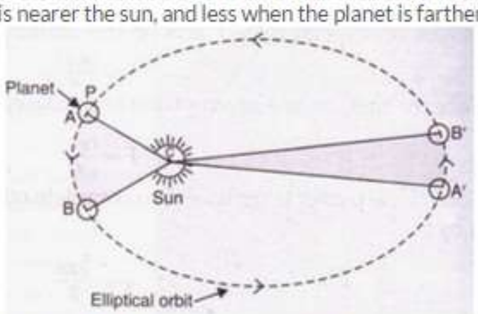

Kepler's Third Law states that: The cube of the mean distance of a planet from the sun is directly proportional to the square of time it takes to move around the sun.

$r^3 \alpha T^2$

Solution 55:

Acceleration due to gravity,

Acceleration due to gravity,

$$g = G \times \frac{M}{R^2}$$

Mass, M = $6x\ 10^{24}$kg

Diameter = 12.8×10^3 km = 12.8×10^6 m

Radius, R = $(12.8 \times 10^6)/2 = 6.4x\ 10^6$m

Gravitational constant, G= 6.7 x 10-11Nm^2/kg^2

$$g = 6.7 \times 10^{-11} \times \frac{6 \times 10^{24}}{(6.4x\ 10^6)^2}$$

$$g = \frac{6.7x\ 60}{6.4x\ 6.4}$$

$$g = 9.8 m/s^2$$

As the value of g=9.8m/s^2, the planet could be Earth.

Page No:103

Solution 71:

Gravitational force is given by:

Gravitational force is given by:

$$F = G \times \frac{m \times M}{d^2}$$

Distance between two masses is increased s.t. new distance is D= 5 d

New gravitational force $F_1 = F$

Let on of the mass is changed to m_1 so as to maintain the same gravitational force.

$$F_1 = G \times \frac{m_1 \times M}{D^2}$$

$$D = 5\,d$$

$$F = F_1$$

$$G \times \frac{m \times M}{d^2} = G \times \frac{m_1 \times M}{D^2}$$

$$G \times \frac{m \times M}{d^2} = G \times \frac{m_1 \times M}{25d^2}$$

$$\frac{m_1}{m} = 25$$

$m_1 = 25m$

Hence one of the masses should be increased by 25 times in order to have the same gravitational force.

Hence one of the masses should be increased by 25 times in order to have the same gravitational force.

Solution 72:

In order to be able to notice the gravitational force of attraction between any two objects, at least one of the objects on the earth should have an extremely large mass. Since no object on the earth have an extremely large mass, we cannot notice such forces.

The two objects in a room do not move towards each other because due to their small masses, the gravitational force of attraction between them is very, very weak.

Solution 73:

Acceleration due to gravity of earth,

Acceleration due to gravity of earth,

$$g = G \times \frac{M}{R^2} = 9.8 m/s^2$$

If mass of planet, m= M/2

And radius of planet, r= R/2

Acceleration due to gravity on the surface of planet will be:

$$g = G \times \frac{m}{r^2} \quad ---(i)$$

$$m = \frac{M}{2} \quad ----(ii)$$

$$r = \frac{R}{2} \quad -----(iii)$$

Put (ii) and (iii) in (i) eq. we get

$$g = G \times \frac{\frac{M}{2}}{(\frac{R}{2})^2} = \frac{4}{2} \times (G \times \frac{M}{R^2})$$

$$g = 2 \times 9.8 m/s^2$$

$$g = 19.6 m/s^2$$

Page No:104

Solution 74:

The coin reaches the ground first as compared to the piece of paper because it experiences lesser resistance from air than that felt by paper.

If the coin and the piece of paper are dropped in vacuum, both of them will touch the ground at the same time.

Solution 75:

The mass of a stone is very small, due to which the gravitational force produces a large acceleration in it. Due to large acceleration of stone, we see stone falling towards the earth. The mass of earth is, however, very, very large. Due to the very large mass of the earth, the same gravitational force produces very, very small acceleration in the earth, that it cannot be observed. And hence we do not see the earth rising up towards the stone.

Solution 76:

The actual shape of the orbit of a planet around the sun is elliptical. The assumption made by the Newton regarding the shape of an orbit of a planet around the sun was that the orbit of a planet around the sun is ‘circular’.

