

CBSE NCERT Solutions for Class 9 Science Chapter 10

Back of Chapter Questions

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

Solution:

The law of gravitation states that the gravitational force (F) acting between two objects is inversely proportional to the square of the distance (r) between them.

Hence, if the distance is reduced to half, then the gravitational force would become four times.

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

Solution:

The speed of the falling object depends on the acceleration of the body. Although the force is more on a heavier object, the acceleration due to gravity is the same for all. Hence all will fall with the same speed.

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).

Solution:

As per the laws of gravitation, the gravitational force between two objects of masses M and m at a distance r from each other is given by:

$$F = G \frac{Mm}{r^2}$$

The mass of earth be represented by $M = 6 \times 10^{24}$ kg

The mass of the object be represented by $m = 1$ kg

Universal gravitational constant, $G = 6.7 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$

Since the object is on the surface of the Earth, $r =$ radius of the Earth = (R)

$$r = R = 6.4 \times 10^6 \text{ m}$$

$$\begin{aligned} F &= G \frac{Mm}{r^2} \\ &= 6.7 \times 10^{-11} \times \frac{6 \times 10^{24} \times 1}{(6.4 \times 10^6)^2} = 9.8 \text{ N} \end{aligned}$$

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?

Solution:

The earth attracts the moon with a force which is same as the force with which the moon attracts the earth because according to Newton's third law of motion, the force of action and reaction are always equal and opposite. Therefore, the force of attraction of the earth on the moon is equal and opposite to the force of attraction of the moon on the earth.

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

Solution:

The motion of an object depends upon its acceleration, not on its force. It is true that the force on both is the same; the acceleration will be different. As the mass of the earth is very large, its acceleration is very small, and hence, the earth does not move towards the moon.

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?

Solution:

As per the laws of gravitation, the force of gravitation between two objects is given by:

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

- (i) F is directly proportional to the product of masses of the objects. Since the mass of one object is doubled, then the gravitational force will also get doubled.
- (ii) F is inversely proportional to the square of the distance between the objects. If the distance is doubled, then the gravitational force becomes one-fourth of its original value.

Similarly, if the distance is tripled, then the gravitational force becomes one-ninth of its original value.

- (iii) F is directly proportional to the product of masses of the objects. If the masses of both the objects are doubled, the product of masses becomes four times and hence the gravitational force will also become four times the original value.

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

Solution:

Importance of universal laws of gravitation:

It explains the motion of planets around the Sun, the motion of the moon and other artificial satellites around the earth, tides due to the moon and the Sun and many other phenomena.

8. What is the acceleration of free fall?

Solution:

An object is in a state of free fall if it is moving under the influence of only gravitational force. Near the earth, this force produces a uniform acceleration in the objects, which is called acceleration of free fall or acceleration due to gravity. Its value is 9.8 m/s^2 .

9. What do we call the gravitational force between the earth and an object?

Solution:

It is called the weight of the object.

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? [Hint: The value of g is greater at the poles than at the equator].

Solution:

Amit's friend will not agree with the weight of the gold bought.

Weight of a body on the earth is given by:

$$W = m \times g$$

where,

m = Mass of the body

g = Acceleration due to gravity

The value of g is greater at poles than at the equator. Therefore, the same mass of gold weighs lesser at the equator than at the poles.

11. Why does a sheet of paper fall slower than one that is crumpled into a ball?

Solution:

Being the same mass, the force due to gravity on the sheet and the ball will be the same. A sheet of paper has more surface area than a crumpled ball of paper. Hence, the resistance offered by air to a sheet of paper falling through it is more than the resistance offered to a falling crumpled ball of paper. This decreases the speed of the sheet of paper and hence it falls slower than the crumpled ball.

12. Gravitational force on the surface of the moon is only $\frac{1}{6}$ 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?

