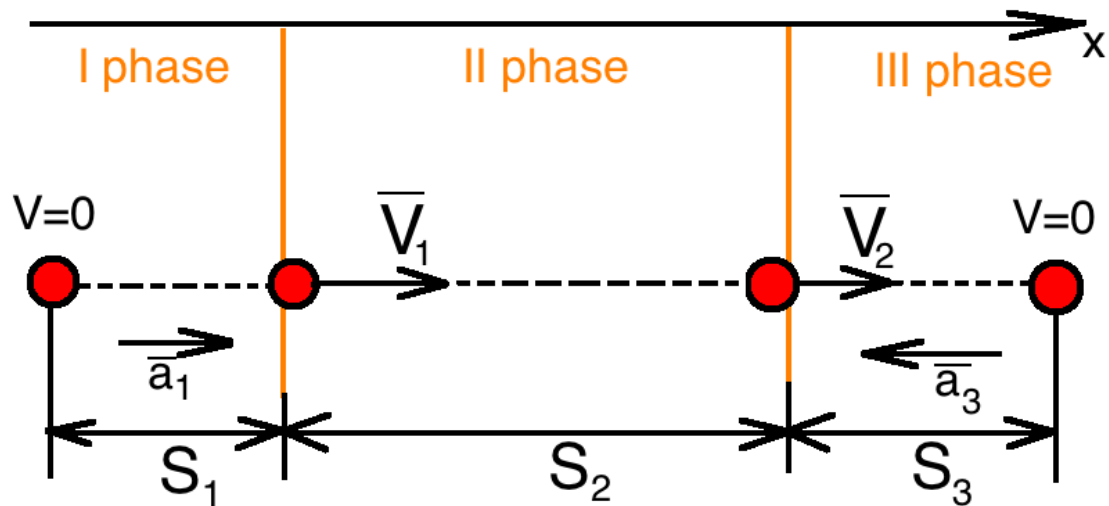


A truck on a straight road starts from rest and accelerates at 2.0 m/s^2 until it reaches a speed of 20 m/s . Then the truck travels for 20 s at a constant speed until the brakes are applied, stopping the car in a uniform manner in an additional 5.0 s . How long is the truck in motion and what is its average velocity during the motion?

Solution



Assumption: to find the average speed we can break all path up into three phases: accelerating $\rightarrow$ coasting $\rightarrow$ decelerating.

First phase (accelerating)

Rate equation for the acceleration phase:

$$V_1 = a_1 t_1$$

$$t_1 = \frac{V_1}{a_1} = \frac{20 \frac{\text{m}}{\text{s}}}{2.0 \frac{\text{m}}{\text{s}^2}} = 10 \text{ s}$$

It means that accelerating will stop after 10 seconds because then the truck will reach velocity 20 m/s .

Equation of motion for the acceleration phase:

$$S_1 = \frac{a_1 t_1^2}{2} = \frac{2.0 \frac{\text{m}}{\text{s}^2} \cdot (10 \text{ s})^2}{2} = 100 \text{ m}$$

Second phase (coasting):

Truck travels path at 20 m/s for 20 s :

$$S_2 = V_2 t_2 = 20 \frac{\text{m}}{\text{s}} \cdot 20 \text{ s} = 400 \text{ m}$$

Third phase (decelerating):

Rate equation for the acceleration phase:

$$0 = V_2 - a_3 t_3$$

$$a_3 = \frac{v_2}{t_3} = \frac{20 \frac{\text{m}}{\text{s}}}{5 \text{ s}} = 4 \frac{\text{m}}{\text{s}^2}$$

It means that accelerating will stop after 10 seconds because then the truck will reach velocity 20 m/s.

Equation of motion for the deceleration phase:

$$S_3 = \frac{a_3 t_3^2}{2} = \frac{4 \frac{\text{m}}{\text{s}^2} \cdot (5 \text{ s})^2}{2} = 50 \text{ m}$$

$$\begin{aligned} \text{Average velocity} &= \frac{\text{all distance}}{\text{all time}} = \frac{S_1 + S_2 + S_3}{t_1 + t_2 + t_3} = \frac{100\text{m} + 400\text{m} + 50\text{m}}{10\text{s} + 20\text{s} + 5\text{s}} = \\ &= 15.7 \frac{\text{m}}{\text{s}} \end{aligned}$$

Time of the travel is $T = 10\text{s} + 20\text{s} + 5\text{s} = 35\text{s}$.

Answer: average velocity during the motion is $15.7 \frac{\text{m}}{\text{s}}$, truck was in motion during 35s.