Task:

A train at rest starts moving with uniform acceleration, keeps moving for 2 min. It reaches 48 km/h after 5 min of its uniform retardation and stops after 3 min. How much distance it covered?

Solution:

Given:

$t_{acc} = 2\ min = \frac{1}{30} h$

$t_{ret} = 5\ min = \frac{1}{12} h$

$t_{stop} = 3\ min = \frac{1}{20} h$

$\dot{s}_2(t_{ret}) = 48\ km/h$

$\dot{s}_2(t_{ret} + t_{stop}) = 0\ km/h$

$s_1(t) = \frac{a_1 \cdot t^2}{2}$

$s_2(t_1) = \frac{a_2 \cdot {t_1}^2}{2} + \dot{s}_1(t_{acc}) \cdot t_1$

$s_{total} = s_1(t_{acc}) + s_2(t_{ret} + t_{stop})$

$s_1(t_{acc}) = \frac{a_1 \cdot {t_{acc}}^2}{2}$

$\dot{s}_1(t) = a_1 \cdot t$

$\dot{s}_1(t_{acc}) = a_1 \cdot t_{acc}$

$\dot{s}_2(t_1) = a_2 \cdot t_1 + \dot{s}_1(t_{acc}) = a_2 \cdot t_1 + a_1 \cdot t_{acc}$

$\dot{s}_2(t_{ret}) = a_2 \cdot t_{ret} + a_1 \cdot t_{acc} = 48\ km/h$

$\dot{s}_2(t_{ret} + t_{stop}) = a_2 \cdot (t_{ret} + t_{stop}) + a_1 \cdot t_{acc} = 0\ km/h$

$a_1 = 3840\ km/h^2$, $a_2 = -960\ km/h^2$;

$s_{total} = \frac{a_1 \cdot {t_{acc}}^2}{2} + \frac{a_2 \cdot (t_{ret} + t_{stop})^2}{2} + a_1 \cdot t_{acc} \cdot (t_{ret} + t_{stop}) = \frac{32}{3}\ km$

Answer:

The train covered $\frac{32}{3}\ km$