Q5. A body is falling freely under 'the action of gravity alone in vacuum. Which of the following quantities remain constant during the fall?

(a) Kinetic energy

(b) Potential energy

(c) Total mechanical energy

(d) Total linear momentum

Sol: (c) As the body is falling freely under gravity, the potential energy decreases continuously and kinetic energy increases continuously as all the conservative forces are doing work. So, total mechanical energy (PE + KE) of the body will be constant.

Let us discuss this in detail:

In the given diagram an object is dropped from-a height H from ground.

At point A total mechanical energy will be EA = K.E + P.E

$$E_A = \frac{1}{2}mv^2 + mgH$$

As velocity will be zero at A, so its kinetic energy will be zero.

$$E_A = mgH$$

Velocity at point B will be, $v_B = \sqrt{2gh}$

So energy at point B will be $E_B = \text{KE} + \text{PE}$

$$E_B = \frac{1}{2}m(2gh) + mg(H - h)$$

$$E_B = \frac{1}{2}m(2gh) + mg(H - h)$$

$$E_B = mgh + mgH - mgh$$

$$E_B = mgH$$

Now, velocity at point C will be $v_c = \sqrt{2gh}$

So, energy at point C will be $E_C = \text{KE} + \text{PE}$

$$E_C = \frac{1}{2}m(2gH) + mg(0)$$

$$E_C = mgH$$

So, total mechanical energy will remain same (if we neglect the air friction).