Answer on Question #72505-Physics-Other

1. The acceleration of a particle in rectilinear motion is defined by a = k square root of v , where a is in m/s^2 , v is is m/s and k is a constant. Given that at times t = 2 sec and t = 3 sec, the velocities are respectively 4 m/s and 9 m/s, and the displacement at t = 3 sec is 20 m. Determine the values of k and Vo or Vinitial. Write the equation of motion.

Solution

$$a = \frac{dv}{dt} = k\sqrt{v}$$

$$\frac{dv}{\sqrt{v}} = kt$$

$$\frac{\sqrt{v}}{\frac{1}{2}} = kt + C$$

$$2\left(\sqrt{v} - \sqrt{v_0}\right) = kt$$

$$\sqrt{v} = \sqrt{v_0} + \frac{kt}{2}$$

$$v = \left(\sqrt{v_0} + \frac{kt}{2}\right)^2$$

$$4 = \left(\sqrt{v_0} + k\right)^2$$

$$9 = \left(\sqrt{v_0} + \frac{3k}{2}\right)^2$$

$$\sqrt{v_0} + k = 2$$

$$\sqrt{v_0} + \frac{3k}{2} = 3$$

$$\frac{k}{2} = 1$$

$$\boldsymbol{k = 2\frac{m^{\frac{1}{2}}}{s^{\frac{3}{2}}}.}$$

$$\sqrt{v_0} + 2 = 2$$

$$\boldsymbol{v_0 = 0\frac{m}{s}.}$$

$$v = \left(\frac{2t}{2}\right)^2 = t^2.$$

$$\frac{dx}{dt} = v = t^2$$

$$x = C + \frac{t^3}{3}$$

$$20 = C + \frac{3^3}{3} = C + 9$$

$$C = 11.$$

The equation of motion is

$$\boldsymbol{x = 11 + \frac{t^3}{3}}$$

2. A car starts from rest at Point O. A car covers 100 m in 10 seconds (Point A to B), while accelerating uniformly at a rate of 1 m/s^2. Determine

a) Velocities of the car at Point A and Point B.

b) Distance traveled before coming to this point A assuming it started from rest

c) Its velocity after the next 10 seconds (Point C)

Solution

a)

$$d = a\frac{t^2}{2}$$

$$d_2 - d_1 = \frac{a}{2}(t_2^2 - t_1^2) = \frac{a}{2}(t_2 - t_1)(t_2 + t_1)$$

$$100 = \frac{1}{2}(10)(t_2 + t_1)$$

$$(t_2 + t_1) = 20$$

$$t_2 - t_1 = 10 \rightarrow t_2 = t_1 + 10.$$

$$(t_1 + 10 + t_1) = 20$$

$$2t_1 = 10$$

$$t_1 = 5\ s.$$

$$t_2 = 15\ s.$$

$$\boldsymbol{v_a = 1(5) = 5\frac{m}{s}.}$$

$$\boldsymbol{v_b = 1(15) = 15\frac{m}{s}.}$$

b)

$$\boldsymbol{d_1 = \frac{1}{2}(5)^2 = 12.5\ m.}$$

c)

$$\boldsymbol{v_c = 1(15 + 10) = 25\frac{m}{s}.}$$

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