17. PROBLEMS ON TRAINS

General Rules for Solving Train Problems:

Rule 1 Train Vs Stationary Object of no Length

Time taken by a train of length *T* meter to pass a stationary object such as a pole, standing man or a building is equal to the time taken by the train to cover L meter.

Speed of the train $= \frac{\textbf{Length of the train}}{\textbf{Time taken to cross the stationary object}}$

Rule 2 Train Vs Stationary Object of Certain Length

Time taken by a train of length *T* meter to pass a stationary object of length 'a' meter such as another standing train, bridge or railway platform is equal to the time taken by the train to cover *(L* + a) meter.

Speed of the train$= \frac{\textbf{Length of the train+ Length of the stationary object}}{\textbf{Time taken to cross the stationary object}}$

Rule 3 Train Vs Moving Object of no Length

Time taken by the train of length *T* meter to pass a man moving is equal to the time taken by the train to cover *L* meter

(i) When the train and man move in the same direction with speeds of *x* m/s and *y* m/s. Then,

$$(x - y) = \frac{\textbf{Length of the train}}{\textbf{TIme taken to cross each other}}$$

(ii) When the train and man move in opposite directions with speeds of *x* m/s and *y* m/s then,

$$(x + y) = \frac{\textbf{Length of the train}}{\textbf{TIme taken to cross each other}}$$

Rule 4 Train Vs Moving Object of Certain Length

Time taken by the train of length *T* meter to pass a moving object of length '*a*' meter such as another moving train is equal to the time taken by the train to cover *(L + a)* meter.

(i) When the two trains move in the same direction with speeds of *x* m/s and *y* m/s, *(x > y)*, then

$$(x - y) = \frac{\textbf{Sum of the lengths of the two objects}}{\textbf{TIme taken to cross each other}}$$

(ii) When the two trains move in opposite directions with speeds of *x* m/s and y m/s. Then,

$$(x + y) = \frac{\textbf{Sum of the lengths of the two objects}}{\textbf{TIme taken to cross each other}}$$

Rule 5 Two Moving Trains

If two trains start at the same time from points *A* and *B* towards each other and after crossing they take *a* and *b* seconds in reaching *B* and *A* respectively.

Then, (A's speed): *(B's* speed) = $\sqrt{\boldsymbol{b}}$: $\sqrt{\boldsymbol{a}}$

Example 1: A train of length 100 m crosses a man who is coming to the train from opposite direction in 6 s. What is the speed of train?

Solution: Let speed of train = *x* km/h

Then, speed of train relative to man = (x + 5) km/h

$$= (\boldsymbol{x + 5}) \times \frac{5}{18}\text{m/s}$$

$$\therefore \frac{\boldsymbol{100}}{(\boldsymbol{x + 5}) \times \frac{\boldsymbol{5}}{\boldsymbol{18}}} = \boldsymbol{6} \Rightarrow \frac{\boldsymbol{1800}}{\boldsymbol{5(x + 5)}} = \boldsymbol{6}$$

$$\Rightarrow \boldsymbol{x + 5 = 60} \Rightarrow \boldsymbol{x} = 55 \text{ km/h}$$

