Roll No :
Date : 2025-08-20

Name of School : ACHIEVERS
FOUNDATION
Name of Assessment : Gravitation
Subject : PHYSICS
Class : IX-CBSE

Time : 00:00

Marks: 32

1 Write the equations of free fall.   **1**

Ans :
$$\left.\begin{array}{l} v = u + gt \\ h = ut + \dfrac{1}{2}gt^2 \\ v^2 = u^2 + 2gh \end{array}\right\} \text{where symbols have usual meanings}$$

2 A ball is dropped from a tower of height 5 m. With what velocity does it strike the ground? [g = 10 m/s^2]   **1**

Ans :
$h = 5$ m, $\quad u = 0, \quad g = 10$ m/s^2.
$v^2 = u^2 + 2gh = 0 + 2 \times 10 \times 5 \quad \Rightarrow \quad v = 10$ m/s.

3 The gravitational force between two objects is 100N. How should the distance between these objects be changed so that the force between them becomes 50 N?   **3**

Ans :
$F = 100$ N. When distance between objects is R.
$$F \propto \frac{1}{R^2} \text{ (inverse square law)}$$
If F becomes $\left(\dfrac{F}{2}\right)$, then let distance becomes R'.

Ratio
$$\frac{F}{(F/2)} = \frac{(R')^2}{R^2}$$
$$\Rightarrow \quad 2 = \frac{R'^2}{R^2} \quad \Rightarrow \quad \frac{R'}{R} = \sqrt{2}$$
$$\Rightarrow \quad R' = \sqrt{2}\, R$$
i.e. distance is increased $\sqrt{2}$ times.

4 State universal law of gravitation. The gravitational force between two objects is 100 N. How should the distance between the objects be changed so that the force between them becomes 50 N?   **3**

Ans :
Universal law of gravitation states that force of gravitation between any two objects is directly proportional to product of their masses and inversely proportional to square of distance between their centres.
$F = 100$ N
If F is halved, i.e. 50 N, the distance between objects should be increased by $\sqrt{2}$ times as $F = \dfrac{1}{r^2}$.

5 (i) Give reason for the following: **3**
   (a) A sheet of paper falls slower than when it is crumpled into a ball.
   (b) A body weighs more at the poles than at equator.
   (ii) What is meant by the statement that acceleration due to gravity is 9.8 ms^{-2}?

Ans :
(i) (a) The sheet of paper has larger surface area and experiences greater air resistance during free fall. So it falls slowly.
(b) Value of 'g' is greater at poles as compared to equator because $r_p < r_{eq}$ and $g \propto \dfrac{1}{r^2}$.
(ii) It means that a freely falling body accelerates at 9.8 m/s^2 towards the centre of earth, during the course of its fall towards the earth.

6 If the distance between two masses be increased by a factor of 6, by what factor would the mass of one of them hence to be altered to maintain the same gravitational force? **3**

Ans : By law of gravitation, of F ∝ mass $F \propto \dfrac{1}{(\text{distance})^2}$
If distance is increased by a factor of 6, F decreases by $\dfrac{1}{36}$ times.
Thus, mass should be increased by $(6)^2$ times i.e. 36 times.
Thus mass also has to be increased.

7 State the difference between gravitation and gravity. What would happen if gravitational force of the earth vanished away? **3**

Ans :
Gravitational pull of earth exerted on an object is called gravity while gravitation is a universal phenomenon of attraction between two bodies present any where. If gravitation of the earth is vanished away, all objects would float freely in the state of weightlessness. There would be no atmoshpere and pull of other celestial bodies would significantly act.

8 On what factors does acceleration due to gravity depend? An object weighs 600 N on the earth. Find its weight on the surface of moon, given mass of the moon = 7.4×10^{22} kg, radius of the moon = 1.74×10^6 m.   **5**

Ans :

It depends on mass of the celestial body and distance between its centre and the centre of the object.

$$\text{Mass of object} = \frac{600 \text{ N}}{10 \text{ m/s}^2} = 60 \text{ kg}$$

$$g_{moon} = \frac{GM_m}{R^2} = \frac{6.67 \times 10^{-11} \times 7.4 \times 10^{22}}{(1.74 \times 10^6)^2} = 1.63 \text{ m/s}$$

Weight on the surface of the moon = mg_{moon} = $60 \times 1.63 = 97.80$ N

9 State universal law of gravitation. Explain its significance. Mass of an object is 20 kg. Find its weight on earth and on moon.   **5**

Ans :

Universal law of gravitation states that the gravitational force (F) between two bodies of masses m_1 and m_2, whose centres are separated by distance 'r' is

(a) directly proportional to the product of masses; $F \propto m_1 m_2$.

(b) inversely proportional to the square of distance between their centre; $F \propto \frac{1}{r^2}$.

i.e. $F \propto \dfrac{m_1 m_2}{r^2}$ or $F = \dfrac{Gm_1 m_2}{r^2}$ **where, G = gravitational constant**

Universal law of gravitation has successfully explained different phenomenons which were earlier considered to be separate:

(a) it explains about the force which holds us on earth.

(b) it explains the cause of motion of the planets around the sun.

(c) it explains the cause of motion of the moon around the earth.

(d) it explains about occurrence of tides in the ocean.

'g' on earth, g_e = 9.8 ms^{-2},

'g' on moon, g_m = 1.6 ms^{-2},

weight = mg, m = 20 kg

Weight on earth, W_e = mg_e = 20 × 9.8 = 196 N

Weight on moon, W_m = mg_m = 20 × 1.6 = 32 N

10 (a) Differentiate between acceleration due to gravity and universal gravitational constant. Derive a relation between 'g' and 'G'.   **5**

(b) State universal law of Gravitation.

Ans :

(a)

'G'	'g'
(a) It is the universal gravitation constant.	(a) It is acceleration produced due to gravity.
(b) Value of $G = 6.67 \times 10^{-11}$ Nm²/kg² remains constant at every point.	(b) Its value changes from point to point.
(c) It is equal to force between two unit masses separated by unit distance.	(c) It is equal to acceleration experienced by a body of any mass.
(d) It has an extremely small value.	(d) It has relatively large magnitude.

Acceleration due to gravity:

(i) The gravitational force exerted by earth upon an object is called its gravity.

(ii) The acceleration of a body near the surface of earth due to its gravity is called acceleration due to gravity (g).

By Newton's law of gravitation,

$$F = \frac{GMm}{r^2} \qquad ...(i)$$

if M = mass of earth
m = mass of object
r = distance between centres of earth and object

Also, by Newton's second law,

$$F = ma$$

i.e.
$$F = mg$$

(a = acceleration due to gravity = g)   ...(ii)

Equating R.H.S. of (i) and (ii),

$$mg = \frac{GMm}{r^2} \quad \text{or} \quad g = \frac{GM}{r^2}$$

(On surface of earth, $g = 9.8$ ms⁻²)

(b) Universal law of gravitation: It states that the gravitational force exerted between any two objects of mass 'm_1' and 'm_2' whose centres are 'r' units apart, is

(i) directly proportional to the product of masses, i.e. $F \propto m_1 m_2$.

(ii) inversely proportional to square of distance between their centres,

i.e.
$$F \propto \frac{1}{r^2}$$

Thus,
$$F \propto \frac{m_1 m_2}{r^2}$$

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

where G is the constant of proportionality called Universal Gravitational Constant.