Answer on Question #82105 Physics / Other

A train at station p accelerates uniformly from rest until it attains a speed of 100 km/h. It then continues at that speed for some time and decelerates uniformly until it comes to a stop area station, Q 60 km from P. The total time taken for the journey is one hour. If the rate of deceleration is twice that of the acceleration, calculate the (I) Time taken during which the constant speed is maintained. (II) Acceleration of the train.

Solution:

Let t_1 is the time of acceleration, t_2 is the time of moving with constant speed, t_3 is the time of deceleration.

$$t_1 + t_2 + t_3 = 1 \text{ h}$$

Since the rate of deceleration is twice that of the acceleration, we get $t_3 = \frac{1}{2}t_1$. So

$$1.5t_1 + t_2 = 1 \text{ h} \quad (1)$$

The total distance traveled by the train

$$s_1 + s_2 + s_3 = 60 \text{ km}$$

where

$$s_1 = \frac{0+v}{2}t_1 = 50t_1, \qquad s_2 = vt_2 = 100t_2, \qquad s_3 = \frac{v+0}{2}t_3 = 50t_3 = 25t_1$$

Thus

$$50t_1 + 100t_2 + 25t_1 = 60 \text{ km}$$

$$75t_1 + 100t_2 = 60 \text{ km} \quad (2)$$

Equations (1) and (2) have solution

$$t_1 = \frac{8}{15}\text{h}, \qquad t_2 = \frac{1}{5}\text{h} = 12 \text{ m}$$

Acceleration

$$a = \frac{\Delta v}{t_1} = \frac{100 \text{ km/h}}{\frac{8}{15}\text{h}} = 187.5 \text{ km/h}^2$$

Answer: $\frac{1}{5}\text{h} = 12 \text{ m}, 187.5 \text{ km/h}^2$