Solution:

Weight = Mass \times Acceleration

Acceleration due to gravity on earth, $g_e = 9.8 \text{ m/s}^2$

Therefore, the weight of a 10 kg object on the earth = $10 \times 9.8 \text{ N} = 98 \text{ N}$

As given in the question, acceleration due to gravity on the moon, $g_m = \frac{1}{6} g_e = \frac{9.8}{6} \text{ m/s}^2$

Therefore, the weight of the same object on the moon = $10 \times \frac{9.8}{6} \text{ N} = 16.3 \text{ N}$

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.

Solution:

- (i) Use the equation of motion under gravity:

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

where,

u = Initial velocity of the ball = 49 m/s (Given)

v = Final velocity of the ball = 0 (At the highest point)

h = Maximum height attained by the ball

g = Acceleration due to gravity = -9.8 m/s^2 (Ball goes up)

Putting the values, we get

$$0^2 - 49^2 = 2 \times (-9.8) \times h$$

$$h = \frac{49^2}{2 \times 9.8} = 122.5 \text{ m}$$

- (ii) Let T be the time taken by the ball to return to the ground. Its displacement will be zero.

Using the equation of motion,

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

Here $s = 0$

$u = 49 \text{ m/s}$

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

Putting the values, we get

$$0 = 49 T + \frac{1}{2} 9.8 \times T^2$$

$$T = \frac{2 \times 49}{9.8} = 10 \text{ s}$$

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.

Solution:

Given,

The initial velocity of the stone, $u = 0$

The final velocity of the stone, $v = ?$

Height of the tower, $h = 19.6 \text{ m}$

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

Using the equation of motion,

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

$$v^2 - 0 = 2 \times 9.8 \times 19.6$$

$$v^2 = (19.6)^2$$

$$v = 19.6 \text{ m/s}$$

Hence, the velocity of the stone just before touching the ground is 19.6 m/s

15. A stone is thrown vertically upward with an initial velocity of 40 m/s . Taking $g = 10 \text{ m/s}^2$, find the maximum height reached by the stone. What are the net displacement and the total distance covered by the stone?

Solution:

The initial velocity of the stone, $u = 40 \text{ m/s}$ (Given)

The final velocity of the stone, $v = 0$ (At the highest point)

The maximum height reached by the stone, $h = ?$

Acceleration due to gravity, $g = -10 \text{ m/s}^2$ (Stone goes up)

Using the equation of motion:

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

Putting the values, we get,

$$0 - 40^2 = 2 \times 10 \times h$$

$$h = \frac{40^2}{2 \times 10} = 80 \text{ m}$$

Therefore, the total distance covered by the stone during its upward and downward journey = $80 + 80 = 160 \text{ m}$

The net displacement of the stone during its upward and downward journey = 0 (since final position coincides with the initial position)

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

Solution:

The force of attraction between the earth and the Sun is given by:

$$F = \frac{GM_{\text{sun}}M_{\text{earth}}}{r^2}$$

Here,

M_{Sun} = Mass of the Sun = 2×10^{30} kg

M_{Earth} = Mass of the Earth = 6×10^{24} kg

R = Average distance between the earth and the Sun = 10^{11} m

G = Universal gravitational constant = 6.7×10^{-11} N m² kg⁻²

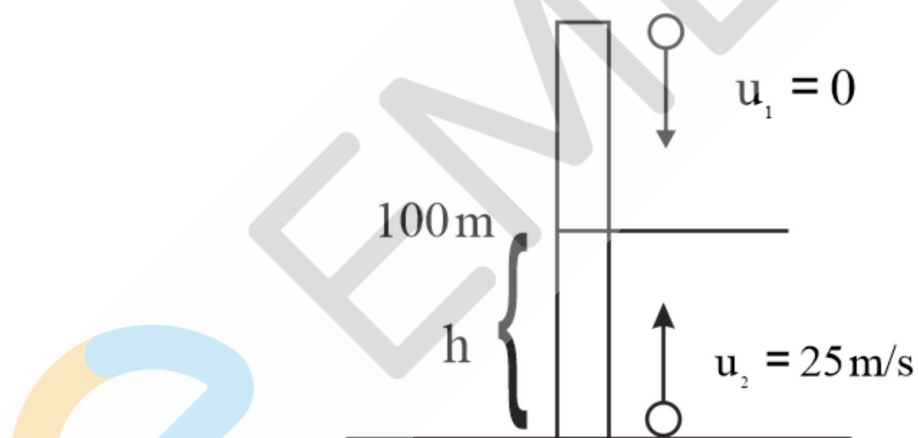
On substituting the values, we get

$$F = \frac{6.7 \times 10^{-11} \times 2 \times 10^{30} \times 6 \times 10^{24}}{(1.5 \times 10^{11})^2} \text{ N} = 3.57 \times 10^{22} \text{ N}$$

17. 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.

