Acceleration Due to Gravity.

The force of attraction exerted by the earth on a body is called gravitational pull or gravity.

We know that when force acts on a body, it produces acceleration. Therefore, a body under the effect of gravitational pull must accelerate.

The acceleration produced in the motion of a body under the effect of gravity is called acceleration due to gravity, it is denoted by g.

Consider a body of mass m is lying on the surface of earth then gravitational force on the body is given by

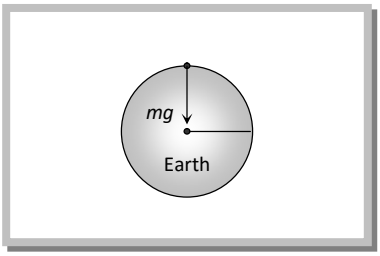
$$F = \frac{GMm}{R^2} \quad \text{.....(i)}$$

Where M = mass of the earth and R = radius of the earth.

If g is the acceleration due to gravity, then the force on the body due to earth is given by

Force = mass × acceleration

or $F = mg$ .....(ii)



From (i) and (ii) we have $mg = \frac{GMm}{R^2}$

$$\therefore \quad g = \frac{GM}{R^2} \quad \text{.....(iii)}$$

$$\Rightarrow \quad g = \frac{G}{R^2}\left(\frac{4}{3}\pi R^3 \rho\right)$$ [As mass (M) = volume ($\frac{4}{3}\pi R^3$) × density (ρ)]

$$\therefore \quad g = \frac{4}{3}\pi\rho GR \quad \text{.....(iv)}$$

Important points

(i) From the expression $g = \frac{GM}{R^2} = \frac{4}{3}\pi\rho GR$ it is clear that its value depends upon the mass radius and density of planet and it is independent of mass, shape and density of the body

placed on the surface of the planet. i.e. a given planet (reference body) produces same acceleration in a light as well as heavy body.

(ii) The greater the value of (M / R^2) or $\rho R,$ greater will be value of g for that planet.

(iii) Acceleration due to gravity is a vector quantity and its direction is always towards the center of the planet.

(iv) Dimension [g] = [LT–2]

(v) Its average value is taken to be 9.8 m/s2 or 981 cm/sec2 or 32 feet/sec2, on the surface of the earth at mean sea level.

(vi) The value of acceleration due to gravity vary due to the following factors: (a) Shape of the earth, (b) Height above the earth surface, (c) Depth below the earth surface and (d) Axial rotation of the earth.