Solution 77:
(a) 9.23 m/s^2 , 7.34 m/s^2 , 3.08 m/s^2 , 1.49 m/s^2 , 0.57 m/s^2 , 0.30 m/s^2

(b) This distance F of 10000 km is high up in the sky. The distance of 10000 km cannot be deep inside the earth because the radius of earth is only about 6400km and the value of g at the centre of earth becomes zero.

Page No:123

Solution 1:
Grams per cubic centimtre (g/cm^3).

Solution 2:
Density of water =1000kg/m^3.

Solution3 :
Relative density of water is 1.

Solution 4:
Pressure has unit of Pascal (Pa).

Solution 5:
Pressure is measured in newtons per square metre (N/m^2) i.e., pascal (Pa).

Solution 6:
(a) False
(b) True

Solution 7:
Buoyant force on an object due to a liquid act s in the vertically upward direction.

Solution 8:
Upthrust is the other name of buoyant force.

Solution 9:
Buoyant force.

Solution 10:
The upward force acting on an object immersed in a liquid is called upthrust.

Solution 11:
Archimedes' Principle.

Solution 12:
The relative density of mercury is 13.6, this means that mercury is 13.6 times as heavy as an equal volume of water.

Solution 13:
Pressure is ‘thrust per unit area’.

Solution 14:
Buoyant force or upthrust.

Solution 15:
The tendency of a liquid to exert an upward force on an object placed in it, is called buoyancy.

Solution 16:
The buoyant force on a boat is caused by the pressure of water ‘pushing up’ on the bottom of the boat.

Solution 17:
The density of ice is less than that of water, so ice floats in water.

Solution 18:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$\begin{aligned}\text{Force} &= \text{Area} \times \text{pressure}\\ &= 0.5 \times 500\\ &= 250\text{N}\end{aligned}$$

Solution 19:
Since the object floats in the liquid, so the magnitude of the buoyant force exerted by the liquid is equal to the weight of the object.
Hence, buoyant force =200N

Solution 20:
Archimedes gave the magnitude of buoyant force acting on a solid object immersed in a liquid

Solution 21:

$$\text{Density of gold} = \frac{\text{mass of gold}}{\text{volume of gold}}$$

$$\text{Volume of gold} = \frac{\text{mass of gold}}{\text{density of gold}}$$

$$= \frac{95}{19} = 5cm^3$$

Solution 22:

Volume=5m^3

Density= 3000kg/m^3

Volume=5m^3

Density= 3000kg/m^3

$$\text{Density of cement} = \frac{\text{mass of cement}}{\text{volume of cement}}$$

$$\text{mass of cement} = \text{Density of cement} \times \text{volume of cement}$$

$$= 3000 \times 5 = 15000\text{kg}$$

Solution 23:

Mass of the substance = 100g

Volume of the substance =10cm^3

Mass of the substance = 100g

Volume of the substance =10cm^3

$$\text{Density of substance} = \frac{\text{mass of substance}}{\text{volume of substance}}$$

$$\text{Density} = \frac{100}{10} = 10g/cm^3$$

Solution 24:

Because the weight of the block of wood is less than the weight of an equal volume of water. So when it is completely submerged in water, the upward buoyant force on it is greater than the downward gravitational force on it. Hence, the lock rises to the surface.

Solution 25:

The body will float when dipped in a bucket of water as its density is less than that of water.

Solution 26:

(a) pressure

(b) buoyant

(c) average
(d) all; increases
(e) less; density
(f) weight; area
(g) bigger; smaller

Page No:124

Solution 27:
(a) The **density** of a substance is defined as mass of the substance per unit volume.

(a) The **density** of a substance is defined as mass of the substance per unit volume.

$$\text{Density of substance} = \frac{\text{mass of substance}}{\text{volume of substance}}$$

SI unit of density is kg/m^3.

The **relative density** of a substance is the ratio of its density to that of water.

$$\text{Relative Density of substance} = \frac{\text{Density of substance}}{\text{Density of water}}$$

It has no units.

(b)

$$\text{Relative Density of substance} = \frac{\text{Density of substance}}{\text{Density of water}}$$

$$7.1 = \frac{\text{Density of substance}}{1000 kg/m^3}$$

$$\text{density of substance} = 7.1 \times 10^3 kg/m^3$$

Solution 28:
The force acting on a body perpendicular to its surface is called thrust. The SI unit of thrust is newton (N).