EXERCISE - 1

1. A train 600 m long passes a pole in 9 seconds. What is the speed of the train in km/hr?
   (a) 120 km/hr (b) 180 km/hr
   (c) 240 km/hr (d) 60 km/hr
   (e) None of these
2. A train 100 m long crosses a standing man in 10 sec. What is the speed of the train in km/hr?
   a) 36 km/hr b) 24 km/hr
   c) 12 km/hr d) 48 km/hr
   e) None of these
3. Find the speed of train in km/hr whose length is 200 m and crosses a platform of length 240m in 22 seconds?
   a) 47 km/hr b) 39 km/hr
   c) 87 km/hr d) 72 km/hr
   e) none of these
4. A train 150 m long passes an electric pole in 5 sec, How long will it take to cross a bridge of 180 m length?
   a) 11 sec b) 15 sec c) 24 sec
   d) 29 sec e) none of these
5. A train 800 m long running at the speed of 78 km/hr will cross a tunnel in 1 minute. The length of the tunnel is?
   a) 700 m b) 500 m c) 1300 m
   d) 800 m e) none of these
6. A train 200 m long running with the speed of 60 km/hr passes a man who is running at 12 km/hr in the same direction of the train. How much time will it take to cross him?
   a) 14 sec b) 15 sec c) 19 sec
   d) 23 sec e) Non e of these
7. Two trains one 260m and other 140m long are running in opposite direction on parallel lines. Speed of 1st is 77 km/hr and other is 67 km/hr, how long will it take to cross each other?
   (a) 10 sec (b) 7sec (c) 2 mins
   (d) 70 sec (e) None of these
8. Two trains are moving in the same direction at the rate of 80 km/hr and 50 km/hr. The fast train crosses a man in the slower train in 27 sec. Find the length of the faster train?
   (a) 225 m (b) 275 m (c) 325 m
   (d) 256 m (e) None of these
9. A train 200 m long passes a stone in 15 seconds and passes another train of same length by 12 sec coming from opposite direction. The speed of the second train is?
   a) 72 km/hr b) 56 km/hr c) 85 km/hr
   d) 65 km/hr e) None of these
10. Excluding stoppages speed of the train is 40 km/hr and including stoppages speed of the train is 29 km/hr. for how many minutes does the train stops per hour?
    a) 16.5 min b) 17 min
    c) 16 min d) 15.5 min
    e) none of these
11. Two trains one from A to B another from B to A, started simultaneously. After they meet the trains reach their destinations after 9 hours and 16 hours respectively. The ratio of the speed is?
    a) 4 :3 b) 2:4
    c) 3:4 d) 2: 5
    e) none of these
12. Two trains A and B start from Delhi and Patna and simultaneously B starts from Patna to Delhi. After passing each other they take 4 hours 48 minutes and 3 hours 20 minutes respectively. What is B's speed if A's speed is 45 km/hr?
    a) 28 km/hr b) 54 km/hr
    c) 78 km/hr d) 85 km/hr
    e) none of these
13. Two trains start at the same time from two stations 240 km apart and going in opposite direction and cross each other 150 km apart from first stations. What is the ratio of their speeds?
    a) 5: 3 b) 2: 4
    c) 3: 4 d) 2: 5
    e) none of these
14. Two trains of length 200m and 175m run on parallel tracks. When running in the same direction faster train cross slower one in 37 $\frac{1}{2}$ sec. When running in opposite direction at their earlier speeds they pass each other completely in 7 $\frac{1}{2}$ sec. Find the speed of each train?
    (a) 30 m/sec, 20 m/sec
    (b) 20 m/sec, 15 m/sec
    (c) 45 m/sec, 27 m/sec
    (d) 40 m/sec, 16 m/sec
    (e) None of these
15. Two trains, each of length 90m run on parallel tracks. When running in the same

direction faster train crosses slower one in 18 sec completely. When running in opposite direction, at their earlier speeds they pass each other completely in 9 sec. Find the speed of each train?
(a) 48 m/sec, 38 m/sec
(b) 15 m/sec, 5 m/sec
(c) 45 m/sec, 27 m/sec
(d) 30 m/sec, 20 m/sec
(e) none of these

16. 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?
(a) 75 km/hr (b) 82 km/hr
(c) 79 km/hr (d) 79.2 km/hr

17. 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?
(a) 32 (b) 30
(c) 40 (d) 48

18. A jogger running at 9 kmph alongside a railway track is 240 metres ahead of the engine of a 120 metre long train running at 45 kmph in the same direction. In how much time will the train pass the jogger?
(a) 38 sec (b) 20 sec
(c) 36 sec (d) 72 sec

19. Two trains 200 m and 150 m long are running on parallel rails at the rate of 40 kmph and 45 kmph respectively. In how much time will they cross each other, if they are running in the same direction?
(a) 80 sec (b) 136 sec
(c) 192 sec (d) 252 sec

20. 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:
(a) 39 (b) 47
(c) 48 (d) 49

Answer Key							
1	c	6	b	11	a	16	d
2	a	7	a	12	b	17	b
3	d	8	a	13	a	18	c
4	a	9	a	14	a	19	d
5	b	10	a	15	b	20	c

SOLUTIONS

1. Speed = $\frac{Distance}{Time} = \frac{600}{9}$ m/sec
$= \frac{600}{9} \times \frac{18}{5}$ km/hr = 240 km/hr
[$\because$ 1 m/sec = $\frac{18}{5}$ km/hr]

2. Speed = $\frac{distance}{Time} = \frac{100}{10}$
= 10 m/sec
= $10 \times \frac{18}{5}$ = 36 km/hr

3. Speed = $\frac{Distance}{Time} = \frac{200+240}{22} = \frac{440}{22}$
= 20 m/sec
= $20 \times \frac{18}{5}$ = 72 km/hr

4. Speed = $\frac{Distance}{Time} = \frac{150}{5} = 30$ m/sec
$\therefore$ Required Time = $\frac{150+180}{30} = \frac{330}{30}$
= 11 sec

5. Distance = Speed × Time = $78 \times \frac{5}{18} \times 60$
= 1300 m
$\therefore$ Length of the tunnel = 1300 – 800 = 500 m

6. Speed of the train relative to man = (60 – 12) km/hr
= $48 \times \frac{5}{18}$ m/sec = $\frac{40}{3}$ m/sec
Time taken by the train to cross the man = Time taken by it to cover 200 m at $\left(\frac{40}{3}\right)$ m/sec = $200 \times \frac{3}{40}$ sec = 15 sec

