

Arithmetic Word Problems: Master Formula Sheet

Essential Formulas, Shortcuts, and Strategies for Rapid Problem Solving

1. Fundamental Percentages

- **Percentage Change:**

$$\% \text{ Change} = \frac{\text{New Value} - \text{Old Value}}{\text{Old Value}} \times 100$$

- **Successive Percentage Changes (a & b):**

$$\text{Net Change} = \left(a + b + \frac{ab}{100} \right) \%$$

- **Percentage Point vs. Percentage:** Percentage point is the arithmetic difference between two percentages.

2. Profit, Loss & Discount

- **Profit/Loss Basics:**

$$\text{Profit} = SP - CP, \quad \text{Loss} = CP - SP$$

$$\text{Profit}\% = \left(\frac{SP - CP}{CP} \right) \times 100$$

- **Discount Formula:**

$$\text{Discount} = MP - SP$$

$$\text{Discount}\% = \left(\frac{MP - SP}{MP} \right) \times 100$$

- **Marked Price (MP) & Cost Price (CP):**

$$SP = MP \times \left(1 - \frac{D}{100} \right) = CP \times \left(1 + \frac{P}{100} \right)$$

3. Ratio, Proportion & Variation

- **Direct Variation:** If $y \propto x$, then $y = kx$ or $\frac{y_1}{x_1} = \frac{y_2}{x_2}$.

- **Inverse Variation:** If $y \propto \frac{1}{x}$, then $xy = k$ or $x_1y_1 = x_2y_2$.

- **Partnership Sharing:**

$$\text{Profit Share} \propto \text{Investment} \times \text{Time}$$

4. Averages, Mixtures & Alligation

- **Weighted Average:**

$$\text{Avg}_{avg} = \frac{n_1\bar{x}_1 + n_2\bar{x}_2}{n_1 + n_2}$$

- **Rule of Alligation:**

$$\frac{Q_1}{Q_2} = \frac{C_2 - \text{Mean}}{\text{Mean} - C_1}$$

$$\text{where } C_1 < \text{Mean} < C_2.$$

5. Time, Speed & Distance

- **Core Relations:**

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

- **Average Speed (Equal Distances):**

$$S_{avg} = \frac{2v_1v_2}{v_1 + v_2}$$

- **Relative Speed:**

- Same direction: $S_1 - S_2$
- Opposite direction: $S_1 + S_2$

- **Boats and Streams:** Let downstream speed be u and upstream be v .

$$\text{Speed of Boat} = \frac{u + v}{2}, \quad \text{Speed of Current} = \frac{u - v}{2}$$

6. Time & Work, Pipes & Cisterns

- **Work Rate Principle:** If A completes work in n days, 1-day work = $\frac{1}{n}$.

- **Combined Work:**

$$\text{Time}_{together} = \frac{xy}{x + y}$$

- **M-D-H Formula:**

$$\frac{M_1D_1H_1}{W_1} = \frac{M_2D_2H_2}{W_2}$$

- **Pipes and Cisterns:** Inlet pipes carry positive rates, outlet (leak) pipes carry negative rates.

7. Simple & Compound Interest

- **Simple Interest (SI):**

$$SI = \frac{P \times R \times T}{100}$$

- **Compound Interest (CI):**

$$A = P \left(1 + \frac{R}{100} \right)^n, \quad CI = A - P$$

- **Difference (2 Years):**

$$CI - SI = P \left(\frac{R}{100} \right)^2$$

- **Difference (3 Years):**

$$CI - SI = P \left(\frac{R}{100} \right)^2 \left(3 + \frac{R}{100} \right)$$