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SUBJECT:- PHYSICS CLASS:- IXTH DATE :- 13/07/XXI

SUBJECT TEACHER:- MR. NEEL NIRANJAN

CHAPTER 3. (GRAVITATION)(BASED ON NCERT PATTERN)

Free Fall :-

When an object falls from any height under the influence of gravitational force only, it is known as free fall.

Acceleration Due to Gravity :-

When an object falls towards the earth there is a change in its acceleration due to the gravitational force of the earth. So this acceleration is called acceleration due to gravity.

The acceleration due to gravity is denoted by g.

The unit of g is same as the unit of acceleration, i.e., ms^{-2}

Mathematical Expression for g

From the second law of motion, force is the product of mass and acceleration.

$$F = ma$$

For free fall, acceleration is replaced by acceleration due to gravity.

Therefore, force becomes:

$$F = mg \quad ....(i)$$

But from Universal Law of Gravitation,

$$F = \frac{GMm}{d^2} \quad \text{....(ii)}$$

From equations (i) and (ii), we get:

$$mg = \frac{GMm}{d^2}$$

$$\Rightarrow \quad g = \frac{GM}{d^2}$$

Where M is the mass of the earth and d is the distance between the object and the earth.

For objects near or on the surface of the earth distance d is equal to the radius of the earth R.

Thus, $g = \frac{GM}{R^2}$ .....(iii)

Factors Affecting the Value of g :-

- As the radius of the earth increases from the poles to the equator, the value of g becomes greater at the poles than at the equator.
- As we go at large heights, value of g decreases.

To Calculate the Value of g :-

Value of universal gravitational constant, G = 6.7×10^{-11} N m^2/ kg^2,

Mass of the earth, M = 6×10^{24} kg, and

Radius of the earth, R = 6.4×10^6 m

Putting all these values in equation (iii), we get:

$$g = \frac{6.7\times10^{-11}\text{Nm}^2/\text{kg}^2 \times 6\times10^{24}\text{kg}}{\left(6.4\times10^{6}\text{m}\right)^2} = 9.8\,\text{m/s}^2$$

Thus, the value of acceleration due to gravity of the earth, g = 9.8 m/s^2.