Answer on Question #51374, Physics, Mechanics | Kinematics | Dynamics

Question

Two particles move along an x axis. The position of particle 1 is given by

x = 9.00t^2 + 6.00t + 5.00 (in meters and seconds);

the acceleration of particle 2 is given by a = -8.00t (in meters per seconds squared and seconds) and, at t = 0, its velocity is 20.0 m/s. When the velocities of the particles match, what is their velocity?

Solution

Let's compute the velocity of the particle 1.

$$x_1(t) = 9t^2 + 6t + 5$$

$$V_1(t) = \left(x(t)\right)' = \left(9t^2 + 6t + 5\right)' = 18t + 6$$

Velocity of the particle 2 can be expressed as:

$V_2(t) = \int a(t)\,dt$, where V_0 is the initial velocity of the particle 2.

We know that:

$$a(t) = -8t$$

$V_2(0) = 20$, then:

$$V_2(t) = \int -8t\,dt = -4t^2 + C$$

$$V_2(0) = C = 20$$

$$V_2(t) = 20 - 4t^2$$

So, we should solve the equation:

$$V_1(t) = V_2(t)$$

$$18t + 6 = 20 - 4t^2$$

$$4t^2 + 18t - 14 = 0$$

$$2t^2 + 9t - 7 = 0$$

$$D = 81 + 56 = 137$$

$$t_1 = \frac{-9 + \sqrt{137}}{4} \; t_2 = \frac{-9 - \sqrt{137}}{4}$$

$$t_2 < 0 \Rightarrow t_1 \; is \; a \; unique \; solution$$

$$t_1 \approx 0{,}676(s)$$

Answer

$0{,}676\,s$