Answer on Question #82148, Physics / Mechanics | Relativity

a train at station p accelerates uniformly from rest until it attains a speed of 100km/h. It then continues at that speed for some time and decelerates uniformly until it comes to a stop area station, Q 60km 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

The total distance:

$$d = \frac{at_1^2}{2} + vt_2 + \frac{1}{2}(2a)t_3^2$$

$$t_1 = \frac{v}{a}, t_3 = \frac{v}{2a}, t_2 = t - t_1 - t_3 = t - \frac{v}{a} - \frac{v}{2a} = t - \frac{3v}{2a}.$$

$$d = \frac{a}{2}\left(\frac{v}{a}\right)^2 + v\left(t - \frac{3v}{2a}\right) + \frac{1}{2}(2a)\left(\frac{v}{2a}\right)^2 = \frac{3}{4}\frac{v^2}{a} + v\left(t - \frac{3v}{2a}\right)$$

$$d = vt - \frac{3}{4}\frac{v^2}{a}$$

$$a = \frac{3}{4}\frac{v^2}{vt - d} = \frac{3}{4}\frac{\left(\frac{100}{3.6}\right)^2}{\left(\frac{100}{3.6}\right)(3600) - 60000} = 0.0145\frac{m}{s^2}.$$

$$t_1 = \frac{v}{a} = \frac{\left(\frac{100}{3.6}\right)}{0.0145}s = \frac{\left(\frac{100}{3.6}\right)}{0.0145}\frac{1}{60}\ min = 32\ min.$$

$$t_3 = \frac{v}{2a} = \frac{t_1}{2} = 16\ min.$$

(I) Time taken during which the constant speed is maintained.

$$t_2 = 60 - 32 - 16 = 12\ min.$$

(II) Acceleration of the train.

$$a = 0.0145\frac{m}{s^2}.$$