Solution 29:
A mug full of water appears light as long as it is under water because buoyant force acts on it which reduces its effective weight and makes it appear lighter.

Solution 30:
As more and more volume of the solid object is immersed in the liquid, the upward 'buoyant force' also keeps on increasing. When the object is completely immersed in the liquid, the buoyant force acting on the solid becomes maximum and remains constant thereafter.

Solution 31:
As more and more volume of our body is immersed in water, the apparent weight of the body goes on decreasing and the body seems to become lighter. This is due to the increase in upward buoyant force acting on the body.

Solution 32:
Big boulders weig much less while in water and as such are easily moved by the flood.

Solution 33:
An iron nail sinks in water but it floats in mercury because density of iron is more than that of water but less than that of mercury.

Solution 34:
A piece of glass sinks in water but it floats in mercury because density of glass is more than that of water but less than that of mercury.

Solution 35:
A piece of steel sinks in water because steel is denser than water. However, a steel ship is a hollow object made of steel and contains a lot of air in it. Due to presence of a lot of air in it, the average density of the ship becomes less than the density of water. Hence a ship floats in water.

Solution 36:
School bags have wide straps so that their weight may spread over a large area of shoulder producing less pressure on the shoulder.

Solution 37:
A sharp knife cuts objects easily because due to its very thin edge, the force of our hand falls on a very small area of the object producing large pressure.

Solution 38:
Concrete or wooden sleepers are kept below the railway line so that the weight of passing train is spread over a large area of ground and the track may not sink into the ground.

Solution 39:
A wide steel belt is provided over the wheels of an army tank so that they exert less pressure on the ground and do not sink into it.

Solution 40:
The tip of the sewing needle is sharp so that due to its sharp tip, the needle may put the force on a very small area of the cloth, producing a large pressure sufficient to pierce the cloth being stitched.

Solution 41:
When a man is walking, then at one time only one foot is on the ground. Due to this, the force of weight of man falls on a smaller area of the ground and produces more pressure on the ground. On the other hand, when the man is standing, then both his feet are on the ground. Due to this, the weight of the man falls on a larger area of the ground and produces lesser pressure on the ground.

Solution 42:
Snow shoes stop us from sinking into soft snow because due to large area of snow shoes, our weight is spread over a large area of the snow producing small pressure.

Solution 43:
When a person stands on a cushion then only his two feet (having small area) are in contact with the cushion. Due to this the weight of man falls on a small area of the cushion producing a large pressure causing a big depression in the cushion. On the other hand, when the same person lies down on the cushion, then his whole body (having large area) is in contact with the cushion. Here, his weight falls on a much larger area of the cushion producing much smaller pressure and very little depression in the cushion.

Solution 44:
Flat shoes have greater area in contact with the soft sand as compared to heels. Due to this, there is less pressure on soft sand because of which they do not sink much in the sand and it is easy to walk on it.

Solution 45:
A nail has a pointed tip, so that when it is hammered, the force of hammer is transferred to a very small area of wood creating a large pressure which pushes the nail into the wood.

Page No:125

Solution 46:
The foundations of buildings and dams are laid on a large area of ground so that the weight of the building or dam produces less pressure on the ground and they may not sink into the ground.

Solution 47:
A ship made of iron and steel is a hollow object which contains a lot of air in it. Due to the presence of a lot of air in it, the average density of the ship becomes less than the density of water. Hence a ship floats in water.
On the other hand, a piece of iron is denser than water, so it sinks in water.

Solution 48:
Camels have large flat feet so that there is a greater area in contact with the sand which produces less pressure on the sand and the camels can move easily on the sand.

