Lec 12 29 Jan, 2023

Speed, Time & Distance

① $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$ i.e it shows how fast or slow an object moves

$\text{Dist} \propto \text{Speed}$ i.e. as Dist ↑ Speed ↑

$\text{Time} \propto \frac{1}{\text{Speed}}$ i.e. Speed ↑ Time ↓

Time: seconds (s), minutes (min), hours (hr)

Dist: meters (m), kilometers (km), miles, feet

Speed: m/s, km/hr

$D = S.T$

Conversions:

1. $1\,km = 1000\,m$
2. $1\,hr = 60\,min = 60 \times 60\,sec = 3600\,s$
3. $\therefore 1\,km/hr = \frac{1000\,m}{3600\,s} = \frac{5}{18}\,m/s$

$\therefore$ **A m/s = B (km/hr) $\times \frac{5}{18}$ m/s**

eg: 60 km/hr ⟶ x m/s

B = ? A = ?

$$\therefore A = \frac{\cancel{60}^{10}}{\cancel{18}_{3}} \times \frac{5}{1} \text{ m/s} = \frac{50}{3}$$

$$= 16.66 \text{ m/s}$$

eg: Train running at 120 km/hr. How many m/s?

B = 120 km/hr

A = ?

$$A \text{ m/s} = \left(\frac{5}{18} \times B\right) \text{ m/s}$$

$$= \frac{5}{\cancel{18}_{3}} \times \frac{\cancel{120}^{20}}{\cancel{60}_{1}}$$

$$= \frac{100}{3}$$

$$= 33.33. \text{ m/s}$$

$$\approx 33.34 \text{ m/s}$$

4. $1\ km = 1000\ m$ $\qquad$ $1\ hr = 3600\ sec$

$1\ km = 1 \times 1000\ m$ $\qquad$ $1\ hr = 1 \times 3600\ sec$

$\therefore \frac{1}{1000}\ km = 1\ m$

$\therefore$ $\boxed{1\ m = \frac{1}{1000}\ km}$ $\qquad$ $\therefore$ $\boxed{1\ sec = \frac{1}{3600}\ hr}$

$\therefore 1\ m/s = \frac{1/1000}{1/3600}$

$= \frac{3600}{1000}$

$= \frac{36}{10}$

$= \frac{18}{5}$

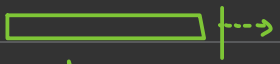
$\therefore$ $\boxed{A\ km/hr = B \times \frac{18}{5}\ km/hr}$

B : m/s

5 An object covers equal distance at speed S_1 & other equal dist at speed S_2, then avg speed for the dist covered $= \frac{2 \cdot S_1 \cdot S_2}{S_1 + S_2}$

Train: Conventions

S_T: Speed of Train
S_O: —u— Object
L_T: Length of Train
L_O: —u— Object



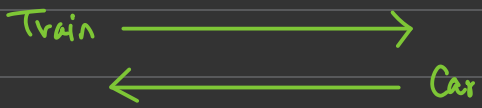
Case 1: When train crosses a stationary object with no length (eg: Pole) in time t,

$$S_T = \frac{L_T}{t}$$

Case 2: When train crosses a stationary object with Length L_O (eg: Platform) in time t,

$$S_T = \frac{L_T + L_O}{t}$$

Case 3: When Train crosses a moving object with no length (eg: Maruti Alto – negligible length) in time t,

(a) 

Objects moving in Opposite direction:

$$S_T + S_0 = \frac{L_T}{t}$$

(b) Objects moving in same direction

$$S_T - S_0 = \frac{L_T}{t}$$

Case 4: When a train crosses a moving object with length L_0 (eg: another train) in time t,

(a) Objects (Trains) moving in Opposite direction.

$$S_T + S_0 = \frac{L_T + L_0}{t}$$

(6) Objects (Trains) moving in same direction

$$S_T - S_O = \frac{L_T + L_O}{t}$$

eg: A person covered a dist of 60 km in 2 hrs. Calculate the speed of his car

Soln:

