

Rate Problems: Speed, Work, Pipes and Cistern Tricks and Formulas

Time, Speed and Distance

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

Important Conversion Factors:

$$1 \frac{\text{km}}{\text{hr}} = \frac{5}{18} \frac{\text{m}}{\text{s}} \text{ and } 1 \frac{\text{m}}{\text{s}} = \frac{18}{5} \text{ km/hr}$$

Average Speed

- $\text{Average Speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}} = \frac{d_1 + d_2 + d_3 + \dots}{t_1 + t_2 + t_3 + \dots}$
- If the distance is constant, then average speed is given by harmonic mean of two speeds: $S_{avg} = \frac{2s_1s_2}{s_1+s_2}$
- If the time is constant, then average speed is given by arithmetic mean of two speeds $S_{avg} = \frac{s_1+s_2}{2}$

Relative Speed

For Trains

$$\text{Time} = \frac{\text{sum of the lengths}}{\text{Relative speed}} = \frac{L_1 + L_2}{s_1 \pm s_2}$$

For Boats and Streams

- $S_{\text{downstream}} = S_{\text{boat}} + S_{\text{stream}}$
- $S_{\text{upstream}} = S_{\text{boat}} - S_{\text{stream}}$

Time and Work

$$\text{Number of days to complete the work} = \frac{1}{\text{work done in one day}}$$

Time & Work

- If A can do a piece of work in n days, then A's 1 day's work = $\frac{1}{n}$.
- If A's 1 day's work = $\frac{1}{n}$, then A can finish the work in n days.

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- If A is thrice as good a workman as B, then: Ratio of work done by A and B = 3 : 1, Ratio of times taken by A & B to finish a work = 1 : 3

Pipes & Cisterns

If a pipe can fill a tank in 'x' hours and another pipe can empty the full tank in 'y' hours (where $y > x$), then on opening both the pipes, the net part of the tank filled in 1 hour is $\left(\frac{1}{x} - \frac{1}{y}\right)$