Solution 49:
(a) Buoyant force
(b) Force of friction
(c) Gravitational force
(d) Reaction force

Solution 50:
If the area is made one-third i.e. $1m^2$, then the force would be:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$\text{force} = \text{Area} \times \text{pressure}$$
$$= 3 \times 10$$
$$= 30N$$

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$$= 1 \times 10$$
$$= 10N$$

Solution 51:
Force, F= 550N
Area of contact of one shoe $= 160\ cm^2 = 160 \times 10^{-4} m^2$

Area of contact with two shoes =160 x 2 =320 cm^2=320 x $10^{-4}m^2$

Force, F= 550N

Area of contact of one shoe =160 cm^2 =160 x $10^{-4}m^2$

Area of contact with two shoes =160 x 2 =320 cm^2=320 x $10^{-4}m^2$

(a) If the girl stands on two feet,

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$= \frac{550}{320 \times 10^{-4}} = 17\,187.5 N/m^2$$

(b)

If she stands on one foot,

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$= \frac{550}{160 \times 10^{-4}} = 34375 N/m^2$$

Solution 52:

Volume =$3m^3$

Mass = 9kg

$$\text{Density of substance} = \frac{\text{mass of substance}}{\text{volume of substance}}$$

$$\text{Density of substance} = \frac{9}{3} = 3kg/m^3$$

And density of water = 1000kg/m3

The object will float in the water as the density of the object is less than the density of water.

The object will float in the water as the density of the object is less than the density of water.

Solution 53:

The object will weigh less in water because an upward force (buoyant force) equal to the weight of water displaced acts on the object when immersed in water which reduces its weight apparently.

Solution 54:

(a)

(a)

$$\text{Density of substance} = \frac{\text{mass of substance}}{\text{volume of substance}}$$

(b)

For material A:

Mass= 5kg

Volume =20 cm^3 = 20 x $10^{-6}m^3$

$$\text{Density of material A} = \frac{5}{20 \times 10^{-6}} = 0.25 \times 10^{6} kg/m^3$$

For material B:

Mass =20kg

Volume =90 cm^3 = 90x $10^{-6}m^3$

$$\text{Density of material B} = \frac{20}{90 \times 10^{-6}} = 0.22 \times 10^{6} kg/m^3$$

Density of material A is more than density of material B.

(b)

For material A:

Mass= 5kg

Volume =20 cm^3 = 20 x $10^{-6}m^3$

For material B:

Mass =20kg

Volume =90 cm^3 = 90x $10^{-6}m^3$

Density of material A is more than density of material B.

Solution 55:

(a) The upward force acting on an object immersed in a liquid is called buoyant force.

Factors affecting buoyant force:

(i) Volume of object immersed in the liquid,

(ii) Density of the liquid.

(b) The cause of buoyant force is the greater upward pressure exerted by water underneath the object..

(c) Mass of water displaced = 600kg

Weight of water displaced, W =m x g

=600 x 10 =6000N

Since, the weight of water displaced by the boat is 6000N, therefore the buoyant force acting on the boat will also be 6000N.

Solution 56:
(a) According to the principle of floatation: An object will float in a liquid if the weight of object is equal to the weight of liquid displaced by it.
Weight of object = Weight of liquid displaced by it.
(b) Weight of water displaced by boat= 6000N
(i) Buoyant force =6000N, as the weight of water displaced is equal to buoyant force.
(ii) Weight of a floating object = Weight of water displaced by it = 6000N

Solution 57:

Solution 58:
(a) Pressure is the force acting perpendicularly on a unit area of the object.

(a) Pressure is the force acting perpendicularly on a unit area of the object.

(b)

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

(c) (i) Pressure on an area of 10 m^2

Force =200N

$$\text{Pressure} = \frac{200}{10} = 20\text{Pa}$$

(ii) Pressure on an area of 5 m^2

Force =200N

$$\text{Pressure} = \frac{200}{5} = 40\text{Pa}$$

Page No:126

Solution 59:
(a) Those substances which can flow easily are called fluids. All the liquid and gases are fluids, like water, air etc.

(b) Archimedes' Principle :
When an object is wholly (or partially) immersed in a liquid, it experiences a buoyant force (or upthrust) which is equal to the weight of liquid displaced by the

object.
Buoyant force on an object = weight of liquid displaced by that object

(c) If the buoyant force exerted by the liquid is less than the weight of the object, the object will sink in the liquid. If the buoyant force exerted by the liquid is equal to or greater than the weight of the object, the object will float in the liquid.

Solution 60:
(a) A floating boat displaces water equal to its own weight. This displaced water exerts buoyant force to balance the weight of boat and keep it afloat.

