Answer on Question #51377, Physics, Mechanics | Kinematics | Dynamics

Question

A train started from rest and moved with constant acceleration. At one time it was traveling 20 m/s, and 170 m farther on it was traveling 46 m/s. Calculate (a) the acceleration, (b) the time required to travel the 170 m mentioned, (c) the time required to attain the speed of 20 m/s, and (d) the distance moved from rest to the time the train had a speed of 20 m/s.

Solution

(a) Since the train started from rest and moved with constant acceleration:

$$V_2 = V_1 + at$$
$$V_1 = 20m/s, V_2 = 46m/s$$

By the same time:

$$S = V_1 t + \frac{at^2}{2},\ S = 170m$$

So, we have a system with 2 variables a and t :

$$\begin{cases} S = V_1 t + \dfrac{at^2}{2} \\ V_2 = V_1 + at \end{cases}$$

$$t = \frac{V_2 - V_1}{a} \Rightarrow S = V_1 \frac{V_2 - V_1}{a} + \frac{a}{2}\left(\frac{V_2 - V_1}{a}\right)^2$$

$$S = \frac{V_1(V_2 - V_1)}{a} + \frac{(V_2 - V_1)^2}{2a} = \frac{2V_1(V_2 - V_1) + (V_2 - V_1)^2}{2a} \Rightarrow$$

$$a = \frac{2V_1(V_2 - V_1) + (V_2 - V_1)^2}{2S} = \frac{40(46 - 20) + 26^2}{340}\frac{m^2}{s^2 m} =$$

$$= 5.047\frac{m}{s^2}$$

(b) $t = \dfrac{V_2 - V_1}{a} = \dfrac{46m/s - 20m/s}{5.047m/s^2} = 5.152s$

(c) Since the train speeds up at a constant rate from rest:

$$V_0 = 0$$

$$V_1 = V_0 + at_0 = at_0$$

$$t_0 = \frac{V_1}{a} = \frac{20m/s}{5.047\frac{m}{s^2}} = 3{,}963\text{s}$$

(d) $S_0 = \frac{at_0^2}{2} = 0.5 \cdot 5.047\frac{m}{s^2} \cdot (3{,}963)^2 s^2 = 39{,}627\text{m}$

Answer

(a) $5.047\frac{m}{s^2}$

(b) $5.152s$

(c) 3,963s

(d) 39,627m