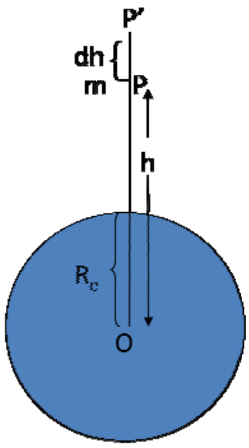
Escape Velocity:

When a particle is thrown up since it moves against the acceleration due to gravity its velocity decreases continuously and when its velocity becomes zero it stops and starts coming down in the direction of acceleration due to gravity. The height up to which it rises depends on the initial velocity of throw.

If a particle can be thrown with such a higher initial velocity that it can go up to infinity i.e. beyond the gravitational field of earth the particle never returns to the surface of earth again and the particle is said to escape the gravitational field of earth.

Definition : The minimum velocity of projection at which any particle go up to infinity i.e. escape the gravitational field of earth and never returns to earth again is known as escape velocity.



Given M_e & R_e = Mass and Radius of earth

$$g = \frac{GM_e}{R_e^2} \longrightarrow (1)$$

Acceleration due to gravity on the surface of earth.

Let us consider a particle of mass m at P at a distance h from the center of earth.

Gravitational force of earth on that particle

$$F = \frac{GM_e m}{h^2}$$

To take the particle from P to P' through a small distance dh (so small that the force F between P and P' can be assumed to be constant) against the force work done is dw

$$dw = Fdh = \frac{GM_e m}{h^2}.dh \longrightarrow (2)$$

Hence the total work done in taking the particle from the surface of earth to infinity can be obtained by integrating equation (2)

$$dw = \int dw = \int_{R_e}^{\infty} \frac{GM_e m}{h^2}.dh = GM_e m\left[-\frac{1}{h}\right]_{\mathrm{Re}}^{\infty}$$

$$W = \frac{GM_e m}{R_e} \longrightarrow \quad (3)$$

This work i.e. the energy required to go from the surface of earth to infinity is obtained from the K.E supplied to the particle by throwing it.

Let V_e = Velocity of escape

K.E supplied $= \frac{1}{2} m v_e^2$

Equating (2) and (3) $\frac{1}{2} m v_e^2 = \frac{GM_e m}{R_e}$

$$v_e = \sqrt{\frac{2GM_e}{R_e}} \longrightarrow \quad (4)$$

Equation (4) gives the velocity of escape

$$g = \frac{GM_e}{R_e^2}$$

$$gR_e = \frac{GM_e}{R_e} \longrightarrow \quad (5)$$

$$v_e = \sqrt{2gR_e} \longrightarrow \quad (6)$$

From (5) and (7) we see that velocity of escape is constant.

g = 9.8 m / sec^2

R_e = 6400 KM

V_e = 11.2 KM / sec