

Q- Sketch graphs of total mechanical, potential and kinetic energy verses time, on the same paper, for

(a) a 0.5 kg metal ball dropped from rest falling from point A to B in 5 second under gravity. ($g = 10 \text{ m/s}^2$)

(b) a 5.0g sheet of paper falling with terminal velocity 1 m/s from point A to B.

(a) Neglecting air resistance, the total mechanical energy of the object will remain constant.

At A the velocity of the object is zero and hence the KE will be zero and the potential energy taking B as a reference point will be given by mgh

The distance fallen in 5 s is given by

$$h = \frac{1}{2} g t^2 = 0.5 \cdot 10 \cdot 25 = 125 \text{ m}$$

and hence the potential energy at A will be

$$PE = mgh = 0.5 \cdot 10 \cdot 125 = 625 \text{ J}$$

Hence the total mechanical energy of the object is 625 J and will remain constant. Thus, its graph will be a straight-line parallel to time axis.

The velocity of the object as a function of time is given by the first equation of motion

$$v = u + at$$

$$v = 0 + 10t$$

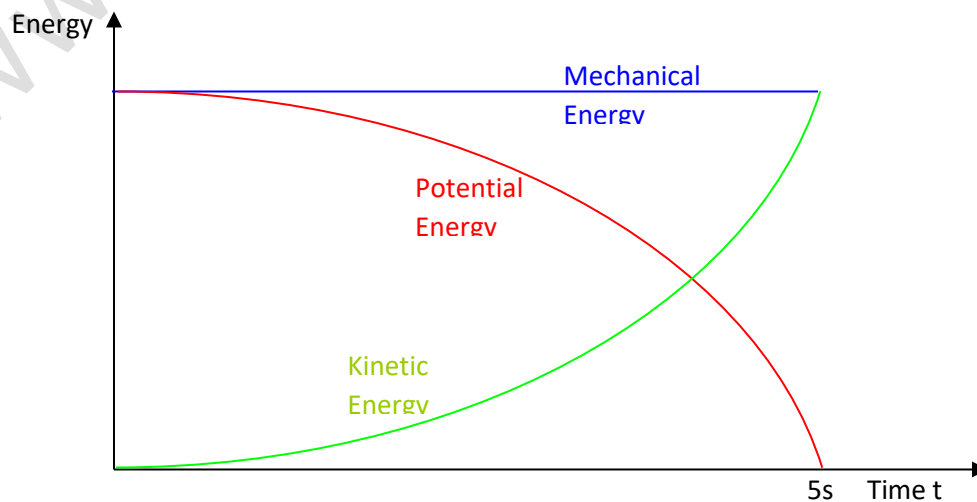
and hence the kinetic energy of the object at time t is given by

$$KE = \frac{1}{2} mv^2 = 0.5 \cdot 0.5 \cdot 100 t^2 = 25 t^2$$

This is a square function of time and hence the graph will be a parabola as with initial KE zero and final KE 625 J

The potential energy is initially 625 J and then it converts in to kinetic energy and hence the way in which kinetic energy increases, potential energy decreases and the graph will also be a parabola but with opposite direction

Hence the graphs can be drawn as



(b) Here the mass of the sheet is small, air resistance becomes considerable and hence the sheet is falling with a constant terminal velocity.

As the velocity of the sheet is constant its kinetic energy is constant given by

$$KE = \frac{1}{2} mv^2 = 0.5 * 5 * 10^{-3} * 1.0^2 = 2.5 * 10^{-3} \text{ J}$$

and hence the graph will be a straight line without slope.

$$\text{Initial potential energy at point A} = mgh = 5 * 10^{-3} * 10 * 125 = 6.25 \text{ J}$$

As the sheet is falling with constant velocity its height is decreasing constantly to zero and hence potential energy decreases uniformly to zero and the graph will be a straight line with a slope.

The mechanical energy is also decrease due to decrease in potential energy but it is more than PE by amount of KE.

