# IMPORTANT FORMULA AND EQUATIONS

1. **Speed, Time and Distance:**

   - Speed = Distance / time
   - Time = distance / speed
   - Distance = speed * distance

2. **km/hr to m/sec conversion:**
   
   \[ x \text{ km/hr} = \left(\frac{x \times 5}{18}\right) \text{ m/sec} \]

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   \[ x \text{ m/sec} = \left(\frac{x \times 18}{5}\right) \text{ km/hr} \]

4. If the ratio of the speeds of A and B is \(a : b\), then the ratio of the times taken by them to cover the same distance is \(1/a : 1/b\) or \(b : a\)

5. Suppose a man covers a certain distance at \(x\) km/hr and an equal distance at \(y\) km/hr. Then, the average speed during the whole journey is \(\frac{xy}{x+y}\) km/hr

   - Average speed: if both the time taken are equal i.e \(t_1 = t_2 = t\), then, \(\frac{t_1 + t_2}{2}\)
   - The average of odd numbers from 1 to \(n\) is \(\frac{\text{Last odd no.} + 1}{2}\).
   - The average of even numbers from 1 to \(n\) is \(\frac{\text{Last even no.} + 2}{2}\).
   - \((x + y)\) t km apart of they more in opposite direction.

**KEY NOTE:**

Caution average speed should not be calculated as average of different speeds, i.e., Ave. speed ≠ 

\[ \frac{\text{Sum of speed}}{\text{No. of different Speed}} \]

There are two different cases when average speed is required.

**Case I**
When time remains constant and speed varies:

If a man travels at the rate of \(x\) km/h for \(t\) hours and again at the rate of \(y\) km/h for another \(t\) hours, then for the whole journey, his average speed is given by

\[
\text{Average speed} = \frac{\text{Total distance}}{\text{Total time taken}} = \frac{xt + yt}{t + t} = \frac{x + y}{2} \text{ km/h.}
\]

**Case II**
When the distance covered remains same and the speeds vary:
When a man covers a certain distance with a speed of \(x\) km/h and another equal distance at the rate of \(y\) km/h, then for the whole journey, the average speed is given by

\[
\text{Average speed} = \frac{2xy}{x+y} \text{km/h.}
\]

**Velocity**

The speed of a moving body is called as its velocity if the direction of motion is also taken into consideration.

\[
\text{Velocity} = \frac{\text{Net displacement of the body}}{\text{Time taken}}
\]

**Relative speed**

**a) Bodies moving in same direction**

- When two bodies move in the same direction, then the difference of their speeds is called the relative speed of one with respect to the other.
- When two bodies move in the same direction, the distance between them increases (or decreases) at the rate of difference of their speeds.

**b) Bodies moving in opposite direction**

- The distance between two bodies moving towards each other will get reduced at the rate of their relative speed (i.e., sum of their speeds). The

\[
\text{Initial distance between two bodies} / \text{Some of their Speed}
\]

- Relative speed of one body with respect to other body is sum of their speeds.
- Increase or decrease in distance between them is the product of their relative speed and time.

**Key notes to solve problems**

- When a moving body covers a certain distance at \(x\) km/h and another same distance at the speed of \(y\) km/h, then average speed of moving body during its entire journey will be

\[
\frac{2xy}{x+y} \text{km/h}
\]

- A man covers a certain distance at \(x\) km/h by car and the same distance at \(y\) km/h by bicycle. If the time taken by him for the whole journey by \(t\) hours, then Total distance covered by him

\[
= \frac{2xy}{x+y} \text{km.}
\]
A boy walks from his house at \(x\) km/h and reaches the school '\(t_1\)' minutes late. If he walks at \(y\) km/h he reaches '\(t_2\)' minutes earlier. Then, distance between the school and the house:

\[
= \frac{xy}{(y-x)}\left(\frac{t_1 + t_2}{60}\right) \text{ km}
\]

If a man walks with \((x/y)\) of his usual speed he takes \(t\) hours more to cover a certain distance.

Then the time to cover the same distance when he walks with his usual speed, \(\frac{xt}{y-x}\) hours.

If two persons A and B start at the same time in opposite directions from the points and after passing each other they complete the journeys in '\(x\)' and '\(y\)' hrs. respectively, then A's speed : B's speed = \(\sqrt{y} : \sqrt{x}\).

If the speed is \((a/b)\) of the original speed, then the change in time taken to cover the same distance is given by Change in time = \(\left(\frac{b}{a} - 1\right)\times\) original time.

Key notes to solve problems on Trains

The time taken by a train in passing a signal post or a telegraph pole or a man standing near a railway line:

\[
= \frac{\text{Length of the train}}{\text{Speed of the train}}
\]

The time taken by a train passing a railway bridge or a platform or a tunnel or a train at rest:

\[
= \frac{x+y}{\text{Speed}} \quad \text{where, } x = \text{length of the train} \quad y = \text{length of the bridge or platform or standing train or tunnel}
\]

Time taken by faster train to pass the slower train in the same direction:

where, \(x = \text{length of the first train}\)
\(y = \text{length of the second train}\)
\(u = \text{speed of the first train}\)
\(v = \text{speed of the second train and } u > v\)

Time taken by the trains in passing each other while moving in opposite direction:

\[
= \frac{x+y}{u+v}
\]
\[ \frac{x}{u-v} \]

- Time taken by the train to cross a man where, both are moving in the same direction and
  \[ x = \text{length of the train} \]
  \[ u = \text{speed of the train} \]
  \[ v = \text{speed of the man.} \]

- Time taken by the train to across a man running in the opposite direction

- If two trains start at the same time from two points A and B towards each other and after crossing, they take \( a \) and \( b \) hours in reaching B and A respectively. Then.
  \[ A \text{’s speed : B’ s speed} = \left( \sqrt{a} : \sqrt{b} \right) \]

- A train starts from a place at \( u \) km/h and another fast train starts from the same place after \( t \) hours at \( v \) km/h in the same direction. Find at what distance from the starting place both the trains will meet and also find the time of their meeting.
  \[ \text{Distance} = \frac{uvt}{v-u} \text{ km} \]
  \[ \text{time} = \frac{ut}{v-u} \text{ hours} \]

- The distance between two places A and B is \( x \) km. A train starts from A to B at \( u \) km/h. One another train after \( t \) hours starts from B to A at \( v \) km/h. At what distance from A will both the train meet and also find the time of their meeting.
  \[ \text{Time} = \frac{x-ut}{u+v} + t \text{ hours} \]
  \[ \text{Distance from A} = u \left( \frac{x-ut}{u+v} + t \right) \text{ km.} \]

- Two trains starts simultaneously from the stations A and B towards each other at the rates of \( u \) and \( v \) km/h respectively. When they meet it is found that the second train had traveled \( x \) km more than the first. Then the distance between the two stations
  \[ \text{is} \frac{x(u+v)}{v-u} \text{ km.} \]
  (i.e., between A and B)