7. Relative speed of the trains
= (77 + 67) km/hr = 144 km/hr

$= 144 \times \frac{5}{18}$ m/sec = 40 m/sec

Time taken by the trains to cross each other = Time taken to cover (260 + 140) m at 40 m/sec = $\left(\frac{400}{40}\right)$ sec

= 10 sec

8. Relative speed of the trains = (80 − 50) km/hr = 30 km/hr

$= 30 \times \frac{5}{18}$ m/sec = $\left(\frac{25}{3}\right)$ m/sec

∴ Length of the train = $\frac{25}{3} \times 27 = 225$ m

9. Speed of the first train = $\left(\frac{200}{15}\right)$ m/sec = $\left(\frac{40}{3}\right)$ m/sec

Let the speed of the second train be x m/sec

Relative speed = $\left(\frac{40}{3} + x\right)$ m/sec

$\therefore \frac{400}{\frac{40}{3}+x} = 12 \Leftrightarrow 400 = 12\left(\frac{40}{3} + x\right) \Leftrightarrow$

400 = 160 + 12 x

$$x = \frac{(400-160)}{12} = \frac{240}{12}$$
$$= 20\, m/sec$$

So, speed of second train = $\left(20 \times \frac{18}{5}\right)$ km/hr = 72 km/hr

10. Due to stoppages, it covers (40 – 29) = 11 km less

Time taken to cover 11 km = $\frac{11}{40} \times 60$ = 16.5 min

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

12. $T_1 = 4hours48minutes$

$= 4 \times \frac{48}{60} = \frac{24}{5}$;

$T_2 = 3hours20minutes$

$= 3 \times \frac{20}{60} = \frac{10}{3}$

$\left(\frac{S_1}{S_2}\right) = \left(\frac{\sqrt{T_2}}{\sqrt{T_1}}\right) \Rightarrow \frac{A's\ speed}{B's\ speed} = \frac{\sqrt{\frac{10}{3}}}{\frac{\sqrt{24}}{5}}$

$\Rightarrow \frac{45}{B} = \left(\frac{\sqrt{10}}{\sqrt{3}} \times \frac{\sqrt{5}}{\sqrt{24}}\right)$

$B = \left(\frac{\sqrt{3}}{\sqrt{10}} \times \frac{\sqrt{24}}{\sqrt{5}}\right) \times 45$

$= 54 km/hr$

B's speed = 54 km/hr

13. In the same time, they cover 150 km and 90 km respectively.

∴ Ratio of their speeds = 150: 90 = 5: 3

14. length: L_1= 200m;

L_2 = 175m

$T_1 = 37\frac{1}{2} sec$; $T_2 = 7\frac{1}{2} sec$

$S_F = \left(\frac{L_1+L_2}{2}\right)\left(\frac{T_1+T_2}{T_1 \times T_2}\right)$;

$$S_L = \left(\frac{L_1 + L_2}{2}\right)\left(\frac{T_1 - T_2}{T_1 \times T_2}\right)$$

Speed of each train:

$T_1 = 37\frac{1}{2} = \frac{75}{2} sec$; $T_2 = 7\frac{1}{2} = \frac{15}{2} sec$

$S_F = \left(\frac{200+175}{2}\right)\left(\frac{\frac{75}{2}+\frac{15}{2}}{\frac{75}{2}\times\frac{15}{2}}\right)$;

$$S_L = \left(\frac{200 + 175}{2}\right)\left(\frac{\frac{75}{2} - \frac{15}{2}}{\frac{75}{2} \times \frac{15}{2}}\right)$$

S_F = 30 m/s S_L = 20 m/s

15. $S_F = \left(\frac{90+90}{2}\right)\left(\frac{18+9}{18\times 9}\right)$

$$S_L = \left(\frac{90 + 90}{2}\right)\left(\frac{18 - 9}{18 \times 9}\right)$$

S_F = 15 m/s S_L = 5 m/s

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

Then,

$\frac{x}{y} = 8 \Rightarrow x = 8y$ Now, $\frac{x+264}{20} = y$

$\Leftrightarrow 8y + 264 = 20y \Leftrightarrow y = 22$.

∴ Speed = 22 m/sec

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

17. Speed of train relative to man

= (63 - 3) km/hr = 60 km/hr

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

∴Time taken to pass the man

$= \left(500 \times \frac{3}{50}\right)$ sec = 30 sec.

18. Speed of train relative to jogger

= (45 - 9) km/hr = 36 km/hr

$= \left(36 \times \frac{5}{18}\right)$m/sec = 10 m/sec.

Distance to be covered

= (240+ 120) m = 360 m.

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

19. Relative speed = (45 - 40) kmph

= 5 kmph

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

$\therefore$ Time taken = $\left(350 \times \frac{18}{25}\right)$ sec

=252 sec

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

= $\left(150 \times \frac{5}{18}\right)$ m/sec = $\frac{125}{3}$ m/sec.

Distance covered = (1.10 + 0.9) km

= 2km = 2000m.

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

= 48 sec