Answer on Question #60190, Physics / Other |

a body starts from rest accelerates uniformly at rate of 10 cm/s^2 and retards at 20 cm/s^2 . find least time in which it can complete 5 km journey if max velocity attained is 72 km /hr

Solution:

It will accelerate to max possible speed with the max possible acceleration and then it will slow down with the max possible negative acceleration

So the uniform acceleration is

$$a_1 = 10\ \text{cm/s}^2 \cdot [1\ \text{m} / 100\ \text{cm}] = 0.1\ \text{m/s}^2$$

The maximum speed is

$$v_{max} = 72\ \text{km/h} \cdot [1000\ \text{m} / \text{km}]\ \text{x}\ [1\ \text{h} / 3600\ \text{s}] = 20\ \text{m/s}$$

and max uniform slowing acceleration is

$$a_2 = -20\ \text{cm/s}^2 \cdot [1\text{m} / 100\ \text{cm}] = -0.2\ \text{m/s}^2\ .$$

The time to accelerate to max speed = t_1, at max speed from t_1 to t_2, slowing from 20 m/s to 0 m/s from t_2 to t_3 and that means we have to find t_3 because t_3 is the least time to complete the trip.

Finding of t_1:

$$t_1 = \frac{v_{max} - v_0}{a_1} = \frac{20}{0.1} = 200\ \text{s}$$

The distance is

$$d_1 = \frac{a_1 t_1^2}{2} = \frac{0.1 \cdot 200^2}{2} = 2000\ \text{m}$$

The time of retarding is

$$t_2 = \frac{0 - v_{max}}{a_2} = \frac{-20}{-0.2} = 100\ \text{s}$$

The distance when retarding is

$$d_2 = v_{max} t_2 + \frac{a_2 t_2^2}{2} = 20 \cdot 100 - \frac{0.2 \cdot 100^2}{2} = 1000\ \text{m}$$

The remain distance is

$$d_3 = d - d_1 - d_2 = 5000 - 2000 - 1000 = 2000\ \text{m}$$

The distance d_3 will moving at maximum speed, and time t_3 is

$$t_3 = \frac{d_3}{v_{max}} = \frac{2000}{20} = 100\ \text{s}$$

Total time is

$$t = t_1 + t_2 + t_3 = 200 + 100 + 100 = 400\ \text{s}$$

So the least time required to complete the trip is 400 s.

Answer: 400 s.