PROBLEMS ON TRAINS

IMPORTANTS FACTS AND FORMULAE

1. km/hr to m/s conversion:

$$a \text{ km/hr} = \left(a \times \frac{5}{18} \right) \text{m/s}.$$

2. m/s to km/hr conversion:

$$a \text{ m/s} = \left(a \times \frac{18}{5} \right) \text{km/hr}.$$

3. Time taken by a train of length *l* metres to pass a pole or standing man or a signal post is equal to the time taken by the train to cover *l* metres.

4. Time taken by a train of length *l* metres to pass a stationery object of length *b* metres is the time taken by the train to cover (*l* + *b*) metres.

5. Suppose two trains or two objects bodies are moving in the same direction at *u* m/s and *v* m/s, where *u* > *v*, then their relative speed is = (*u* - *v*) m/s.

6. Suppose two trains or two objects bodies are moving in opposite directions at *u* m/s and *v* m/s, then their relative speed is = (*u* + *v*) m/s.

7. If two trains of length *a* metres and *b* metres are moving in opposite directions at *u* m/s and *v* m/s, then:

$$\text{The time taken by the trains to cross each other} = \frac{(a + b)}{(u + v)} \text{ sec.}$$

8. If two trains of length *a* metres and *b* metres are moving in the same direction at *u* m/s and *v* m/s, then:

$$\text{The time taken by the faster train to cross the slower train} = \frac{(a + b)}{(u - v)} \text{ sec.}$$

9. If two trains (or bodies) start at the same time from points A and B towards each other and after crossing they take *a* and *b* sec in reaching B and A respectively, then:

$$\text{(A's speed) : (B's speed)} = (\sqrt{b} : \sqrt{a}).$$

Ex.1. ***A train 100 m long is running at the speed of 30 km / hr. Find the time taken by it to pass a man standing near the railway line.***

Sol. Speed of the train $= \left(30 \times \frac{5}{18}\right)$ m / sec. $= \left(\frac{25}{3}\right)$ m/sec.

Distance moved in passing the standing man = 100 m.

Required time taken $= \frac{100}{\left(\frac{25}{3}\right)} = \left(100 \times \frac{3}{25}\right)$ sec. = 12 sec.

Ex.2. ***A train 220 m long is running with a speed of 59 kmph. In what time will it pass a man who is running at 7 kmph in the direction opposite to that in which the train is going?***

Sol. Speed of the train relative to man = (59 + 7) kmph

$= \left(66 \times \frac{5}{18}\right)$ m/sec. $= \left(\frac{55}{3}\right)$ m/sec.

Time taken by the train to cross the man

= Time taken by it to cover 220 m at $\left(\frac{55}{3}\right)$ m / sec. $= \left(220 \times \frac{3}{55}\right)$ sec. = 12 sec.

Ex.3. ***Two trains 137 metres and 163 metres in length are running towards each other on parallel lines , one at the rate of 42 kmph and another at 48 kmph . In what time will they be clear of each other from the moment they meet?***

Sol. Relative speed of the trains = (42 + 48) kmph = 90 kmph

$= \left(90 \times \frac{5}{18}\right)$ m/sec. = 25 m/sec.

Time taken by the trains to pass each other

= Time taken to cover (137 + 163) m at 25m/sec. $= \left(\frac{300}{25}\right)$ sec = 12 seconds.

Ex.4. ***A man sitting in a train which is travelling at 50 kmph observes that a goods train , travelling in opposite direction , takes 9 seconds to pass him. If the goods train is 280 m long, find its speed.***

Sol. Relative speed $= \left(\frac{280}{9}\right)$ m/sec. $= \left(\frac{280}{9} \times \frac{18}{5}\right)$ kmph = 112 kmph.

: Speed of goods train = (112 – 50) kmph = 62 kmph.

Ex.5. ***A train 100 metres long takes 6 seconds to cross a man walking at 5 kmph in a direction opposite to that of the train . Find the speed of the train .***

Sol. Let the speed of the train be x kmph.

Speed of the train relative to man $= (x + 5)$ kmph $= (x + 5) \times \frac{5}{18}$ m / sec.

$$\frac{100}{(x + 5) \times \frac{5}{18}} = 6 \Leftrightarrow 30 (x + 5) = 1800 \Leftrightarrow x = 55.$$

: Speed of the train is 55 kmph.

Ex.6. ***Two trains 100 metres and 120 metres long are running in the same direction with speed of 72 km/hr and 54 km/hr . In how much time will the first train cross the second ?***

Sol. Relative speed of the trains $= (72 - 54)$ km/hr $= 18$ km/hr.