(b) (i) Mass = 96 g
Volume = $12 cm^3$

$$\text{Density of substance} = \frac{\text{mass of substance}}{\text{volume of substance}}$$

$$\text{Density of substance} = \frac{96}{12} = 8 g/cm^3$$

(ii) Mass = 96×10^{-3} kg
Volume = $12 \times 10^{-6} m^3$

$$\text{Density of substance} = \frac{\text{mass of substance}}{\text{volume of substance}}$$

$$\text{Density of substance} = \frac{96 \times 10^{-3}}{12 \times 10^{-6}} = 8 \times 10^{3} kg/m^3$$

Solution 61:
Weight of elephant=40000N
Area of one foot =1000 cm^2= 1000 x $10^{-4} m^2$
Weight of girl=400N
Area of heel of girl =1 cm^2=1 x $10^{-4} m^2$
(a) Elephant has a larger weight of 40000N, therefore, elephant exerts a larger force on the ground. Elephant exerts a larger force on the ground by 40000N – 400 N=39600N.
(b)Weight of elephant = 40000N

Area of one foot =1000cm^2= 1000 x 10^{-4}m^2

Weight of elephant=40000N
Area of one foot =1000 cm^2= 1000 x 10^{-4}m^2
Weight of girl=400N
Area of heel of girl =1 cm^2=1 x 10^{-4}m^2

(a) Elephant has a larger weight of 40000N, therefore, elephant exerts a larger force on the ground. Elephant exerts a larger force on
by 40000N - 400 N=39600N.

(b) Weight of elephant = 40000N
Area of one foot =1000cm^2= 1000 x 10^{-4}m^2

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$\text{Pressure} = \frac{40000}{1000 \times 10^{-4}} = 400000\text{N}/\text{m}^2$$

(c) Weight of the girl = 400N
Area of heel of girl = 1 cm^2 = 1 x 10^{-4}m^2

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$\text{Pressure} = \frac{400}{1 \times 10^{-4}} = 4000000\text{N}/\text{m}^2$$

(d) Girl exerts a larger pressure on the ground.

(e)

$$\text{Ratio} = \frac{\text{Pressure exerted by the girl}}{\text{Pressure exerted by the elephant}}$$

$$= \frac{4000000}{400000} = \frac{10}{1}$$

The pressure exerted by girl is 10 times greater than that exerted by the elephant.

Page No:127

Solution 72:
The two equal weights of unequal volumes which are balanced in air, will get imbalanced when they are completely dipped in water because due to their unequal volumes, they will displace unequal volumes of water and hence suffer unequal loss in weight.

Solution 73:
No, it is not necessary that their weights in air should also be the same. This is because the two bodies have undergone the same loss in weight on completely immersing in water due to their equal volumes and not because of their equal weights, so they may have different weights in air.

Solution 74:
The body will sink less in water. This is because the density of water is more than that of kerosene due to which water will exert a greater upward buoyant force on the body.

Solution 75:
The reading on spring balance will be zero. This is because the weight of floating block of wood is fully supported by the liquid in which it is floating and hence it does not exert any force on the spring balance.

Solution 76:
When a lot of salt is dissolved in water, then the density of salt solution becomes much more than pure water. Due to its much higher density, the salt solution exerts a greater upward buoyant force on the egg making it rise and then float.

Page No:128

Solution 77:
The reading of spring balance will not change if a cork is placed in water because cork, being lighter than water, floats in water.
(b)The reading of spring balance will change if a piece of heavy metal is placed in
water because heavy metal being denser than water, sinks in water.

Solution 78:
Volume of golf ball = rise in water level = 30 cm^3

Volume of golf ball = rise in water level = 30 cm^3

$$\text{Density of ball} = \frac{\text{Mass of ball}}{\text{Volume of ball}} = \frac{33}{30} = 1.1\,g/cm^3$$

Solution 79:
a) The boat sinks a little more in water, that is, the boat floats lower in water.
b) The weight of water displaced (by the submerged part of the boat) increases.
c) The buoyant force acting on the boat increases.

Solution 80:
The sheet of tin sinks in water because the density of tin is higher than that of water. When the same sheet of tin is converted into a box or a boat, then due to the trapping of lot of 'light' air in the box or boat, the average density of the box or boat made of tin sheet becomes lower than that of water and hence it floats in water.