Relationship

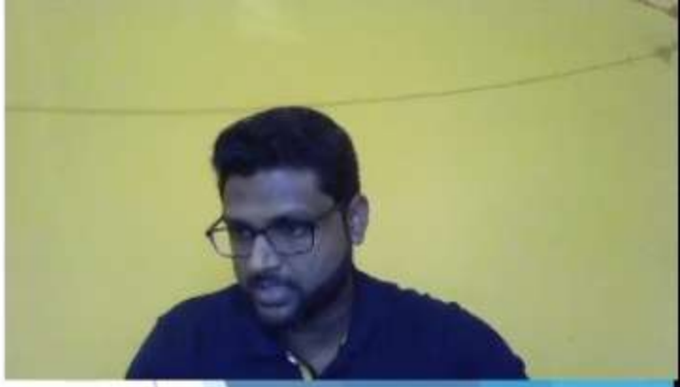
$$\text{Speed} = \frac{Distace\ Covered}{Time\ Taken}$$

Distance = Speed × Time taken

$$\text{Time} = \frac{Distace\ Covered}{Speed}$$

Terms	Unit
Distance	Kilometres , Metres , Miles
Time	Hours , Minutes , Seconds
Speed	Km/hour , Mitre/minute , Mile/hour

Example



25% ↑

A car covers a certain distance in 80 min at a speed of 100 kmph. What will be the time taken to cover the same distance with a speed of 125 kmph?

$d = S \times t$

$\Rightarrow d = 100 \times \frac{80}{60} =$

$t = \frac{d}{125}$

$\frac{a}{n} \uparrow \qquad \frac{a}{a+n} \downarrow$

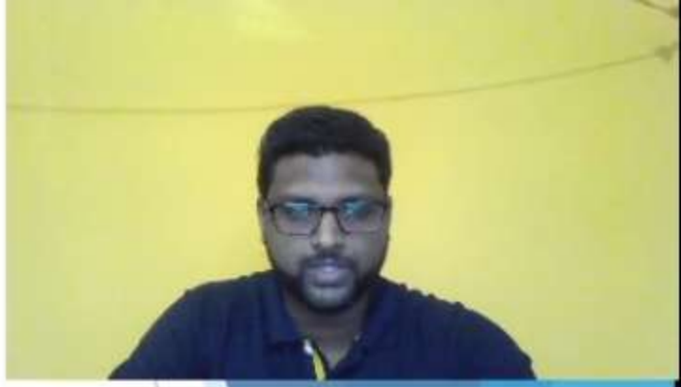
$d = S \times t$

$d = \frac{1}{4} \uparrow \qquad \frac{1}{5} \downarrow$

$\frac{1}{5}(80\ min) = 16$

$80 - 16 = 64\ min$

Conversions of units



Distance / Time	
1 Kilometres	1000 metres
1 Miles	1.609 km
1 Hour	60 minutes
1 Minute	60 seconds

Speed	
1 Km/hr	$\frac{1\ km}{1hr} = \frac{1000\ m}{3600\ sec} = \frac{5}{18}$ m/sec
1 M/sec	$\frac{18}{5}$ km/hour

Proportionality Concept

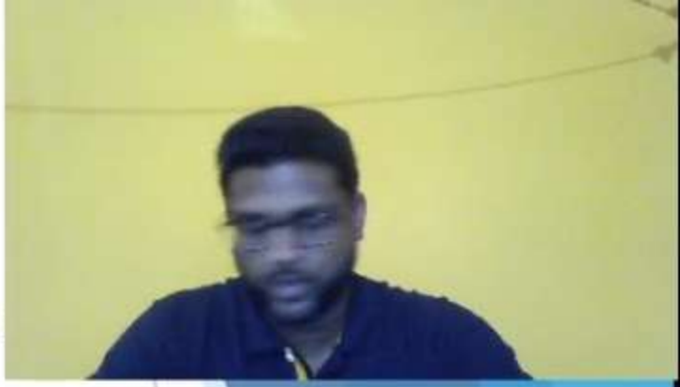
Constant	Relationship	Formula
Time	Speed ∝ Distance	$\frac{S1}{S2} = \frac{D1}{D2}$
Speed	Time ∝ Distance	$\frac{T1}{T2} = \frac{D1}{D2}$
Distance	Speed ∝ 1/Time	$\frac{S1}{S2} = \frac{T2}{T1}$

Example

The ratio of time taken by Johan and Savita to travel from their home to a park is 4:5. Then, what will be the ratio of their speed?