$= \left(18 \times \frac{5}{18}\right)$ m/ sec. $= 5$ m/sec.

Time taken by the trains to cross each other

= Time taken to cover $(100 + 120)$ m at 5 m/sec. $= \left(\frac{220}{5}\right)$ sec. $= 44$ sec.

Ex.7. ***A train is moving at a speed of 132 km/hr . If the length of the train is 110 metres , how long will it take to cross a railway platform 165 metres long ?***

Sol. Speed of train $= \left(132 \times \frac{5}{18}\right)$ m/sec. $= \left(\frac{110}{3}\right)$ m/sec.

Distance covered in passing the platform $= (110 + 165)$ m $= 275$ m.

Time taken $= \left(275 \times \frac{3}{110}\right)$ sec. $= \frac{15}{2}$ sec. $= 7\frac{1}{2}$ sec.

Ex.8. ***A train running at the speed of 60 km/hr crosses a pole in 9 seconds. What is the length of the train?***

Sol. Speed $= \left(60 \times \frac{5}{18}\right)$ m/sec. $= \left(\frac{50}{3}\right)$ m/sec.

Length of the train = (Speed x Time) = $\left(\frac{50}{3} \times 9\right)$ m = 150 m.

Ex.9. ***A train 125 m long passes a man, running at 5 km/hr in the same direction in which the train is going, in 10 seconds. The speed of the train is:***

Sol. Speed of the train relative to man = $\left(\frac{125}{10}\right)$ m/sec.

$= \left(\frac{25}{2}\right)$ m/sec.

$= \left(\frac{25}{2} \times \frac{18}{5}\right)$ km/hr.

= 45 km/hr.

Let the speed of the train be *x* km/hr. Then, relative speed = (*x* - 5) km/hr.

$\therefore$ *x* - 5 = 45 $\Rightarrow$ *x* = 50 km/hr.

Ex.10. ***A train 240 m long passes a pole in 24 seconds. How long will it take to pass a platform 650 m long?***

Sol. Speed = $\left(\frac{240}{24}\right)$ m/sec. = 10 m/sec.

$\therefore$ Required time = $\left(\frac{240 + 650}{10}\right)$ sec. = 89 sec.

Ex.11. ***Two trains of equal length are running on parallel lines in the same direction at 46 km/hr and 36 km/hr. The faster train passes the slower train in 36 seconds. The length of each train is:***

Sol. Let the length of each train be *x* metres.

Then, distance covered = 2*x* metres.

Relative speed = (46 - 36) km/hr

$= \left(10 \times \frac{5}{18}\right)$ m/sec.

$= \left(\frac{25}{9}\right)$ m/sec.

$$: \quad \frac{2x}{36} = \frac{25}{9}$$

$\Rightarrow 2x = 100$

$\Rightarrow x = 50.$

Ex.12. ***A 270 metres long train running at the speed of 120 kmph crosses another train running in opposite direction at the speed of 80 kmph in 9 seconds. What is the length of the other train?***

Sol. Relative speed = (120 + 80) km/hr

$$= \left(200 \times \frac{5}{18}\right) \text{ m/sec.}$$

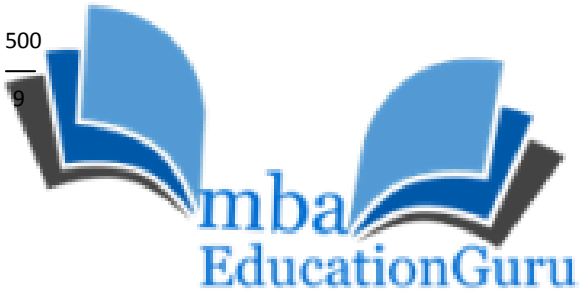
$$= \left(\frac{500}{9}\right) \text{ m/sec.}$$

Let the length of the other train be x metres.

Then, $\frac{x + 270}{9} = \frac{500}{9}$

$\Rightarrow x + 270 = 500$

$\Rightarrow x = 230.$



Ex.13. ***A goods train runs at the speed of 72 kmph and crosses a 250 m long platform in 26 seconds. What is the length of the goods train?***

Sol. Speed $= \left(72 \times \frac{5}{18}\right)$ m/sec. $=$ 20 m/sec.

Time = 26 sec.

Let the length of the train be x metres.

Then, $\frac{x + 250}{26} = 20.$

$\Rightarrow x + 250 = 520$

$\Rightarrow x = 270.$

Ex.14. ***A train travelling at a speed of 75 mph enters a tunnel 3.5 miles long. The train is $\frac{1}{4}$ mile long. How long does it take for the train to pass through the tunnel from the moment the front enters to the moment the rear emerges?***

Sol. Total distance covered $= \left(\frac{7}{2} + \frac{1}{4}\right)$ miles $= \frac{15}{4}$ miles.

