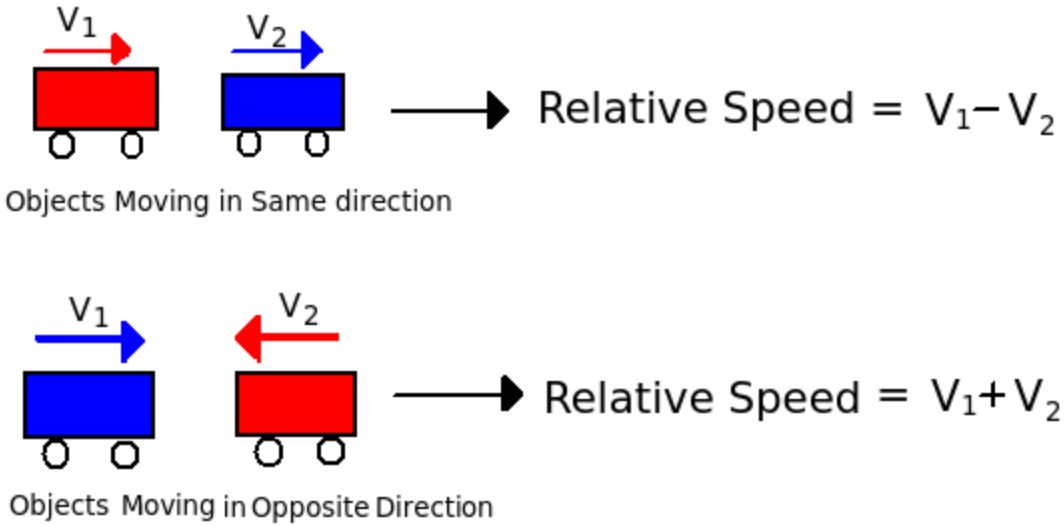
Problems on Trains

Important Points to Remember

1) If the **length of one train** is P and the **length of second train** is Q, the **total distance** to be covered is **(P+Q)**

2) Finding Relative speed:



3) If two trains of lengths P and Q move in **opposite directions** at V_1 m/s and V_2 m/s, then time taken by the trains to cross each other, can be calculated by

$$\text{Time Taken} = \frac{(P + Q)}{(V_1 + V_2)}$$

4) If two trains of different lengths P and Q move in **same direction** at V_1 m/s and V_2 m/s, then time taken by the trains to cross each other, is calculated by

$$\text{Time Taken} = \frac{(P + Q)}{(V_1 - V_2)}$$

Quick Tips and Tricks

1) Time taken by a train of length L meter to pass a signal post or standing man = Time taken by the train to cover L meter.

$$\text{Time} = \frac{L}{\text{Speed}}$$

A signal post or a standing man is considered to be the point object.

2) The time taken by a train of length L_1 meter to pass a **stationary object** of length L_2 is basically the time taken by the train to cover $(L_1 + L_2)$ meter.

$$\text{Time} = \frac{(L_1 + L_2)}{\text{Speed}}$$

3) The time taken by a train of length L_1 meter to pass a **moving object** of length L_2 is determined by considering the relative speed between the moving objects.

$$\text{Time} = \frac{(L_1 + L_2)}{R_s}$$

R_s is the relative speed between moving objects in same or opposite direction.
L_1 is the length of train.
L_2 is the length of moving object other than train.

4) Two trains start from two points P and Q at the same time and move towards each other. These trains take p and q seconds to reach points Q and P respectively, the relation between them is given by

$$\frac{(\text{P's Speed})}{(\text{Q's Speed})} = \frac{\sqrt{q}}{\sqrt{p}}$$

Conversion of Units

1) To convert km/hr into m/s

$$\frac{\text{km}}{\text{hr}} = \frac{1000\ \text{m}}{60 \times 60\ \text{sec}} = \frac{5}{18}\ \text{m/s}$$

Example: 50 km/hr = 50 x 5 /18 = 13.88 m/s

2) To convert m/s into km/hr

$$\frac{\text{m}}{\text{s}} = \frac{18}{5}\ \text{km/hr}$$

Example: 50 m/s = 50 x 18 / 5 = 180 km/hr

3) To convert minutes into seconds, multiply by 60

4) To convert hours into seconds, multiply by 60 x 60

Type 1 : A train crosses a stationary object on the platform. Find

a) the time taken or

b) length of train

Q 1. A train of length 250 m runs at a speed of 70 km/hr. What will be the time taken to cross any stationary object standing at the railway station?

Given: Length of train = 250 m, speed of train = 70 km/hr

Length of train is always considered as distance, and hence here distance = 250 m

1) First convert speed of km/hr into m/s

$$\text{Speed of train} = 70 \times \frac{5}{18} = 19.44 \text{ m/s}$$

2) We know that,

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

$$\text{Time taken to cross stationary object} = \frac{250}{19.44}$$

Time taken to cross stationary object= 12.86 sec

Q 2. A train takes 10 sec to pass a signal post and covers a distance of 10 km in 15 min. Find the length of train?

