

SPEED, DISTANCE AND TIME

SPEED

Distance covered per unit time is called speed.

For example, Speed = Distance / time or

Distance = Speed × Time or

Time = Distance/Speed

- If two bodies travel with the same speed, Distance covered a Time (Direct Variation).
- If two bodies travel for the same period of time, Distance covered a Speed (Direct Variation).
- If two bodies travel the same distance.

Time $\frac{1}{Speed}$ (Inverse Variation)

Distance is normally measured in kilometres, metres or miles; time in hours or seconds and speed in km/hr or kmph, miles/hr or mph and metres/second or m/s.

Conversion of units:

1) kmph to m/sec = kmph × 5/18

Example: A man walking at the rate of 8 km/h crosses a bridge in 30 minutes. The length of the bridge (in metres) is:

Sol. Speed = 8 km/h
 $= 8 \times \frac{1000}{60} \text{ m/sec} = \frac{400}{3} \text{ m/sec}$

length of the bridge = $\frac{400}{3} \times 30 = 4000$ metres

2) m/sec to kmph = m/sec × 18/5

Example: A Lady crosses a road 350 metres wide in 70 seconds. Her speed in km/h is:

Sol. Speed = $\frac{Distance}{Time}$
 $= \frac{350}{70} = 5 \text{ m/sec}$

Speed in km/h = $5 \times \frac{18}{5}$
 $= 18 \text{ km/h}$

In the case of moving trains, three different situations need to be considered. If the train is crossing a platform or a bridge, the distance covered by the train in the crossing is equal to the length of the train plus the length of the platform or bridge. If two trains pass each other or travelling in the same direction or in opposite directions, the total distance covered in the crossing or the overtaking, as the case may be is equal to the sum of the lengths of the two trains.




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AVERAGE SPEED

$$\text{Average Speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

AVERAGE SPEED of a moving body is **NOT EQUAL** to the **AVERAGE OF THE SPEEDS**.

If an object travels from point A to point B with a speed of p and back to point A (from point B) with a speed of q , then the average speed of the body can be calculated as $2pq / (p + q)$. this does not depend on the distance between A and B.

If an object covers part of the journey at speed p and the remaining part of the journey at speed q and the distances of the two parts of the journey are in the ratio $a:b$, then the average speed for the entire journey is $(a + b) pq / (aq + bp)$.

Example: A travel for 5 hours at the 8 km/hour and for 4 hours at the 7 km/hours the average speed of the journey in km/hour is

Sol. total distance = $(5 \times 8) + (4 \times 7)$

$$= 40 + 28$$

$$= 68 \text{ km}$$

$$\text{total time} = 5 + 4 = 9 \text{ hours}$$

$$\text{Average speed} = \frac{68}{9} = 7.55 \text{ km/h}$$

Example: A and B are 80 km apart, A can walk at an average speed of 8 km/h and B at 4 km/h. If they start walking towards each other at 10 am, when will they meet?

Sol. A Speed = 8 km/h | 80 km | B speed = 4 km/h

$$\text{Relative Speed} = 8 + 4$$

$$= 12 \text{ km/h}$$

$$T = \frac{D}{S} = \frac{80}{12} = 6 \text{ hour } 40 \text{ min}$$

$$\text{They will meet at} = 10 \text{ am} + 6 \text{ hours } 40 \text{ min}$$

$$= 4: 40 \text{ pm}$$

RELATIVE SPEED

The speed of one body in relation to another moving body is called the relative speed of these two bodies, i.e., it is the speed of one moving body as observed, from the second moving body.

If two bodies are moving in the same direction, the relative speed is equal to the difference of the speeds of the two bodies.

If two bodies are moving in opposite directions, the relative speed is equal to the sum of the speeds of the two bodies.

Example: Find the time taken by a train of length 100 m running at a speed of 72 kmph to cross another train of length 200 m running at a speed of 63 kmph in the same direction.

Sol: Total distance covered = $100 + 200 = 300 \text{ m}$.

Relative speed of the two trains

$$= 72 - 63 = 9 \text{ kmph}$$

$$= 9 \times \frac{5}{18} = \frac{5}{2} \text{ m/s}$$

$$\text{Therefore, time taken} = 300 / (5/2) = 120 \text{ seconds}$$

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Example: Two trains are running 60 km/h and 30 km/h respectively in the same direction. The fast train completely passes a child sitting in the slower train in 6 seconds. the length of the faster train is

Sol. Relative speed in the same direction = $60 - 30$
= 30 km/h

the length of the train = $30 \times \frac{5}{18} \times 6 = 50\text{m}$

BOATS AND STREAMS

Problems related to boats and streams are different in the computation of relative speed from those of trains/cars.

When a boat is moving in the same direction as the stream or water current, the boat is said to be moving **WITH THE STREAM OR CURRENT.**

When a boat is moving in a direction opposite to that of the stream or water current, it is said to be moving **AGAINST THE STREAM OR CURRENT.**

If the boat is moving with a certain speed in water that is not moving, the speed of the boat is then called the **SPEED OF THE BOAT IN STILL WATER.**

When the boat is moving upstream, the speed of the water opposes (and hence reduces) the speed of the boat.

When the boat is moving downstream, the speed of the water aids and adds to the speed of the boat. So, we have

Speed of the boat against stream = Speed of the boat in still water - Speed of the stream Speed of the boat with the stream = Speed of the boat in still water + Speed of the stream

These two speeds, the speed of the boat against the stream and the speed of the boat with the stream, are **RELATIVE SPEEDS.**

If **u** is the speed of the boat down the stream and **v** is the speed of the boat up the stream, then we have the following two relationships.

Speed of the boat in still water = $(u + v)/2$

Speed of the water current = $(u-v)/2$

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