$\therefore$ Time taken $= \left(\frac{15}{4 \times 75}\right)$ hrs.

$= \frac{1}{20}$ hrs.

$= \left(\frac{1}{20} \times 60\right)$ min.

$= 3$ min.

Ex.15. ***A train 800 metres long is running at a speed of 78 km/hr. If it crosses a tunnel in 1 minute, then the length of the tunnel (in meters) is:***

Sol. Speed $= \left(78 \times \frac{5}{18}\right)$ m/sec. $= \left(\frac{65}{3}\right)$ m/sec.

Time = 1 minute = 60 seconds.

Let the length of the tunnel be x metres.

Then, $\left(\frac{800 + x}{60}\right) = \frac{65}{3}$

$\Rightarrow 3(800 + x) = 3900$

$\Rightarrow x = 500.$

Ex.16. ***How many seconds will a 500 metre long train take to cross a man walking with a speed of 3 km/hr in the direction of the moving train if the speed of the train is 63 km/hr?***

Sol. Speed of the train relative to man $=$ (63 - 3) km/hr $=$ 60 km/hr

$= \left(60 \times \frac{5}{18}\right)$ m/sec.

$= \left(\frac{50}{3}\right)$ m/sec.

$\therefore$ Time taken to pass the man $= \left(500 \times \frac{3}{50}\right)$ sec. $=$ 30 sec.

Ex.17. Two goods train each 500 m long, are running in opposite directions on parallel tracks. Their speeds are 45 km/hr and 30 km/hr respectively. Find the time taken by the slower train to pass the driver of the faster one.

Sol. Relative speed = (45 + 30) km/hr

$$= \left(75 \times \frac{5}{18}\right) \text{ m/sec.}$$

$$= \left(\frac{125}{6}\right) \text{ m/sec.}$$

We have to find the time taken by the slower train to pass the DRIVER of the faster train and not the complete train.

So, distance covered = Length of the slower train.

Therefore, Distance covered = 500 m.

$$\therefore \text{ Required time} = \left(500 \times \frac{6}{125}\right) = 24 \text{ sec.}$$

Ex.18. Two trains are running at 40 km/hr and 20 km/hr respectively in the same direction. Fast train completely passes a man sitting in the slower train in 5 seconds. What is the length of the fast train?

Sol.

Relative speed = (40 - 20) km/hr $= \left(20 \times \frac{5}{18}\right)$ m/sec. $= \left(\frac{50}{9}\right)$ m/sec.

$$\therefore \text{ Length of faster train} = \left(\frac{50}{9} \times 5\right) \text{m} = \frac{250}{9} \text{m} = 27\frac{7}{9} \text{m.}$$

Ex.19. 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:

Sol. 2 kmph $= \left(2 \times \frac{5}{18}\right)$ m/sec. $= \frac{5}{9}$ m/sec.

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

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

Then, $\left(\frac{x}{y - \frac{5}{9}}\right) = 9$ and $\left(\frac{x}{y - \frac{10}{9}}\right) = 10.$

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

$\Rightarrow 9y - x = 5$ and $90y - 9x = 100$.

On solving, we get: $x = 50$.

$\therefore$ Length of the train is 50 m.

Ex.20. ***Two, trains, one from Howrah to Patna and the other from Patna to Howrah, start simultaneously. After they meet, the trains reach their destinations after 9 hours and 16 hours respectively. The ratio of their speeds is:***

Sol. Let us name the trains as A and B. Then,

(A's speed) : (B's speed) = $\sqrt{b} : \sqrt{a} = \sqrt{16} : \sqrt{9} = 4 : 3$.

Ex.21. ***A train passes a station platform in 36 seconds and a man standing on the platform in 20 seconds. If the speed of the train is 54 km/hr, what is the length of the platform?***

Sol. Speed $= \left(54 \times \frac{5}{18}\right)$ m/sec. $= 15$ m/sec.

Length of the train = (15 x 20)m = 300 m.

Let the length of the platform be x metres.

Then, $\frac{x + 300}{36} = 15$

$\Rightarrow x + 300 = 540$

$\Rightarrow x = 240$ m.

Ex.22. ***Two trains running in opposite directions cross a man standing on the platform in 27 seconds and 17 seconds respectively and they cross each other in 23 seconds. The ratio of their speeds is:***

Sol. Let the speeds of the two trains be x m/sec and y m/sec respectively.

Then, length of the first train = $27x$ metres,

and length of the second train = $17y$ metres.

