Class 09 Chapter Gravitation NCERT Solution by Jsunil Sir

In Text Questions Answer

Q 1: State the universal law of gravitation

Answer: First law: The force acting between two objects is directly proportional to the product of their masses

$$f \propto m1\ m2$$

2nd law: The force acting between two objects is inversely proportional to the square of the distance between their centers. $f \propto \frac{1}{r^2}$

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: $F = G\frac{m1\,x\,m2}{r^2}$ $, G = gravitational\ constant = 6.67\ x\ 10^{-11}\ Nm^2/Kg^2$

Q 1: What do you mean by free fall?

Answer: When an object fall towards the earth under the influence of Earth gravitational force. The motion of the object is called free fall.

Question 2: What do you mean by acceleration due to gravity?

Answer: During free fall velocity of object changes continuously. The rate of the change n velocity during free fall is called as acceleration due to gravity (g). Its value is 9.8 m/s^2

Q 1: What are the differences between the mass of an object and its weight?

Answer: Mass : Mass is the quantity that a body contained into it. the body. It is measured by pan balance. Its SI unit is Kg.

Weight : Weight is the product of mass and acceleration due to gravity.. It is measured by spring balance. Its SI unit is N.

Q 2: Why is the weight of an object on the moon 1/6 th its weight on the earth?

Ans: Weight of object = mg. As we know that g on moon is 1/6th of g on Eath . Thus, the weight of an object on the moon 1/6 th its weight on the earth. $\frac{w\ on\ moon}{w\ on\ the\ earth} = \frac{mg'}{mg} = \frac{g'}{g} = \frac{1}{6}$

Q 1: Why is Why is it difficult to hold a school bag having a strap made of a thin and strong string?

Answer: A thin and strong string of school bag distributes weight of bag over small area creates large pressure on the Shoulders. Thus, it is difficult to hold a school bag having a strap made of a thin and strong string.

Q 2: What do you mean by buoyancy?

Answer: An upthrust exerted by fluid on an object immersed in it is known as buoyancy.

Q3: Why does an object float or sink when placed on the surface of water?

Answer: An object floats on the surface of the water If its density is greater than that of water. An object sinks in water if its density is less than that of water.

Question 1: You find your mass to be 42 kg on a weighing machine. Is your mass more or less than 42 kg?

Answer: weight measured by spring balance is 9.8 times the mass of object. Thus your mass less than 42 kg
If we consider buoyancy of air on object. This upward force make object lighter than actual weight.

Q 2: You have a bag of cotton and an iron bar, each indicating a mass of 100 kg when measured on a weighing machine. In reality, one is heavier than other. Can you say which one is heavier and why?

Answer: The iron bar is heavier than the bag of cotton as density of iron is more than iron. Since the surface area of 100kg the cotton bag is larger than the iron bar, more buoyant force acts on the cotton bag than that on an iron bar. This makes the cotton bag lighter than its actual value.

Exercise Question Answer

Question 1: How does the force of gravitation between two objects change when the distance between them is reduced to half?

Ans: $r' = ½ r \; so, F' = \frac{1}{\left(\frac{1}{2r}\right)^2} = 4\, x \frac{1}{r^2} = 4\, F$.

Thus the force of gravitation between two objects increases 4 times.

Q2: Gravitational force acts on all objects in proportion to their masses. Why then, a heavy object does not fall faster than a light object?

Answer: Acceleration due to gravity does not depends on the mass of object Hence, heavy objects do not fall faster than light objects.

Q 3: What is the magnitude of the gravitational force between the earth and a 1 kg object on its surface? (Mass of the earth is 6 × 10^24 kg and radius of the earth is 6.4 × 10^6 m).

Answer: the magnitude of the gravitational force between the earth and object on its surface = weight = mg= 1x 9.8=9.8N

Q 4: The earth and the moon are attracted to each other by gravitational force. Does the earth attract the moon with a force that is greater or smaller or the same as the force with which the moon attracts the earth? Why?

