Train

Important Points

(i) When two trains are moving in opposite directions, their speeds should be added to find the relative speed.

(ii) When they are moving in the same direction, the relative speed is the difference of their speeds.

(iii) When a train passes a platform, it should travel the length equal to the sum of the lengths of trains & platform both.

Trains Passing a Telegraph Post or Stationary Object

1. How many seconds will a train 100 meters long running at the rate of 36 km an hour take to pass a certain telegraph post?

Solution: In passing the post the train must travel its own length.

Now, 36 km/hr = 36 ×5/18 = 10 m/sc.

∴Required time = 100/10 = 10 seconds.

Trains Crossing A Bridge or a Railway Station

2.How long does a train 110 meters long running at the rate of 36 km/hr take to cross a bridge 132 meters in length?

Solution: In crossing the bridge the train must travel its own length plus the length of the bridge.

$$\text{Now, } 36 \text{ km/hr} = 36 \times \frac{5}{18} = 10 \text{ m/sc.}$$

$$\text{Required time} = \frac{242}{10} = 24.2 \text{ seconds.}$$

Trains Running in Opposite Directions

3. Two trains 121 meters and 99 meters in length respectively are running in opposite directions, one at the rate of 40 km and the other at the rate of 32 km an hour. In what time will they be completely clear of each other from the moment they meet?

Solution: As the two trains are moving in opposite directions their relative speed = 40 + 32 = 72 km/hr, i.e. they are approaching each other at 72 km/hr or 20 m/seconds.

$$\therefore \quad \text{Required time} = \frac{\textit{Total length}}{\textit{Relative speed}} = \frac{121+99}{20} = 11 \text{ seconds.}$$

Trains Running in the Same Direction

4. In the example above. If the trains were running in the same direction, in what time will they be clear each other?

Solution: Relative speed = 40 -32 = 8 km/hr = $\frac{20}{9}$ m/sec.

Total length = 121 + 99 = 220 m.

$$\therefore \quad \text{Required time} = \frac{\textit{Total length}}{\textit{Relative speed}} = \frac{220}{20} \times 9 = 99 \text{ seconds.}$$

Trains passing a Walking Man

5. A train 110 meters in length travels at 60 km/hr. In what time will it pass a man who is walking at 6 km an hour (i) against it; (ii) in the same direction?

Solution: This question is to be solved like the above examples 3 and 4, the only difference being that the length of the man is zero.

(i) Relative speed = $60 + 6 = 66$ km/hr = $\frac{55}{3}$ = m/sec.

$\therefore$ Required time = $\frac{110}{55} \times 3 = 6$ seconds.

(ii) Relative speed = $60 - 6 = 54\ km/hr$ = 15m/sec.

$\therefore$ Required time = $\frac{110}{15} = 7\frac{1}{3}$ seconds.

6. Two trains are moving in the same direction at 50 km/hr and 30 km/hr. The faster train crosses a man in the slower train in 18 seconds. Find the length of the faster train.

Solution: Relative speed = $(50 - 30)$ km/hr = $\left[20 \times \frac{5}{18}\right]$ m/sec.

$= \frac{50}{9}$ m/sec.

Distance covered in 18 sec at this speed = $18 \times \frac{50}{9} = 100$ m

$\therefore$ Length of the faster train = 100m.

7. A train running at 25 km/hr takes 18 seconds to pass a platform. Next, it takes 12 seconds to pass a man walking at 5 km/hr in the opposite direction. Find the length of the train and that of the platform.

Solution: Speed of the train relative to man = 25 + 5 = 30 km/hr

$$= \left[30 \times \frac{5}{18}\right] \text{m/sec.} \quad = \frac{25}{3} \text{ m/sec.}$$

Distance covered in 12 sec at this speed = $\frac{25}{3} \times 12 = 100$ m

$\therefore$ Length of the faster train = 100m.

Speed of the train = 25 km/hr = $\left[25 \times \frac{5}{18}\right] = \frac{125}{18}$ m/sec.

Distance covered in 18 sec at this speed = $\frac{125}{18} \times 18 = 125$ m.

$\therefore$ Length of train + length of platform = 125 m.

$\therefore$ Length of platform = 125 – 100 = 25 m.

Relationship Between Speed, Time & Distance

Speed = Distance / Time

We can deduce the following from this formula:-

– When time is constant, distance covered is directly proportional to the speed.

– When distance is the same, speed is inversely proportional to time.

Average Speed

Average Speed = Total Distance Traveled / Total Time Taken

– Remember that average speed is NOT the arithmetic mean of the speeds.

– Also, average speed can never be double or more than double of any of the original speeds.

Relative Speed

When two objects with speed S1 and S2 respectively and they are traveling in:

– Same direction, the relative speed (S') is the difference of the individual speeds

S' = S1 – S2

– Opposite direction, the relative speed (S') is the sum of the individual speeds

S' = S1 + S2

Trains Crossing

If L1 and L2 are the lengths of two trains moving at speeds V1 and V2 respectively, then the time taken by them to cross each other given by,

Time to Cross = (L1 + L2) / (Relative Speed)

Boats & Streams

If a boat traveling at the speed (B) is in a stream, the speed of which is denoted by S and it is traveling:

– Upstream (against the direction in which the stream is flowing)

Upstream Speed = B – S

– Downstream (in the same direction as that of the flow of the stream)

Downstream Speed = B+ S

Circular Motion

– When two runners are on the same circular track, the time taken for them to meet for the first time is given by the following expression:-

Length of the track / Relative speed of the runners

– Number of times two runners meet on the circular track = Number of rounds gained by faster

runner over the slower one.

– If ratio of speeds of two runners running in circular track is x : y, they will meet at the starting point again in the time given by the following expressions:-

|x – y| time (if running in the same direction)

(x + y) time (if running in the opposite direction)

Questions on Races

Some points to remember while solving questions based on these are as follows:-

– the distance covered by the winner = length of the race

– loser's distance = winner's distance – (beat distance + start distance)

– winner's time = loser's time – (beat time + start time)

– if a race ends in a deadlock, i.e. both reach the winning post together then beat time = 0 and beat distance = 0