$: \frac{27x + 17y}{x + y} = 23$

$\Rightarrow 27x + 17y = 23x + 23y$

$\Rightarrow 4x = 6y$

$\Rightarrow \frac{x}{y} = \frac{3}{2}$.

Ex.24. A jogger running at 9 kmph alongside a railway track in 240 metres ahead of the engine of a 120 metres long train running at 45 kmph in the same direction. In how much time will the train pass the jogger?

Sol. Speed of train relative to jogger = (45 - 9) km/hr = 36 km/hr.

$$= \left(36 \times \frac{5}{18}\right) \text{ m/sec.}$$

= 10 m/sec.

Distance to be covered = (240 + 120) m = 360 m.

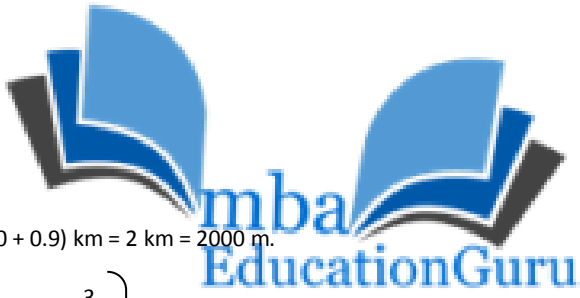
$$\therefore \text{ Time taken } = \left(\frac{360}{10}\right) \text{ sec.} = 36 \text{ sec.}$$

Ex.25. Two trains are moving in opposite directions @ 60 km/hr and 90 km/hr. Their lengths are 1.10 km and 0.9 km respectively. The time taken by the slower train to cross the faster train in seconds is:

Sol. Relative speed = (60+ 90) km/hr

$$= \left(150 \times \frac{5}{18}\right) \text{ m/sec.}$$

$$= \left(\frac{125}{3}\right) \text{ m/sec.}$$



Distance covered = (1.10 + 0.9) km = 2 km = 2000 m.

$$\text{Required time } = \left(2000 \times \frac{3}{125}\right) \text{ sec.} = 48 \text{ sec.}$$

Ex.26. A train 110 metres long is running with a speed of 60 kmph. In what time will it pass a man who is running at 6 kmph in the direction opposite to that in which the train is going?

Sol. Speed of train relative to man = (60 + 6) km/hr = 66 km/hr.

$$= \left(66 \times \frac{5}{18}\right) \text{ m/sec.}$$

$$= \left(\frac{55}{3}\right) \text{ m/sec.}$$

$$\therefore \text{ Time taken to pass the man } = \left(110 \times \frac{3}{55}\right) \text{ sec.} = 6 \text{ sec.}$$

Ex.27. Two trains 140 m and 160 m long run at the speed of 60 km/hr and 40 km/hr respectively in opposite directions on parallel tracks. The time (in seconds) which they take to cross each other, is:

Sol. Relative speed = (60 + 40) km/hr = $\left(100 \times \frac{5}{18}\right)$ m/sec. = $\left(\frac{250}{9}\right)$ m/sec.

Distance covered in crossing each other = (140 + 160) m = 300 m.

Required time = $\left(300 \times \frac{9}{250}\right)$ sec = $\frac{54}{5}$ sec = 10.8 sec.

Ex.28. A train moves past a telegraph post and a bridge 264 m long in 8 seconds and 20 seconds respectively. What is the speed of the train?

Sol. Let the length of the train be *x* metres and its speed by *y* m/sec.

Then, $\frac{x}{y} = 8 \Rightarrow x = 8y$

Now, $\frac{x + 264}{20} = y$

$\Rightarrow 8y + 264 = 20y$

$\Rightarrow y = 22.$

$\therefore$ Speed = 22 m/sec = $\left(22 \times \frac{18}{5}\right)$ km/hr = 79.2 km/hr.

Ex.29. A train speeds past a pole in 15 seconds and a platform 100 m long in 25 seconds. Its length is:

Sol. Let the length of the train be *x* metres and its speed by *y* m/sec.

Then, $\frac{x}{y} = 15 \Rightarrow y = \frac{x}{15}$

$: \frac{x + 100}{25} = \frac{x}{15}$

$\Rightarrow 15(x + 100) = 25x$

$\Rightarrow 15x + 1500 = 25x$

$\Rightarrow 1500 = 10x$

$\Rightarrow x = 150$ m.

Ex.30. ***Two stations A and B are 110 km apart on a staright 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?***

Sol. Suppose they meet x hours after 7 a.m.

Distance covered by A in x hours = $20x$ km.

Distance covered by B in $(x - 1)$ hours = $25(x - 1)$ km.

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

$\Rightarrow 45x = 135$

$\Rightarrow x = 3$.

So, they meet at 10 a.m.