Answer on Question#37994 - Physics - Mechanics

A train is coming at the station. It starts decelerating and passes first 50m in 5 seconds, and next 50 m in 7 s. Find acceleration and the starting velocity.

Solution:

$a-$ decceleration of the train;

V_0- initial velocity of the train;

Equation of motion for the train for first distance $d_1 = 50\text{m}$ $(t_1 = 5\text{s})$:

$$d_1 = V_0 t_1 - \frac{a t_1^2}{2} \qquad (1)$$

$$V_0 = \frac{2d_1 + a t_1^2}{2t_1} \qquad (2)$$

Rate equation for the train for this distance ($V_1 -$ velocity after time t_1):

$$V_1 = V_0 - a t_1 \qquad (3)$$

Equation of motion for the train for first distance $d_2 = 50\text{m}$ $(t_2 = 7\text{s})$:

$$d_2 = V_1 t_2 - \frac{a t_2^2}{2} \qquad (4)$$

$(3)\text{and}(2)\text{in}(4)$:

$$d_2 = (V_0 - a t_1)t_2 - \frac{a t_2^2}{2} = \left(\frac{2d_1 + a t_1^2}{2t_1} - a t_1\right) t_2 - \frac{a t_2^2}{2}$$

$$2d_2 t_1 = 2d_1 t_2 + a t_1^2 t_2 - 2a t_1^2 t_2 - a t_2^2 t_1$$

$$2d_2 t_1 = 2d_1 t_2 - a t_1^2 t_2 - a t_2^2 t_1$$

$$a = \frac{2(d_1 t_2 - d_2 t_1)}{t_1 t_2 (t_1 + t_2)} = \frac{2(50\text{m} \cdot 7\text{s} - 50\text{m} \cdot 5\text{s})}{5\text{s} \cdot 7\text{s} \cdot (5\text{s} + 7\text{s})} = 0.48 \frac{\text{m}}{\text{s}^2}$$

$$(2)\text{:}\ V_0 = \frac{2d_1 + a t_1^2}{2t_1} = \frac{2 \cdot 50\text{m} + 0.48 \frac{\text{m}}{\text{s}^2} \cdot (5\text{s})^2}{2 \cdot 5\text{s}} = 11.2 \frac{\text{m}}{\text{s}}$$

Answer: deceleration of the train is equal to $0.48 \frac{\text{m}}{\text{s}^2}$; starting velocity of the train is $11.2 \frac{\text{m}}{\text{s}}$.