Answer on Question #73991, Physics / Mechanics — Relativity —

Question A particle starts moving along a straight line with initial velocity of 25m/s, from O under a uniform acceleration of -2.5 m/s2. Deterime
(i) Velocity, displacement and the distance travelled at t= 5 sec
(ii) How long the particle moves in the same direction? What is its velocity, displacement and the distance covered then?
(iii) The instantaneous velocity , displacement and the distance covered at t=15 sec
(iv) The time required to come back to O, velocity, displacement and distance covered then
(v) Instantaneous velocity, , displacement and distance covered at t=25 sec

Solution (i)From equation for velocity:

$$v(t) = v_0 - at$$

where $v_0 = 25$ m/s, $a = -2.5$ m/s^2. So we find:

$$v(5) = 25 - 2.5 \cdot 5 = 12.5\, m/s$$

In this case distance and displacement are the same, as particle didn't change the direction.

$$d = s(5) = v_0 t - at^2/2 = 25 \cdot 5 - 2.5 \cdot 5^2/2 = 93.75\, m$$

(ii) Time when direction is change is defined by condition:

$$v(t_x) = 0$$

$$v_0 - at_x = 0$$

$$t_x = \frac{v_0}{a} = \frac{25}{2.5} = 10\, s$$

Displacement and distance:

$$d = s(10) = v_0 t - at^2/2 = 25 \cdot 10 - 2.5 \cdot 10^2/2 = 125\, m$$

(iii) For $t = 15$:

$$v(15) = 25 - 2.5 \cdot 15 = -12.5\, m/s$$

The displacement is:

$$s(15) = 25 \cdot 15 - 2.5 \cdot 15^2/2 = 93.75\, m$$

The distance is sum of displacements before and after the turn-around:

$$d = s(10) + 2.5 \cdot 5^2/2 = 156.25\, m$$

(iv) The time required to come back to O is defined by condition:

$$v(t_y) = -v_0$$

From this we find that

$$v_0 - at_y = -v_0$$

$$t_y = \frac{2v_0}{a} = \frac{2 \cdot 25}{2.5} = 20\,s$$

The displacement is obviously 0 is this case, d=0, while distance is twice as the particle has travelled to turn around:

$$s(20) = 2 \cdot s(10) = 2 \cdot 125 = 250\,m$$

(v) For $t = 25$ we have:

$$v(25) = 25 - 2.5 \cdot 25 = -37.5\,m/s$$

The distance:

$$s(25) = 25 \cdot 25 - 2.5 \cdot 25^2/2 = -156.25\,m/s$$

The displacement is equal to sum of displacement at 20 and displacement covered in last 5 sec:

$$d = 0 + 156.25 = 156.25$$