TIME AND DISTANCE

The following rules/tricks should be remembered for solving problems on the Time and Distance :

A. Basic Formulae :

(*i*) Distance Travelled = Average speed × Time Taken

(*ii*) $\text{Average Speed} = \dfrac{\text{Distance Travelled}}{\text{Time Taken}}$

(*iii*) $\text{Time Taken} = \dfrac{\text{Distance Travelled}}{\text{Average Speed}}$

Trains passing a telegraph post or a stationary man

Example 1 : How many seconds will a train 100 metres long running at the rate of 36 km per 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/sec

So, required time = 100/10 = 10 seconds

Trains crossing a bridge or passing a railway station

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

Solution : In crossing the bridge the train must travel its own length plus the length of the bridge. Now, 36 km/hr = 36 × 5/18 = 10 m/sec.

So, required time = 242/10 = 24.2 seconds

Trains running in opposite directions

Example 3 : Two trains 121 metres and 99 metres in length respectively are running in opposite directions, one at the rate of 40 km/hr and the other at the rate of 32 km/hr. 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, or 20 m/sec.

$$\text{So, the required time} = \frac{\text{Total length}}{\text{Relative speed}}$$

$$= \frac{121 + 99}{20} = 11 \text{ sec}$$

Trains running in the same direction

Example 4 : In Example 3 if the trains were running in the same direction, in what time will they be clear of each other?

Solution: Relative speed = 40 – 32

$$= 8 \text{ km/hr} = \frac{20}{9} \text{ m/sec}$$

Total length = 121 + 99 = 220 m

$$\text{So, required time} = \frac{\text{Total length}}{\text{Relative speed}} = \frac{220}{20} \times 9$$

$$= 99 \text{ sec}$$

Train passing a man who is walking

Example 5 : A train 110 metres in length travels at 60 km/hr. In what time will it pass a man who is walking at 6 km/hr (*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.

So, required time = $\frac{110}{55} \times 3 \times 3 = 6$ seconds

(*ii*) Relative speed = 60 – 6 = 54 km/hr = 15 m/sec.

So, required time = 110/15 = $7\frac{1}{3}$ seconds.

EXERCISE

1. The speed of a 100 m long running train *A* is 40 % more than the speed of another 180 m long train *B* running in the opposite directions. To find out the speed of train *B*, which of the information given in statements *P* and *Q* is/are sufficient?
P : The two trains cross each other in 6 seconds
Q : The difference between the speeds of the two trains was 26 kmph.
(*a*) Only P is sufficient
(*b*) Only Q is sufficient
(*c*) Both P and Q are needed
(*d*) Both P & Q are not sufficient
(*e*) None of these

2. Two stations *A* and *B* are 110 km apart on a straight line. One train starts from *A* at 7 a.m. and travels towards *B* at 20 kmph. Another train starts from *B* at 8 a.m. and travels towards *A* at a speed of 25 kmph. At what time will they meet?
(*a*) 9 am (*b*) 10 am
(*c*) 11 am (*d*) 10:30 am
(*e*) None of these

3. The length of the train that takes 8 seconds to pass a pole when it runs at a speed of 36 km/hr is :
(*a*) 70 m (*b*) 80 m
(*c*) 85 m (*d*) 90 m
(*e*) None of these

4. A train running at certain speed crosses a stationary engine in 20 seconds. To find out the speed of the train, which of the following information is necessary :
(*a*) Only the length of the train
(*b*) Only the length of the engine
(*c*) Either the length of the train or the length of the engine
(*d*) Both the length of the train and the length of the engine
(*e*) None of these

5. How long will a train 60 m long travelling at 40 km/hr take to pass through a station whose platform is 90 m long?
(*a*) 12.5 seconds
(*b*) 13.5 seconds
(*c*) 14.5 seconds
(*d*) 15.5 seconds
(*e*) None of these

6. A train overtakes two persons who are walking in the same direction in which the train is going, at the rate of 2 kmph and 4 kmph and passes them completely in 9 and 10 seconds respectively. The length of the train is :
(*a*) 72 m (*b*) 54 m
(*c*) 50 m (*d*) 45 m
(*e*) None of these