Dist = 60 km

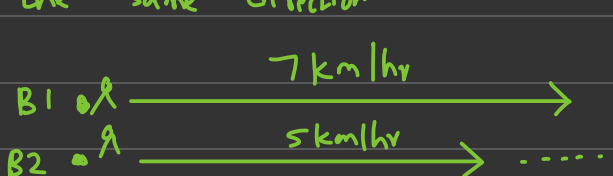
Time = 2 hrs

$\therefore \quad D = ST$

$$\therefore S = \frac{D}{T} = \frac{60}{2} = 30 \text{ km/hr}.$$

eg: Two boys are running from same place at a speed of 7 km/hr & 5 km/hr Find the distance b/w them after 20 mins respectively, if they move in the same direction

Soln:



$\therefore$ the boys are running in the same direction, their relative speed = $(7 - 5) = 2$ km/hr

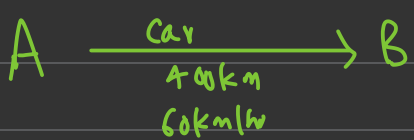
Time taken = 20 min

$$D = ST$$

$$= 2 \times \frac{20}{60}$$

$$= \frac{40}{60}$$

$$= 0.6666 \text{ km}$$



eg: A thief flees city A in a car towards city B on a stretch of straight road, 400 km long, at a speed of 60km/hr. In 30 minutes a police party leaves city A to chase the thief at 80 km/hr. Find the distance travelled by the police when it catches the thief.

Soln:

S T

60 km/hr, 30 min = 60 × 0.5 = 30 km
i.e. 0.5hrs

$$\frac{\text{Thief}}{\text{police}} = \frac{60}{80} = \frac{3}{4} \quad \text{i.e. } 3:4$$

$$\frac{3 \times 30}{4 \times 30} = \frac{90}{120}$$

∴ Police covered 120 km

eg: Moving at $\frac{5}{6}^{th}$ of its usual speed, a train is 10 minutes late. Its usual time to cover the journey is _____.

Soln: Let the usual time be 't' & speed be 'r'.

Let dist. be 'x'.

$D = ST \longrightarrow \boxed{x = vt}$ — (1)

$x = \left(\frac{5}{6} \times v\right)(t + 10)$

$x = \frac{5v}{6}(t + 10)$

$6x = 5v(t + 10)$

$6x = 5vt + 50v$

Subs. (1)

$6x = 5x + 50v$

$x = 50v$

$\therefore \boxed{\frac{x}{v} = 50}$ — (2)

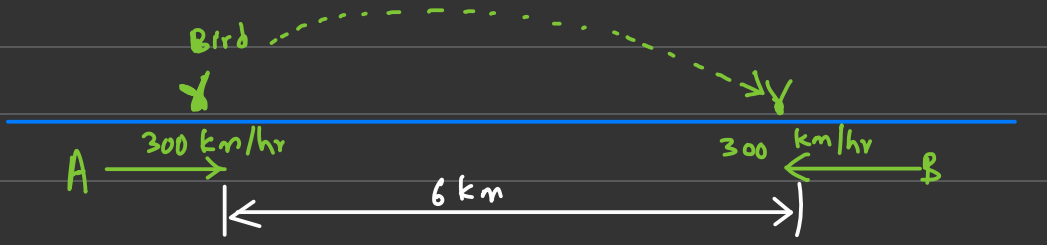
from (1), $x = vt$ $\therefore \boxed{\frac{x}{v} = t}$ — (3)

Subs. (3) in (2),

$\therefore \boxed{t = 50 \text{ min}}$

eg: A bird is sitting on train A moving towards East with a velocity of 300 km/hr. Another train B of same speed is moving in West direction on the same track. When the trains are 6 km apart, the bird starts flying with a velocity of 30 km/hr wrt ground towards B. After touching B, it returns back to A & continue repeating this process until the trains collide. In this process the total dist. covered by the bird is?

Soln:



Relative Speed: $300 + 300 = 600$ km/hr

Time taken for crash, $t = \frac{d}{s} = \frac{6}{600} = \frac{1}{100}$ hrs $= 36$ sec.

Velocity of bird $= 30$ km/hr $= 30 \times \frac{5}{18}$ m/s

$\therefore$ Dist. Travelled by bird is $= \underbrace{30 \times \frac{5}{18}}_{s} \times \underbrace{36}_{t}$

$= 300$ m

X
