

OLYMPIAD · EVERYDAY MATHEMATICS · OLYMPIAD PREPARATION · SHORT NOTES

Chapter 15: Speed, Distance and Time

Topic-wise short notes with solved examples

The speed formula, changing units, average speed, relative speed, trains and boats in streams.

1 Speed, distance and time

- $\text{speed} = \frac{\text{distance}}{\text{time}}$, so $\text{distance} = \text{speed} \times \text{time}$ and $\text{time} = \frac{\text{distance}}{\text{speed}}$.
- Keep the units matching: km with hours gives km/h, and metres with seconds gives m/s.
- To change km/h to m/s, multiply by $\frac{5}{18}$. To change m/s to km/h, multiply by $\frac{18}{5}$.

Example 1.1 Change 72 km/h to m/s.

SOLUTION

$$72 \times \frac{5}{18} = 20.$$

20 m/s

Example 1.2 How long does a car take to cover 150 km at 50 km/h?

SOLUTION

$$\text{time} = \frac{150}{50}.$$

3 hours

2 Average speed

- **Average speed** = $\frac{\text{total distance}}{\text{total time}}$. It is **not** the average of the two speeds unless the times are equal.
- If the **same distance** is covered at speeds x and y , the average speed is $\frac{2xy}{x+y}$.

Example 2.1 A car travels at 60 km/h for 2 hours and at 40 km/h for 3 hours. Find the average speed.

SOLUTION

$$\text{Distance} = 120 + 120 = 240 \text{ km. Time} = 5 \text{ hours. Speed} = \frac{240}{5}.$$

48 km/h

Example 2.2 A person goes to a place at 40 km/h and returns by the same road at 60 km/h. Find the average speed for the whole journey.

SOLUTION

The distances are equal, so the average speed is $\frac{2 \times 40 \times 60}{40 + 60} = \frac{4800}{100}$.

48 km/h

3 Relative speed

- Two objects moving **towards each other** (or in opposite directions) have relative speed = the **sum** of the speeds.
- Two objects moving in the **same direction** have relative speed = the **difference** of the speeds.
- The time to meet or to catch up is $\frac{\text{gap}}{\text{relative speed}}$.

Example 3.1 Two cars start 300 km apart and move towards each other at 50 km/h and 70 km/h. When do they meet?

SOLUTION

Relative speed = $50 + 70 = 120$ km/h. Time = $\frac{300}{120}$.

2.5 hours

4 Trains and boats

- A train of length L crossing a **pole** or a person must cover its own length L . Crossing a **platform** or bridge of length P it must cover $L + P$.
- A boat with speed u in still water in a stream of speed v goes **downstream** at $u + v$ and **upstream** at $u - v$.

Example 4.1 A train 150 m long runs at 54 km/h. How long does it take to cross a pole, and to cross a platform 350 m long?

SOLUTION

Speed = $54 \times \frac{5}{18} = 15$ m/s.

Pole: $\frac{150}{15} = 10$ s. Platform: $\frac{150 + 350}{15} = 33\frac{1}{3}$ s.

10 s and $33\frac{1}{3}$ s

Example 4.2 A boat has a speed of 10 km/h in still water and the stream flows at 2 km/h. How long does it take to go 24 km downstream?

SOLUTION

Downstream speed = $10 + 2 = 12$ km/h. Time = $\frac{24}{12}$.

2 hours

REMEMBER

Change every speed to one unit first, either km/h or m/s, before you divide.

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