DIRECT AND INVERSE PROPORTIONS

TIME, DISTANCE AND SPEED

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We generally say that a body is covering so many kilometres every hour or so many metres in every second. We define speed of a body as the distance covered in unit time. Here, unit time can be one hour or one minute or one second and a body means an object.

Thus, speed is expressed in metres per second $(\frac{m}{s})$ or kilometres per second $(\frac{km}{s})$ or centimetres per second $(\frac{cm}{s})$ To find the speed of a moving object, we divide the distance covered by the time taken.

Speed = $\frac{\text{Distance}}{\text{Time}}$ or $\text{Time} = \frac{\text{Distance}}{\text{Speed}}$

or Distance = Speed \times Time.

Ex.1 A man takes 2 hours to cover a distance when he walks at 3 kilometres per hour (kmph). Find the time taken if he walks at the rate of 4 kmph.

Sol. Speed =
$$3 \frac{\text{km}}{\text{km}}$$
 Time = 2 hours

 \therefore Distance = 3 × 2 = 6 km

New speed = $4\frac{\text{km}}{\text{h}}$

Distance = 6 km

 \therefore Time = $\frac{\text{Distance}}{\text{Speed}} = \frac{6}{4} = 1\frac{1}{2}$ hours

Thus, the time taken by the man is $1\frac{1}{2}$ hours.

Ex.2 A train 375 m long takes 30 seconds to cross a pole. Find the speed of the train in kilometres per hour.

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Sol. To cross a pole means the whole train should cross the pole.

 \therefore The distance travelled = 375 m

Time taken = 30 seconds

 $\therefore \text{ Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{375}{30} \frac{\text{m}}{\text{s}} = 12.5 \frac{\text{m}}{\text{s}}$

In the above example, we have to convert metres per second into kilometres per hour.

Now, 1 hour = 60×60 seconds, 1 km = 1000 m

$$\therefore \frac{\text{km}}{\text{hr}} = \frac{1000}{3600} \frac{\text{m}}{\text{s}} \qquad 1 \frac{\text{km}}{\text{hr}} = \frac{5}{18} \frac{\text{m}}{\text{s}}$$

$$\text{Or} \qquad 1\frac{\text{m}}{\text{s}} = \frac{18}{5} \frac{\text{km}}{\text{h}}$$

 $\therefore 12.5 \frac{\text{m}}{\text{s}} = 12.5 \times \frac{18}{5} = 2.5 \times 18 = 45 \frac{\text{km}}{\text{h}}.$

Remember : To convert $\frac{m}{s}$ to $\frac{km}{hr}$ multiply by $\frac{18}{5}$.

To convert
$$\frac{\text{km}}{\text{hr}}$$
 to $\frac{\text{m}}{\text{s}}$, multiply by $\frac{5}{18}$.

- **Ex.3** A train 400 m long crosses a 800m long bridge. If it is travelling at 40 kmph, find the time taken to cross the bridge.
- **Sol.** The distance travelled will be the whole length of the train and the whole length of bridge = 400 m + 800 m = 1200 m.

Speed =
$$40\frac{\text{km}}{\text{h}} = 40 \times \frac{5}{18} \frac{\text{m}}{\text{s}} = \frac{100}{9}\frac{\text{m}}{\text{s}}$$

Time =
$$\frac{\text{Distance}}{\text{Speed}}$$
 = $\frac{1200}{100/9}$ sec = 108 sec or 1 min 48 sec.

- **Ex.4** Two trains 132 m and 400 m in length are running on parallel tracks towards each other at 40 km/h and 55 km/h. Find the time taken to cross each other.
- Sol. Since they are travelling towards each other, their relative speed will be

$$(40+55)\frac{\text{km}}{\text{h}} = 95\frac{\text{km}}{\text{h}}$$

The distance travelled is the total length of the two trains,

i.e.
$$132 + 400 = 532$$
 m.
Time taken = $\frac{\text{Total distance}}{\text{Total Speed}} = \frac{532}{95 \times \frac{5}{18}}$
= $\frac{532 \times 18}{95 \times 5} = 20.16$ seconds.

- **Ex.5** Two trains of length 150 m and 180 m are running on parallel tracks in the same direction. Find the time taken to cross each other if their speeds are $35 \frac{\text{km}}{\text{h}}$ and 40 $\frac{\text{km}}{\text{h}}$.
- Sol. Since they are moving in the same directing, the relative speed will be

$$(40-35)\frac{\mathrm{km}}{\mathrm{h}} = 5\frac{\mathrm{km}}{\mathrm{h}}.$$

The distance covered will be total length of the two trains = 150 + 180 = 330 m

Time taken =
$$\frac{\text{Distance}}{\text{Speed}}$$

= $\frac{330}{5 \times \frac{5}{18}} = \frac{330 \times 18}{5 \times 5}$

= 237.6 seconds = 3.96 minutes.

- **Ex.6** A train moving at 30 km per hour completes its journey in 14 hours. How much time will the train take for the same journey if it travelled at 60 km per hour?
- **Sol.** The given information can be shown in a tabular form as:

Speed (kmph)	30	60
Time (hours)	14	Х

As the speed increases, the time decreases and the distance remains the same.

 $30 \times 14 = 60 \times x$ (refers to distance).

$$x = \frac{30 \times 14}{60} = 7$$
 hours

Thus, the train will take 7 hours to complete the journey moving at 60 km/hr.