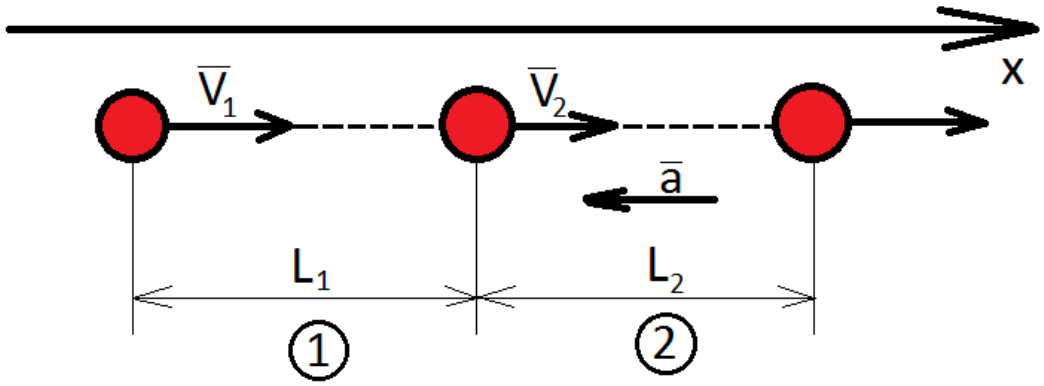
A body travelling with constant retardation travels 250 metres in 10 seconds and next 250 metres in next 20 seconds. Find the retardation.

Solution:

$L_1 = L_2 = 250m$

$t_1 = 10s$

$t_2 = 20s$



The equation of motion for the first part of the distance (1):

$$x: L_1 = V_1 t_1 - \frac{a{t_1}^2}{2} \qquad (1)$$

Rate equation for the same section of all the way (point A) (1):

$$V_2 = V_1 - at_1$$

$$V_1 = V_2 + at_1 \qquad (2)$$

$$(2) in (1): \qquad L_1 = (V_2 + at_1)t_1 - \frac{a{t_1}^2}{2}$$

$$L_1 = V_2 t_1 + \frac{a{t_1}^2}{2}$$

$$V_2 t_1 = L_1 - \frac{a{t_1}^2}{2} \qquad (3)$$

The equation of motion for the second part of the distance (2):

$$x: L_2 = V_2 t_2 - \frac{a{t_2}^2}{2}$$

$$V_2 t_2 = L_2 + \frac{a{t_2}^2}{2} \qquad (4)$$

$$(4) \div (3): \qquad \frac{V_2 t_1}{V_2 t_2} = \frac{2L_1 - a{t_1}^2}{2L_2 + a{t_2}^2}$$

$$\frac{t_1}{t_2} = \frac{2L_1 - at_1^2}{2L_2 + at_2^2}$$

$$2L_2t_1 + at_2^2t_1 = 2L_1t_2 - at_1^2t_2$$

$$a(t_2^2t_1 + t_1^2t_2) = 2(L_1t_2 - L_2t_1)$$

$$a = \frac{2(L_1t_2 - L_2t_1)}{t_2^2t_1 - t_1^2t_2} = \frac{2(250m \cdot 20s - 250m \cdot 10s)}{(20s)^2 \cdot 10s - (10s)^2 \cdot 20s} = 2.5\frac{m}{s^2}$$

Answer: the retardation is $a = 2.5\frac{m}{s^2}$