7. Two trains of equal lengths take 10 seconds and 15 seconds respectively to cross a milestone. If the length of each train be 120 metres, in what time (in seconds) will they cross each other travelling in opposite direction?
(*a*) 20 sec (*b*) 15 sec
(*c*) 12 sec (*d*) 10 sec
(*e*) None of these

8. A train is running at the rate of 40 kmph. A man is also going in the same direction parallel to the train at the speed of 25 kmph. If the train crosses the man in 48 seconds, the length of the train is :
(*a*) 100 m (*b*) 200 m
(*c*) 300 m (*d*) 400 m
(*e*) None of these

9. A train 700 m long is running at 72 kmph. If it crosses a tunnel in 1 minute, the length of the tunnel is :
(*a*) 700 m (*b*) 600 m
(*c*) 550 m (*d*) 500 m
(*e*) None of these

EXPLANATORY ANSWERS

1. (*a*) : Let speed of B be x kmph.

Then, speed of $A = \frac{140\,x}{100} = \frac{7\,x}{5}$ kmph

Relative speed

$$= \left(x + \frac{7\,x}{5}\right) \text{ kmph}$$

$$= \frac{12\,x}{5} \times \frac{5}{18} \text{ m/sec}$$

$$= \frac{2\,x}{3} \text{ m/sec}$$

Time taken to cross each other

$$= [(100 + 180) \times \frac{3}{2\,x}] \text{ sec.} = \frac{420}{x} \text{ sec}$$

Now, $420/x = 6 \Rightarrow x = 70$ kmph.

Thus, only P is sufficient.

2. (*b*) : Suppose they meet in x hours after 7 a.m.

Distance covered by A in x hours $= 20\,x$ km

Distance covered by B in $(x - 1)$ hours

$= 25\,(x - 1)$ km

$\because\ 20\,x + 25\,(x - 1) = 110$

$\Rightarrow \quad 45\,x = 135$

$\Rightarrow \quad x = 3$

So, they meet at 10 a.m.

Quicker Maths (Direct formula) :

They will meet at

$$8 \text{ a.m.} + \frac{110 - (8 \text{ a.m.} - 7 \text{ a.m.})\,20}{20 + 25}$$

$= 8$ a.m. $+ 2$ hr $= 10$ a.m.

3. (b) : 36 km/hr $= 36 \times 5/18 = 10$ m/s

Distance covered by train in 8 seconds = length of train

$= 8 \times 10 = 80$ m

4. (d) : Since the sum of the lengths of the train and the engine is needed, both the lengths must be known.

5. (*b*) : Speed $= 40$ km/hr $= 40 \times \frac{5}{18}$ m/s

So, Time $= \frac{(60 + 90)}{40 \times 5} \times 18$

$$= \frac{150 \times 18}{40 \times 5} = 13.5 \text{ seconds.}$$

6. (*c*) : 2 kmph $= (2 \times 5/18)$ m/sec $= 5/9$ m/sec

and 4 kmph $= \left(4 \times \frac{5}{18}\right)$ m/sec $= 10/9$ m/sec

Let the length of the train be x metres and its speed be y m/sec

Then $\frac{x}{(y - 5/9)} = 9$ and $\frac{x}{(y - 10/9)} = 10$

So, $9\,y - 5 = x$ and $10\,(9\,y - 10) = 9\,x$

So, $9\,y - x = 5$ and $90\,y - 9\,x = 100$

On solving we get : $x = 50$

So, length of the train is 50 m.

7. (*c*) : Speed of first train $= \frac{120}{10} = 12$ m/s

Speed of second train $= \frac{120}{15} = 8$ m/s

Their relative speed $= 12 + 8 = 20$ m/s

Hence, required time $= \frac{120 + 120}{20} = \frac{240}{20}$

$= 12$ sec

8. (*b*) : Length of train = Relative speed × time

$$= (40 - 25)\left(\frac{5}{18}\right) \times 48$$

$$= \frac{15 \times 5 \times 48}{18}$$

$= 200$ m

9. (*d*) : Let length of the tunnel be x m;

speed $= (72 \times 5/18)$ m/ sec $= 20$ m/sec

Time $= 60$ sec

$\because \quad 60 = \frac{700 + x}{20} \Rightarrow 700 + x = 1200$

$\Rightarrow \quad x = 500$ m