Solution:

Let the two stones meet after a time t and at height h above the ground.



- (i) For the stone dropped from the top of the tower:

Initial velocity, $u_1 = 0$

The displacement of the stone in time t is $100 - h$.

Acceleration due to gravity, $g = 10 \text{ ms}^{-2}$

using the equation of motion,

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

$$100 - h = 0 + \frac{1}{2} \times 10 \times t^2 \text{ ----- (1)}$$

- (ii) For the stone thrown upwards:

Initial velocity, $u_2 = 25 \text{ ms}^{-1}$

The displacement of the stone from the ground in time t be h .

Acceleration due to gravity, $g = -10 \text{ ms}^{-2}$

Using the equation of motion,

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

$$h = 25t - \frac{1}{2} \times 10 \times t^2 \text{ ----- (2)}$$

Adding equation (1) and equation (2), we get

$$100 = 25t$$

$$t = \frac{100}{25} \text{ s} = 4 \text{ s}$$

To calculate the height of the stone in 4 s, use equation (2).

$$h = 25 \times 4 - \frac{1}{2} \times 10 \times 4^2 = 20 \text{ m}$$

18. A ball thrown up vertically returns to the thrower after 6 s. Find

- the velocity with which it was thrown up,
- the maximum height it reaches, and
- its position after 4 s.

Solution:

- Time to go up and down = 6 s

Let the initial velocity of the ball be u .

Displacement, $s = 0$

Acceleration due to gravity, $g = -10 \text{ ms}^{-2}$

Using the equation of motion,

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

$$0 = u \times 6 - \frac{1}{2} \times 10 \times 6^2$$

$$u = 30 \text{ m/s}$$

- Let the maximum height attained by the ball be h .

Initial velocity, $u = 30 \text{ m/s}$

Final velocity, $v = 0$

Acceleration due to gravity, $g = -10 \text{ ms}^{-2}$

Using the equation of motion,

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

$$0 = 30^2 - 2 \times 10 \times h$$

$$h = \frac{30^2}{2 \times 10} \text{ m} = 45 \text{ m}$$

(c) To find the position after 4 s:

$$u = 30 \frac{\text{m}}{\text{s}}$$

$$t = 4 \text{ s}$$

$$g = -10 \frac{\text{m}}{\text{s}^2}$$

Using the equation of motion

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

$$s = 30 \times 4 - \frac{1}{2} \times 10 \times 4^2 = 40 \text{ m}$$

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

Solution:

The buoyant force on an object is in an upward direction.

20. Why does a block of plastic released under water come up to the surface of the water?

Solution:

In case of a block of plastic, the upward buoyant force is greater than the weight of the object. The large buoyant force on the block is due to its density being smaller than that of water. Due to the larger buoyant force, the block of plastic comes up when released under water.

21. 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?

Solution:

The density of the substance,

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{50 \text{ g}}{20 \text{ cm}^3} = 2.5 \text{ g cm}^{-3}$$

Since the density of the substance is greater than water, the substance will sink.

22. The volume of a 500 g sealed packet is 350 cm^3 . 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?

Solution:

The density of the 500 g sealed packet

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{500}{350} \text{ g cm}^{-3} = 1.43 \text{ g cm}^{-3}$$

The density of the substance is more than the density of water (1 g cm^{-3}).
Hence, it will sink in water.

As the packet is fully submerged in water,

Mass of water displaced by the packet = volume of the packet \times density of water

$$= 350 \text{ cm}^3 \times 1 \frac{\text{g}}{\text{cm}^3} = 350 \text{ g}$$

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