Board – CBSE	Class – 9th	Topic – Gravitaion

Q.1 State the universal law of gravitation.

Ans: Every object in the universe attracts every other object with force proportional to the product of their masses and inversely proportional to the square of the distance between them. The force is along the line joining the centres of two objects

Q.2 Write the formula to find the magnitude of the gravitational force between the earth and an object on the surface of the earth.

Ans: The gravitational force between the earth and an object on its surface M_e = mass of the earth

Q.3 Why is the weight of an object on the moon 1/6 th its weight on the earth?

Ans: The weight of an object 1/2 depends on ' g ' acceleration due to gravity, and the value of ' g ' on earth: and the moon is not the same.

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

The mass and radius of the earth are more than the mass and radius of the moon.

As $W = G\frac{Mn}{R^2}$ the weight of a body on the earth is 6 times more than the weight of the same body on the moon.

Q.4 Describe how the gravitational force between two objects depends on the distance between them.

Ans: 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,

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

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

Q.5 The Mass of Sun is $2\times10^{30}\ kg$ and the mass of the earth is 6×10^{24} If the average distance between the Sun and the earth be $1.5\times10^{8}\ km$, calculate the force of gravitation between them.

Ans: Distance $d = 1.5\times10^{8}\ km = 1.5\times10^{11}\ m$

Mass of the Sun, $m = 2\times10^{30}\ kg$

Mass of the earth, $M = 6\times10^{24}\ kg$

Force of gravitation

$$F = 6.7\times10^{-11} \times \frac{2\times10^{30}\times6\times10^{24}}{\left(1.5\times10^{11}\right)^{2}}$$

$$F = \frac{6.7\times10^{-11}\times12\times10^{54}}{1.5\times1.5\times10^{23}}$$

$$F = \frac{6.7\times12\times10^{21}}{1.5\times1.5} = 3.57\times10^{22}\ N$$

Q.6 A piece of stone is thrown vertically upwards. It reaches the maximum height in 3 seconds. If the acceleration of the stone be $9.8\ m/s^{2}$ directed towards the ground, calculate the initial velocity of the stone with which it is thrown upwards

Ans: Initial velocity of the stone, u =?

Final velocity of

stone, $v = 0$

Acceleration due to gravity, $g = -\frac{9.8\ m}{s^{2}}$

Time, $t = 3sec$

Using relation, $v = u + gt$

$$0 = u - 9.8x3$$

$$u = 29.4\ m/s$$

Q.7 A ball is thrown up vertically returns to the thrower after 6 s. Find

(a) the velocity with which it was thrown up,

(b) the maximum height it reaches, and

(c) its position after 4 s

Ans: u =?

$v = 0$

$g = -9.8\ m/s2\ (thrown\ upward)$

Total time = 6 s (to go up and down)

∴ Time for upward journey

(a) $v = u + gt$

(b) $0 = u = (-9.8) \times 3$

(c) $= \frac{29.4\ m}{s}$

(b) Maximum height $h = s = ?$

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

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

$= 88.2 + \frac{1}{2}(-88.2)$

$= 88.2 - 44.1$

$h = 44.1\ m$

(c) Position after 4 s

$t = 4s$

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

$= (29.4 \times 4) + \frac{1}{2}(-9.8)(4)^2$

$= 117.6 - 78.4$

∴ Position after 4 $s = 39.2\ m$ from the top.

Q.8 Calculate the force of gravitation between the earth and the Sun, given that the mass of the earth $= 6 \times 10^{24}\ kg$ and of the Sun $= 2 \times 10^{30}\ kg$. The average distance between the two is $1.5 \times 10^{11}\ m$.

Ans: $M_e = 6\times1024\ kgG = 6.67\times10 - 11Nm2/kg2$

$M_s = 2\times1030\ kg$

$d = 1.5\times1011\ m$

$\therefore$ Gravitational force $F = G\frac{m_e M_s}{d^2}$

$$\therefore F = \frac{6.67\times10^{-11}\frac{Nm^2}{kg}\times6\times10^{24}\ kg\times2\times10^{30}\ kg}{\left(1.5\times10^{11}\ m\right)^2}$$

$$= \frac{80.04\times10^{-11+24+30}}{2.25\times10^{22}} = 3.56\times10^{22}\ N$$

Q.9 A girl is wearing a pair of flat shoes. She weighs 550 N. The area of contact of one shoe with the ground is 160 cm^2. What the girl on the ground will exert pressure:

(a) If she stands on two feet?

(b) If she stands on one foot?

