

## 18. PROBLEMS ON TRAINS

### IMPORTANT FACTS AND FORMULAE

1.  $a \text{ km/hr} = (a * \frac{5}{18}) \text{ m/s}.$

2.  $a \text{ m/s} = (\frac{a * 18}{5}) \text{ km/hr}.$

3 Time taken by a train of length  $l$  metres to pass a pole or a 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 stationary object of length  $b$  metres is the time taken by the train to cover  $(l + b)$  metres.

5. Suppose two trains or two bodies are moving in the same direction at  $u \text{ m/s}$  and  $v \text{ m/s}$ , where  $u > v$ , then their relative speed =  $(u - v) \text{ m/s}$ .

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

7. If two trains of length  $a$  metres and  $b$  metres are moving in opposite directions at  $u \text{ m/s}$  and  $v \text{ m/s}$ , then time taken by the trains to cross each other =  $\frac{(a + b)}{(u + v)}$  sec.

8. If two trains of length  $a$  metres and  $b$  metres are moving in the same direction at  $u \text{ m/s}$  and  $v \text{ m/s}$ , then the time taken by the faster train to cross the slower train =  $\frac{(a + b)}{(u - v)}$  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

$(A's \text{ speed}) : (B's \text{ speed}) = (b^{1/2} : a^{1/2}).$

### **SOLVED EXAMPLES**

**Ex.I. 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. (S.S.C. 2001)**

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

Distance moved in passing the standing man = 100 m.

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

**Ex. 2. 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? (Section Officers', 2003)**

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

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

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

**Ex. 3. A man is standing on a railway bridge which is 180 m long. He finds that a train crosses the bridge in 20 seconds but himself in 8 seconds. Find the length of the train and its speed?**

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

Then, the train covers x metres in 8 seconds and  $(x + 180)$  metres in 20 sec

$$\frac{x}{8} = \frac{(x+180)}{20} \Leftrightarrow 20x = 8(x + 180) \quad \Leftrightarrow \quad x = 120.$$

Length of the train = 120 m.

Speed of the train =  $(\frac{120}{8})$  m / sec = m / sec =  $(15 \times \frac{18}{5})$  kmph = 54 km

**Ex. 4. A train 150 m long is running with a speed of 68 kmph. In what time will it pass a man who is running at 8 kmph in the same direction in which the train is going?**

**Sol:** Speed of the train relative to man =  $(68 - 8)$  kmph

$$= (60 * \frac{5}{18}) \text{ m/sec} = \frac{50}{3} \text{ m/sec}$$

Time taken by the train to cross the man I

$$= \text{Time taken by It to cover } 150 \text{ m at } \frac{50}{3} \text{ m/sec} = 150 * \frac{3}{50} \text{ sec} = 9 \text{ sec}$$

**Ex. 5. A train 220 m long is running with a speed of 59 kmph.. In what 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

$$= 66 * \frac{5}{18} \text{ m/sec} = \frac{55}{3} \text{ m/sec.}$$

Time taken by the train to cross the man = Time taken by it to cover 220 m at  $\frac{55}{3}$  m/sec =  $(220 * \frac{3}{55}) \text{ sec} = 12 \text{ sec}$

**Ex. 6. 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

$$= (90 * \frac{5}{18}) \text{ m/sec} = 25 \text{ m/sec.}$$

Time taken by the trains to pass each other

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

**Ex. 7. Two trains 100 metres and 120 metres long are running in the same direction with speeds of 72 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

$$= (18 * \frac{5}{18}) \text{ m/sec} = 5 \text{ m/sec.}$$

Time taken by the trains to cross each other

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

**Ex. 8. A train 100 metres long takes 6 seconds to cross a man walking at 5 kmph in the 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 =  $(x + 5) * 5/18$  m/sec.

Therefore  $100/((x+5)*5/18)=6 \Leftrightarrow 30(x + 5) = 1800 \Leftrightarrow x = 55$

Speed of the train is 55 kmph.

**Ex9. A train running at 54 kmph takes 20 seconds to pass a platform. Next it takes 12 sec to pass a man walking at 6 kmph in the same direction in which the train is going . Find the length of the train and the length of the platform.**

**Sol:**Let the length of train be  $x$  metres and length of platform be  $y$  metres.

Speed of the train relative to man =  $(54 - 6)$  kmph = 48 kmph

=  $48*(5/18)$  m/sec =  $40/3$  m/sec.

In passing a man, the train covers its own length with relative speed.

Length of train = (Relative speed \* Time) =  $(\frac{40}{3})*12$  m = 160 m.

Also, speed of the train =  $54*(5/18)$  m / sec = 15 m / sec.

$(x+y)/15 = 20 \Leftrightarrow x + y = 300 \Leftrightarrow Y = (300 - 160)$  m = 140 m.

**Ex10. A man sitting in a train which is traveling at 50 kmph observes that a goods train, traveling in opposite direction, takes 9 seconds to pass him. If the goods train is 280 m long, find its speed.?**

**Sol:** Relative speed =  $280/9$  m / sec =  $((280/9)*(18/5))$  kmph = 112 kmph.

Speed of goods train =  $(112 - 50)$  kmph = 62 kmph.