We know,

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

$$\text{Speed} = \frac{10}{15} \times 60 = 40 \times \frac{5}{18} \text{ m/sec} = 11.1 \text{ m/sec}$$

Length of train = (Speed x Time)

= (11.11 x 10)

= 111.1 m

Type 2 :

A train of given length crosses the platform at a given speed. Find:
a) Time taken to cross the platform or
b) Length of platform

In this type of numerical, the time taken by a train of length L_1 meter to pass a stationary object of length L_2 is basically the time taken by the train to cover $(L_1 + L_2)$ meter.

$$\text{Speed} = \frac{(L_1 + L_2)}{\text{Time}}$$

Q 3. Chandigarh express of 100 m runs at a speed of 60 km/hr. What will be the time taken to cross a platform of 150 meters long?

Given: Length of train = 100 m, speed of train = 60 km/hr, length of platform = 150 m

1) Always remember first step is the conversion of units.

Convert 60 km/hr into m/s by multiplying it with (5/18)

$$\text{Speed of the train} = 60 \times \frac{5}{18} = 16.66 \text{ m/s}$$

2) Distance covered by the train in passing the platform = (Length of train + Length of platform) = (100 + 150) = 250 m

Therefore,

$$\text{The time taken} = \frac{\text{Distance}}{\text{Speed}}$$

$$= \frac{250}{16.66}$$

= 15 sec

Q 4. A train running at 50 km/hr, passes a man walking on the platform at 7 km/hr in same direction as that of train in 15 sec. If this train takes 30 seconds to cross the platform then find the length of train (L_1) and length of platform (L_2)?

Given: Speed of train = 50 km/hr, time required to cross the platform = 30 sec, time required to cross man standing on platform = 15 sec.

1) Convert km/hr into m/s

- $50 \text{ km/hr} = 50 \times \frac{5}{18} = 13.88 \text{ m/s}$

- $7 \text{ km/hr} = 7 \times \frac{5}{18} = 1.94 \text{ m/s}$

2) The speed of train relative to man = (13.88 – 1.94) = 11.94 m/s ---- (The values are subtracted because the train and man move in same direction)

3) Length of train = (Relative speed x Time)

= (11.94) x (15) = 179.1 m

We know,

$$\text{Speed} = \frac{(L_1 + L_2)}{\text{Time}}$$

$13.88 = \frac{(L_1 + L_2)}{30}$ ---- consider L_1 as length of train and L_2 as length of platform

$(L_1 + L_2) = 416.4$

$L_2 = 416.4 – 179.1 = 237.3$ m

Type 3:

Find time taken by a train to cross a person running in opposite direction at a given speed.

In this type of numerical, generally two values of speeds are mentioned, one is the speed of train and the other is the speed of an object or person. The speed values of train and the moving object are added if they are moving in the direction opposite to each other.

Q 5. The Chennai Express of 200 m runs at a speed of 62 km/hr and a person runs on the platform at a speed of 20 km/hr in the direction opposite to that of train. Find the time taken by the train to cross the running person?

Given: Length of train = 200 m, speed of train = 62 km/hr, speed of person = 20 km/hr

1) Convert km/hr into m/s

- $62 \text{ km/hr} = 62 \times \frac{5}{18} = 17.22 \text{ m/s}$

- $20 \text{ km/hr} = 20 \times \frac{5}{18} = 5.55 \text{ m/s}$

As the train and the running person move in opposite directions, their speed values are added to find the relative speed.

Relative speed **(Speed of train relative to man)** = 17.22 + 5.55 = 22.77 m/s

We know,

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

Therefore, time taken by the train to cross the running person = Time taken by the train to cover 200 m at a relative of 22.77 m/s

$$= \frac{200}{22.78} = 8.77 \text{ sec}$$

Type 4:

Find time taken by a train to cross a person running in same direction at a given speed.

In this type of numerical, generally two values of speeds are mentioned, one is the speed of train and the other is the speed of an object or person. The speed values of train and the moving object are subtracted if they are moving in same direction.

Q 6. A boy runs opposite to that of train at a speed of 20 km/hr. If the relative speed between train and the boy running in opposite direction is 50 km/hr. What is the length of train, if it takes 20 seconds to cross the boy, when he is at rest?

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

Relative speed = Speed of train + Speed of boy

50 = Speed of train + 20

Speed of train = 50 – 20 = 30 km/hr

Convert km/hr into m/s

$$30 \text{ km/hr} = 30 \times \frac{5}{18} = 8.33 \text{ m/s}$$

Distance = Speed x Time

= 8.33 x 20 = 166.6 m

Q 7. A boy runs on the platform of 180 m at a speed of 10 km/hr in the same direction of the train. Find the time taken by the train to cross the running boy if speed of the train is 71 km/hr? (Length of train = Length of platform)

Given:

Convert km/hr into m/s

- $71 \text{ km/hr} = 71 \times \frac{5}{18} = 19.72 \text{ m/s}$

- $20 \text{ km/hr} = 10 \times \frac{5}{18} = 2.77 \text{ m/s}$

As the train and the running person move in same direction, their speed values are subtracted to find the relative speed.