$T = 4 : 5$

$S = 5 : 4$

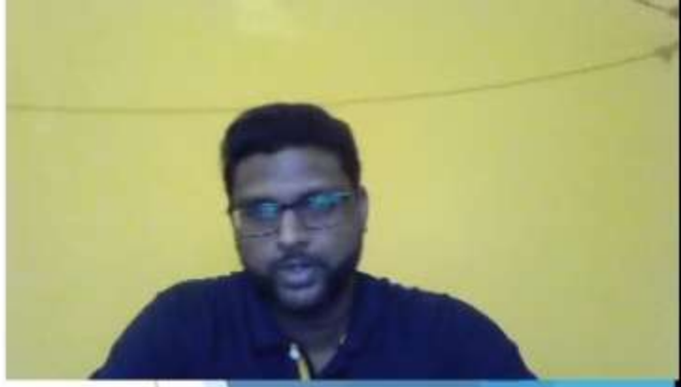


Average Speed

$$\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}} = \frac{80+120}{4} = 50 \text{ Kmph}$$

40 Kmph (2)
60 Kmph (2)

Travelling at a speed, where the following are constant:	Mean	Average Speed, a and b are speeds
Time	Arithmetic Mean	$\frac{(a+b)}{2}$
Distance	Harmonic Mean	$\frac{2ab}{(a+b)}$



Example

Anushree travels from her home to college at 40km/hr and returns to her home at 30 km/hr. What is the average speed for the entire journey?

Distance is constant

Average Speed $= \frac{2ab}{(a+b)}$

$= \frac{2\times40\times30}{(40+30)}$

$= \frac{2\times40\times30}{70}$

$= \frac{2d}{t_m + t_e}$

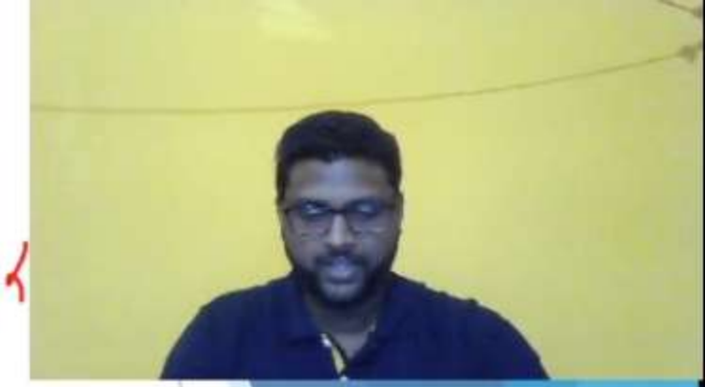
$= \frac{2d}{\frac{d}{40} + \frac{d}{30}}$

$= \frac{2d}{d\left(\frac{1}{40} + \frac{1}{30}\right)}$

$= \frac{2}{\frac{1}{a} + \frac{1}{b}}$

$= \frac{2ab}{a+b}$

Relative Speed



3Kmph 1hr

R 3Kmh 2Kmh S 2K

5Km

$$t = \frac{d}{S} = \frac{5}{5} = 1$$

R.S

(+)

3Kmph 2Kmph

R S

(-)

5km

$$t = \frac{d}{S} = \frac{5}{1} = 5\text{hrs}.$$

Relative Speed

Case 1.

When bodies are moving in the same direction

A(S1) ⟶

B(S2) ⟶

Relative Speed = Difference of their speeds (S1- S2), where S1>S2

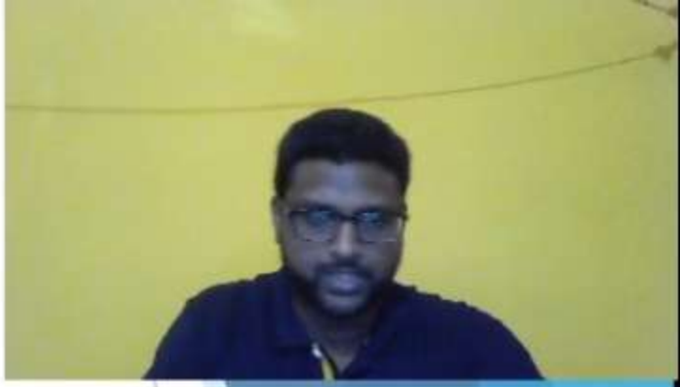
Case 2.

When bodies are moving in the opposite direction

A (S1) ⟶

⟵ B(S2)

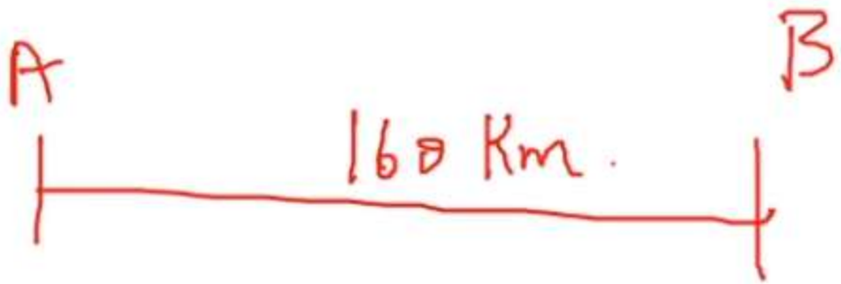
Relative Speed = Sum of their speeds (S1 + S2)



Question

Two cars are 160 km apart and are travelling towards each other at a speed of kmph each. From one car a butterfly takes off, flies straight to the other car a speed of 55 kmph, bounces off it, and flies back to the first car. The butterfly continuous to do this till the two cars crash into each other and the butterfly is smashed!

What is the distance travelled by that butterfly before it gets smashed?



