

CLASS IX
PHYSICS

CHAPTER: GRAVITATION

Gravitation : the attractive force between any two objects of the universe placed at a certain distance apart is called gravitation.

Mass : mass is a measure of quantity of matter contained in a body it is a constant quantity . it is expressed in kilogram (kg)

Acceleration due to gravity of earth : the acceleration of any mass near the surface of the earth due to gravitation of the earth is called acceleration due to gravity (g) of earth.

On the surface of the earth, $g = 9.8 \text{ m/s}^2$

By Newton's second law of motion, $F = ma = mg = GMm/r^2$

$$g = GM/r^2$$

Free fall: when an object falls towards the centre of another object / celestial body under the effect of its gravity alone, we call it as free fall.

- When a body falls freely downwards, $a = +g$
- When a body is thrown upwards $a = -g$

When a body falls freely, it experiences a state of weightlessness, i.e $w = 0$

Universal law of gravitation: it states that the gravitational force exerted between any two objects of mass, m_1 and m_2 , whose centers are 'r' units apart, is

- Directly proportional to product of masses, i.e $F \propto m_1 m_2$
- Inversely proportional to square of distance between their centres, i.e $F \propto 1/r^2$
i.e $F = Gm_1 m_2 / r^2$.

Weight: weight is defined as the force exerted upon a body due to the gravity . $w \propto g$

- Weight is a vector quantity and variable in nature
- It is expressed in Newton (N)
- Weight of a body on moon surface. $g_m = g_e/6$

Gravitational constant : the gravitational force between two objects of unit mass each separated by a unit mass each separated by a unit distance from each other.

- Its unit is $\text{N-m}^2/\text{kg}^2$
- Its value is $6.67 \times 10^{-11} \text{ N-m}^2/\text{kg}^2$.

Answer the following question:

- 1) State the universal law of gravitation.

Ans: **Universal law of gravitation**: it states that the gravitational force exerted between any two objects of mass, m_1 and m_2 , whose centers are 'r' units apart, is

- Directly proportional to product of masses, i.e. $F \propto m_1 m_2$
- Inversely proportional to square of distance between their centers', i.e. $F \propto 1/r^2$
i.e. $F = Gm_1 m_2 / r^2$.

2) write the formula to find the magnitude of gravitational force between the earth and object on the surface of earth.

Ans: let the mass of earth = M , mass of object = m

If radius of object is comparative negligible, $r =$ radius of earth = R

$$F = GMm/R^2.$$

3) what do you mean by free fall?

Ans: when a body falls towards the centre of a bigger body under the effect of the gravity of the latter alone, then it is said to be in free fall. during free fall $a=g$.

4) what do you mean by acceleration due to gravity?

Acceleration due to gravity of earth : the acceleration of any mass near the surface of the earth due to gravitation of the earth is called acceleration due to gravity (g) of earth.

5) what are the differences between mass of a body and its weight?

Mass	Weight
<ul style="list-style-type: none"> a. The quantity of a matter contained in a body is mass. b. S.I unit of mass is kilogram (kg) c. Mass is a scalar quantity. d. Mass remains constant at every point in the universe. e. Mass is measured using a beam balance. f. Mass of a body can never be zero 	<ul style="list-style-type: none"> a. weight is the gravitational force acting on a body by celestial body. b. S.I unit of weight is Newton(N) c. Weight is a vector quantity. d. Weight of a body varies from point to point according to the value of 'g' as weight= mass x acceleration due to gravity. e. Weight is measured using a spring balance. f. Weight of a body can be zero .