Relative speed (Speed of train relative to man) = 19.72 – 2.77 = 16.95 m/s

We know,

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

Therefore, time taken by the train to cross the running person = Time taken by the train to cover 180 m at a relative of 16.95 m/s

$$= \frac{180}{16.95} = 10.61 \text{ sec}$$

Q 8. A person is walking at a speed of 5 km/hr along a railway track. If he is 200 m ahead of the train which is 100 m long and runs at a speed of 60 km/hr in same direction, then what is the time required to pass the person?

Given: Speed of the person = 5 km/hr, length of train = 100 m, speed of train = 60 km/hr

Speed of train relative to walking person = (60 – 5) = 55 km/hr

Convert km/hr into m/s

$$55 \text{ km/hr} = 55 \times \frac{5}{18} = 15.27 \text{ m/s}$$

Distance to be covered by the train = 200 + 100 = 300 m

Therefore, time taken by the train to cross the person

$$= \text{Distance over speed} = \frac{300}{16.27} = 19.64 \text{ sec}$$

Type 5:

Find time taken by two trains moving in opposite direction at given speed, to cross each other

In this type of numerical, speeds and lengths of trains are correspondingly added because the trains move in opposite direction.

Q 9. Two trains A and B of 150 m and 300 m, run at speed of 65 km/hr and 80 km/hr respectively, in the direction opposite direction to each other. Find the time required to cross each other after the moment they met?

Given:

Length of train A = 150 m, speed = 65 km/hr

Length of train B = 300 m, speed = 80 km/hr

1) Convert km/hr into m/s

$$65 \text{ km/hr} = 65 \times \frac{5}{18} = 18.05 \text{ m/s}$$

$$80 \text{ km/hr} = 80 \times \frac{5}{18} = 22.22 \text{ m/s}$$

2) As both trains move opposite to each other, relative speed = 18.05 + 22.22 = 40.27 m/s

Distance = (Length of train A + Length of train B) = (150 + 300) = 450 m

We know,

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

Therefore,

$$\text{Time} = \frac{450}{40.27 \text{ sec}} = 11.17 \text{ sec}$$

Alternately, we can directly use the formula:

$$\text{Time} = \frac{(P + Q)}{(V_1 + V_2)} \text{ sec}$$

(here P and Q are length of trains and V_1 and V_2 are speeds of two trains)

Q 10. A passenger train of 200 m runs at a speed of 55 km/hr. A person traveling in it observes that the goods train moving in opposite direction takes 10 seconds to cross him. Find the speed of the goods train, if it is 250 m long.

Given: Speed of passenger train = 55 km/hr, length of goods train (P)= 250 , length of passenger train (Q)= 200m

Hint:

$$\text{Time} = \frac{(P + Q)}{(V_1 + V_2)} \text{ sec}$$

Goods train and the passenger train move in opposite direction. Hence, the relative speed is the addition of two speeds.

Convert 55 km/hr into m/s

55 x (5/18) = 15.277 m/s

Therefore,

$$10 = \frac{(250 + 200)}{(15.27 + V_2)}$$

$V_2 = 29.73$ m/s

Type 6:

Two trains move at a given speed in same direction.
Find:
a) Time taken to cross each other
b) Length of train

In this type of numerical, lengths of trains are added and speeds are subtracted because the trains move in same direction.

Q 11. Two trains P and Q move in same direction with a speed of 85 km/hr and 70 km/hr respectively. If train P is 120 m long and train Q is 240 m, then find taken by train P to cross the train Q?

Given:

Speed of train P = 70 km/hr, length of train = 120 m

Speed of train Q = 85 km/hr, length of train = 240 m

1) As both trains move in same direction, relative speed = (Speed of train P – Speed of train Q) = (85 – 70) = 15 km/hr

$$15 \text{ km/hr} = 15 \times \frac{5}{18} = 4.16 \text{ m/s}$$

Distance = 120 +240 = 360 m

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

Time = 360 / 4.16 = 86.5 sec

2) Alternately, we can directly use the formula:

$$\text{Time} = \frac{(P + Q)}{(V_1 - V_2)} \text{ sec}$$

(here P and Q are length of trains and V_1 and V_2 are speeds of two trains)

Q 12. Two trains moving in same direction run at a speed of 60 km/hr and 40 km/hr respectively. If a man sitting in slow train is passed by the fast train in 10 seconds, then what is the length of the faster train?

Given: Speed of slow train = 60 km/hr, speed of fast train = 40 km/hr

Here both the trains move in same direction. Hence their relative speed is obtained by subtracting the individual speeds of trains.

Relative speed = 60 – 40 = 20 km/hr

1) Convert km/hr into m/s

$$20 \times \frac{5}{18} = \frac{100}{18} = 5.56 \text{ m/s}$$

2) Distance (Length of faster train) = Speed x Time

Length of faster train = 5.56 x 10 m = 55.6 m