Answer: According to third law of motion, when one object apply force on 2nd object, 2nd object apply equal force on first object , but in opposite directions.

Thus, The Earth attracts the moon with an equal force with which the moon attracts the earth.

Q 5: If the moon attracts the earth, why does the earth not move towards the moon?

Answer: According to 2nd law of motion acceleration is inversely proportion to mass of object. The mass of the Earth is much larger than the mass of the moon. Hence, Earth accelerates lesser than moon towards the Earth. For this reason, Motion of the Earth cannot noticed towards the moon.

Q 6: What happens to the force between two objects, if

(i) the mass of one object is doubled? (ii) the distance between the objects is doubled and tripled?

(iii) the masses of both objects are doubled?

Answer : (i) increases 2 times $F \propto Mm \; So, F' \propto M\, x\, 2m = 2\, x\, Mm = 2\, F$

(ii) a. Reduces 4 times, $r' = 2\, r \; so, F' = \frac{1}{(2r)^2} = \frac{1}{4}\, x \frac{1}{r^2} = \frac{1}{4}\, F$

and reduces 9 times as $r' = 3\, r \; so, F' = \frac{1}{(3r)^2} = \frac{1}{9}\, x \frac{1}{r^2} = \frac{1}{9}\, F$

(iii) four times $F \propto Mm \; So, F' \propto 2M\, x\, 2m = 4\, x\, Mm = 4\, F$

Q7: What is the importance of universal law of gravitation?

Answer: It help us to understands motion of planet around the moon. Existence of life on earth. Cause tides etc.

Q 8: What is the acceleration of free fall?

Answer: Acceleration of free fall is 9.8 m/s2, which is constant for all objects (irrespective of their masses).

Question 9: What do we call the gravitational force between the Earth and an object?

Answer: Gravity

Q 10: Amit buys few grams of gold at the poles as per the instruction of one of his friends. He hands over the same when he meets him at the equator. Will the friend agree with the weight of gold bought? If not, why?

Ans. The value of g is greater at the poles than at the equator thus Weight of gold at the equator is less than at the poles. Hence, Amit's friend will not agree with the weight of the gold bought.

Q 11: Why will a sheet of paper fall slower than one that is crumpled into a ball?

Answer: When a sheet of paper is crumbled into a ball, then its surface area deceases. Hence, resistance or force applied by air decreases and it falls faster than the sheet of paper.

Q12: Gravitational force on the surface of the moon is only 1/6 as strong as gravitational force on the Earth. What is the weight in newtons of a 10 kg object on the moon and on the Earth?

Ans : The weight on the earth = 10 x 9.8 = 98 N , The weight on the moon= 1/6 of 98 =16.3 or 16 N approx.

Q 13: A ball is thrown vertically upwards with a velocity of 49 m/s. Calculate (i) the maximum height to which it rises. (ii)the total time it takes to return to the surface of the earth.

Ans: $u = 49m/s,\ g = -9.8\text{m/s}^2$ $\ Max\ height = \frac{v^2-u^2}{2g} = 0 - \frac{0^2-(49)^2}{2\times -9.8} = 122.5m \quad t = \frac{v-u}{g} = \frac{0-49}{-9.8} = 5\ sec$

But, Time of ascent = Time of descent Therefore, total time taken by the ball to return = 5 + 5 = 10 s

Q 14: A stone is released from the top of a tower of height 19.6 m. Calculate its final velocity just before touching the ground.

Ans; $u = \frac{0m}{s}$, velocity just before touching the ground = v $g = 9.8\text{m/s}^2$

$v^2 = u^2 - 2gs = 0 - 2\times 9.8 \times 19.6 = (19.6)^2\ so, v = 19.6m/s$

Q. 15. A stone is thrown vertically upward with an initial velocity of 40 m/s. Taking g = 10 m/s2 , find the maximum height reached by the stone. What is the net displacement and the total distance covered by the stone?