Ans: Force,

$F = 550\ N$

Area of contact of one shoe $= 160\ cm^2 = 160\times10^{-4}\ m^2$

Area of contact of two shoes $= 160\times2 = 320\ cm^2 = 320\times10^{-4}\ m^2$

(a) If the girl stands on two feet,

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

$$= \frac{550}{320\times10^{-4}} = 17187.5\ N/m^2$$

(b) If she stands on one foot,

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

$$= \frac{550}{160\times10^{-4}} = 34375\ N/m^2$$

Q.10 Calculate the density of an object of volume 3 m^3 and mass 9 kg. State whether this object will float or sink in water. Give a reason for your answer.

Ans: $Volume = 3\ m^3$

$Mass = 9\ kg$

$The\ density\ of\ substance = \frac{Mass\ of\ substance}{Volume\ of\ substance}$

The density of substance $= \frac{9}{3} = 3\ kg/m^3$

And the density of water $= \frac{1000\ kg}{m^2}$

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

Q.11 (a) Define pressure.

(b) What is the relation between pressure, force and area? ,

(c) Calculate the pressure when a force of 200 N is exerted on an area of:

(i) $10\ m^2$

(ii) $5\ m^2$

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

(b) $Pressure = \frac{Force}{Area}$

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

Force $= 200\ N$

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

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

Force $= 200\ N$

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

Q.12 A boy gets into a floating boat.

What happens to the boat?

What happens to the weight of water displaced?

What happens to the buoyant force on the boat?

Ans: (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.

Q.13 (a) Define buoyant force. Name two factors on which buoyant force depends.

(b) What is the cause of buoyant force?

(c) When a boat is partially immersed in water, it displaces 600 kg of water. How much is the buoyant force acting on the boat in newtons? (g = 10 $m\,s^{-2}$)

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

(i) Volume of an 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 = 600 kg

Weight of water displaced, $W = mxg$

$= 600\times10 = 6000\ N$

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

Q.14 Give the formula for the gravitational force F between two bodies of masses M and m kept at a distance d from each other.

Ans: 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, $G = 6.7\times10^{-11}Nm^2\,kg^{-2}$

Q.15 The force of gravitation between two cricket balls is extremely small, but between a cricket ball and the earth is extremely large.

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

$F\propto m\times M$

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

Q.16 A stone falls from a building and reaches the ground 2. 5 seconds later. How high is the building? $\left(g = \frac{8\,m}{s^2}\right)$

Ans: Initial velocity,

$u = 0\,m/s$

Acceleration due to gravity, $g = \frac{9.8\,m}{s^2}$

Time taken to reach the ground, $t = 2.5sec$

Height, h =?

Using relation,

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

$s = 0\times2.5 + \frac{1}{2}\times9.8\times2.5\times2.5$

$s = 0 + 4.9\times2.5\times2.5$

$s = 30.625\,m$

Q.17 When a cricket ball is thrown vertically upwards, it reaches a maximum height of 5 meters.

(a) What was the initial speed of the ball?

(b) How much time is taken by the ball to reach the highest point? $\left(G = 10\,ms^{-2}\right)$

Ans: Initial velocity, u =?

Final velocity, $v = 0$

Acceleration due to gravity, $g = -\frac{10\,m}{s^2}$

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, $u = \frac{10\ m}{s}$

(b) Using relation, $v = u + gt$

$0 = 10 + (-10)t$

$-10 = -10t$

$t = 1\ sec$

Q.18 A force of $20\ N$ acts upon a body whose weight is $9.8\ N$. What is the body's mass, and how much is its acceleration? ($g = 9.8\ m\ s^{-2}$)

Ans: $Weight = 9.8\ N$

$W = mxg$

$9.8 = m\times 9.8$

$m = 1\ kg$

Force, F = mass x acceleration $20\ N = 1\ kg\times a$

Acceleration,

$a = 20\ m/s^2$

Q.19 What is the density of a substance of Mass $100\ g$ and volume $10\ cm^3$?

Ans: Mass of the substance $= 100\ g$

The volume of the substance $= 10\ cm^3$

The density of substance $= \frac{mass\ of\ substance}{Volume\ of\ substance}$ Density $= \frac{100}{10} = 10\ g/cm^2$

Q.20 Write the differences between the mass and weight of an object.

Ans:

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 the kilogram (kg).	2. Sl 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.

Q.21 A stone is thrown vertically upwards with a speed of 20 m/s. How high will it go before it begins to fall? $\left(g = 8\ m/s^2\right)$

Ans: Initial velocity, $u = \frac{20\ m}{s}$

Final velocity, $v = 0$

Acceleration due to gravity, $g = -\frac{9.8\ m}{s^2}$

Height, h =?

Using relation, for a freely falling body:

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

$(0)^2 = (20)^2 + 2x(-9.8)xh$

$0 - 400 = -19.6\ h$

$h = 400/19.6 = 20.4\ m$