PHYSICS

CLASS NOTES FOR CBSE

Chapter 03. Gravitation

A force is necessary to produce motion in a body. A stone dropped from a height falls towards the earth because the earth exerts a force of attraction (called gravity) on the stone and pulls it down.

The earth attracts (or pulls) all the objects towards its centre. The force with which the earth pulls the objects towards its is called the gravitational force of earth or gravity (of earth).

The gravitational force of earth (or gravity of earth) is responsible for holding the atmosphere above the earth; for the rain falling to the earth ; and for the flow of water in the rivers. It is also the gravitational force of earth (or gravity of earth) which keeps us firmly on the ground.

According Newton, every object in this universe attracts every other object with a certain force. The force with which two objects attract each other is called gravitational force (or gravity).

If the masses of the objects (or bodies) are small, then the gravitational force between them is very small (which cannot be detected easily).

If, however, one of the objets (or bodies) is very big (having a very large mass), then the gravitational force becomes very large (and its effect can be seen easily).

The 'gravitational force' or 'gravity' is always a force of attraction between two objects (or two bodies).

01. Universal Law of Gravitation

Every body in the universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

(i) The force between two bodies is directly proportional to the product of their masses.

$$F \propto m_1 \times m_2 \qquad \text{(i)}$$

(ii) The force between two bodies is inversely proportional to the square of the distance between them. That is,

$$F \propto \frac{1}{r^2} \qquad \text{(ii)}$$

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

Gravitational force, $F = G \times \dfrac{m_1 \times m_2}{r^2}$

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Units of Gravitational Constant, G

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

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

$$\frac{\text{newton (metre)}^2}{(\text{kilogram})^2} \quad \text{or} \quad \frac{\text{Nm}^2}{\text{kg}^2} \quad \text{or} \quad \text{Nm}^2/\text{kg}^2 \quad \text{or} \quad \text{Nm}^2\text{kg}^{-2}$$

Value of gravitational Constant, G

F = G (when $m_1 = m_2 = 1$ kg and $r = 1$ m)

The gravitational constant G is numerically equal to the force of gravitation which exists between two bodies of unit masses kept at a unit distance from each other. The value of universal gravitational constant G has been found to be 6.67×10^{-11} Nm^2/kg^2.

Gravitational Force Between Objects of Small Size and Big Size

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

Putting $G = 6.67 \times 10^{-11}$ Nm^2/kg^2; $m_1 = 1$ kg; $m_2 = 1$ kg and $r = 1$ m

We get : $F = \dfrac{6.67 \times 10^{-11} \times 1 \times 1}{(1)^2}$ newtons

or $F = 6.67 \times 10^{-11}$ newtons

Though the various objects on this earth attract one another constantly, they do not cause any motion because the gravitational force of attraction between them is very small.

Gravitational Force Holds the solar System Together

It is the gravitational force between the sun and the earth which keeps the earth in uniform circular motion around the sun.

The tides in the sea formed by the rising and falling of water level in the sea, are due to the gravitational force of attraction which the moon and the sun exert on the water surface in the sea.

02. Kepler's Laws of Planetary Motion

(i) Kepler's frist law states that : The planets move in elliptical orbits around the sun, with the sun at one of the two foci of the elliptical orbit

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