$u = 40\ m/s,\ g = -10\text{m/s}^2\ \ Max\ height = \frac{v^2-u^2}{2g} = 0 - \frac{0^2-(40)^2}{2\times -10} = 80\ m$

Therefore, total distance covered by the stone during its upward and downward journey = 80 + 80 = 160 m

Net displacement of the stone during its upward and downward journey = 80 + (−80) = 0 m

Q 16: Calculate the force of gravitation between the earth and the Sun, given that the mass of the earth = 6 × 10^24 kg and of the Sun = 2 × 10^30 kg. The average distance between the two is 1.5 × 10^11 m.

Ans: The force of gravitation between the earth and the Sun = $\frac{G\ m1\ m2}{r^2}$

$$= \frac{6.67\times 10^{-11}\ 6\times 10^{24}\times 2\times 10^{30}}{(1.5\times 10^{-11})^2} = 3.6\times 10^{22}N$$

Q17: A stone is allowed to fall from the top of a tower 100 m high and at the same time another stone is projected vertically upwards from the ground with a velocity of 25 m/s. Calculate when and where the two stones will meet.

Answer: Let the two stones meet after a time t.

(i) For free falling stone : u = 0 ; g = 9.8 m/ s^2

$$S = ut + ½\ gt^2 = 0\times t + \frac{1}{2}\times 9.8\times t^2 = 4.9t^2$$

(ii) For the stone thrown upwards: u = 25 m/s , g = -9.8m/s^2

$$s = ut + ½\ gt^2 = 025\times t + \frac{1}{2}\times -9.8\times t^2 = 25t - 4.9t^2$$

Now, Tota; distance = 100m = $4.9t^2 + 25t - 4.9t^2 \;=> 25t = 100 => t = 4sec$

So, Both stone meet In 4 sec

Max height above ground after 4 sec. $= 25t - 4.9t^2 = 25\,x\,4 - 4.9\,x\,4\,x\,4 = 21.6m$

Q18: A ball 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 above ground after 4 s.

Answer: (a) Time of ascent is equal to the time of descent. = 6/2 = 3 sec.

Ball takes 3 sec to attain the maximum height. v = 0 , g = −9.8 m/s2

v = u + gt => 0 = u + (−9.8 × 3) => u = 9.8 × 3 = 29.4 m/s

Hence, the ball was thrown upwards with a velocity of 29.4 m/s.

(b)Maximum height attained by the ball be h. u = 29.4 m s−1, v = 0 m/s

$$Max\ height\ = \frac{v^2 - u^2}{2g} = 0 - \frac{0^2 - (29.4)^2}{2\ \times -9.8} = 44.1\,m$$

(c) Displacement after 1 sec during free fall

$$s = ut\ +\ ½\ gt^2\ \ = 0 \times\ 1\ + \frac{1}{2} \times 9.8\ \times 1^2 = 4.9\,m$$

its position above ground after 4 s.= 44.1 – 4.9 m = 39.2 m

Q19:In what direction does the buoyant force on an object immersed in a liquid act?

Answer: An object immersed in a liquid experiences buoyant force in the upward direction.

Q20: Why does a block of plastic released under water come up to the surface of water?

Answer: The upward buoyant force is greater than the downward gravitational force therefore the object comes up to the surface of the water as soon a block of plastic released under water.

Q21:The volume of 50 g of a substance is 20 cm3. If the density of water is 1 g cm−3, will the substance float or sink?

Answer: density of the substance = m/v= 50/20= 2.5 g cm−3

The density of the substance is more than the density of water (1 g cm−3). Hence, the substance will sink in water.

Q22:The volume of a 500 g sealed packet is 350 cm3. Will the packet float or sink in water if the density of water is 1 g cm−3? What will be the mass of the water displaced by this packet?

Answer: Density of sealed packet = 500/350 = 1.428g/cm3

The density of the substance is more than the density of water (1 g/cm3). Hence, it will sink in water.

The volume of water displaced = the volume of the packet = 350 g.

Mass of water = density of water x v of water = 350 x 1 = 350g