$t = \frac{160}{80} = 2\text{hrs}$

110 Km

Trains

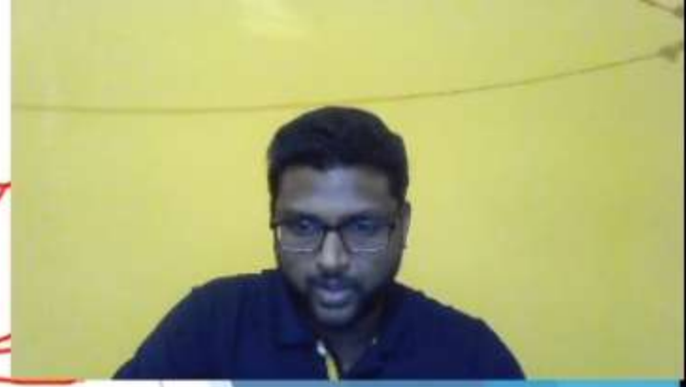
1. Trains → Point (moving) → man / Lamp Post
2. Trains → Length.

$$t = \frac{d}{s}$$

R.S

36 Kmph 1000m

$$t = \frac{1000\ m}{36 \times \frac{5}{18}\ m/s}$$

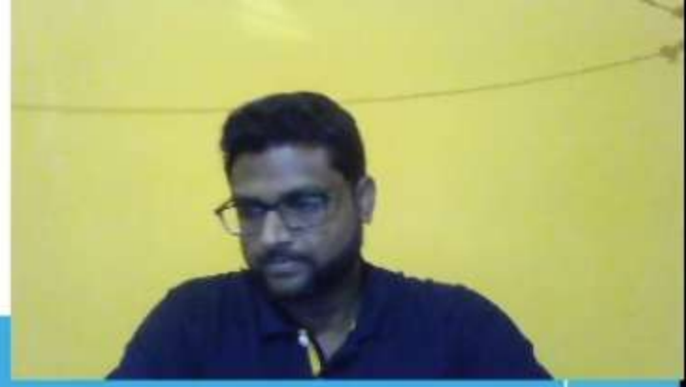


Trains

1. Trains → Point .
2. Trains → Length → Train
   → Platform
   → Bridge

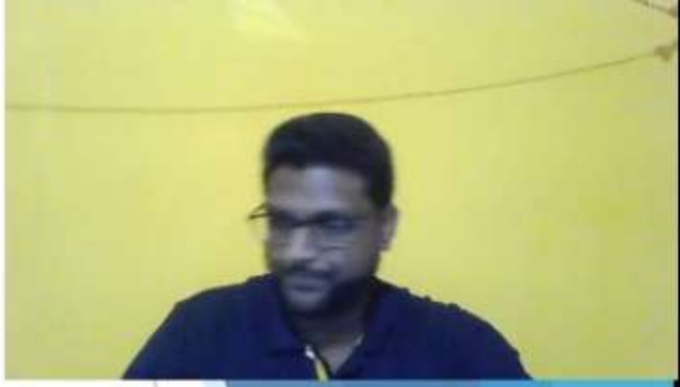
$$t = \frac{d}{s}$$

Trains



Time taken by the train to cross the following:	Formula
A stationary man or a pole	$\frac{Length\ of\ the\ train}{Speed\ of\ the\ train}$
Platform or stationary object	$\frac{Length\ of\ the\ train + length\ of\ the\ platform\ or\ object}{Speed\ of\ the\ train}$
Two moving train T1 & T2, where s1 & s2 are the speed of the trains	$\frac{Length\ of\ the\ train1 + length\ of\ the\ train2}{Relative\ Speed\ of\ the\ trains}$

Example



Rajdhani train crosses a pole in 24 seconds, travelling with a speed of 90km/hr. What is the length of the train in metres?

$$t = \frac{d}{s}$$

$$24 = \frac{L}{90 \times \frac{5}{18}} \Rightarrow L = 24 \times 90 \times \frac{5}{18} = 600$$

$$= 600\,m$$

Example

Two trains M & N, travelling towards each other with the speed of 90 km/hr and 70 km/hr, respectively. If the length of M is 1400 metres and for N is 1800 metres, then how time will M & N take to cross each other?

Time taken by train to cross each other = $\frac{Length\ of\ train1 + length\ of\ train2}{Relatvie\ Speed\ of\ the\ trains}$

$= \frac{1400\ m + 1800\ m}{160 \times \frac{5}{18}\ m/s} = \frac{3200\ m}{160 \times \frac{5}{18}}$

$= 72\ Sec$

Question

A train with a constant speed can cross a lamp post in 9 sec and a platform of length 99 m in 13.5 sec. Find the length of the train.

$t = \frac{d}{s}$

$9 = \frac{L}{s}$

$s = \frac{L}{9} \rightarrow (1)$

$t = d/s$ ✗

$13.5 = \frac{L+99}{s}$

$s = \frac{L+99}{13.5} \rightarrow (2)$

$\frac{L}{9} = \frac{L+99}{13.5}$

9 sec

13.5 sec

9 + 4.5 sec

L m

L + 99 m

= (99 m in 4.5 sec : 9 sec) ×2

198 m