1. Number Systems & Properties

Types of Numbers:

- **Natural** ($\mathbb{N}$): $\{1, 2, 3, \dots\}$
- **Whole** ($\mathbb{W}$): $\{0, 1, 2, 3, \dots\}$
- **Integers** ($\mathbb{Z}$): $\{\dots, -2, -1, 0, 1, 2, \dots\}$
- **Rational** ($\mathbb{Q}$): $\frac{a}{b}$ where $b \neq 0$
- **Irrational**: Non-terminating, non-repeating decimals (e.g., $\pi, \sqrt{2}$).

Properties of Operations

- **Commutative**: $a + b = b + a$, $ab = ba$
- **Associative**: $(a + b) + c = a + (b + c)$
- **Distributive**: $a(b + c) = ab + ac$

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2. Fractions & Decimals

Operations:

$$\frac{a}{b} \pm \frac{c}{d} = \frac{ad \pm bc}{bd}$$

$$\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}, \quad \frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c}$$

Rounding Rules

the digit following the rounding place is ≥ 5, round up. Otherwise, round down.—

3. Ratio, Proportion & Variation

Ratio: Comparison of two quantities $a : b = \frac{a}{b}$.**Proportion**: Equality of two ratios $\frac{a}{b} = \frac{c}{d} \implies ad = bc$.**Variations**:

- Direct: $y \propto x \implies y = kx$
- Inverse: $y \propto \frac{1}{x} \implies xy = k$

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4. Percentages

Percentage Formula:

$$\text{Percentage} = \left(\frac{\text{Part}}{\text{Whole}}\right) \times 100\%$$

Percentage Change:

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

Successive Percentage Change:a value changes by $a\%$ and then by $b\%$, the net change is:

$$\left(a + b + \frac{ab}{100}\right)\%$$

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5. Profit, Loss & Discount

- Profit (P) = SP − CP
- Loss (L) = CP − SP
- Profit% = $\left(\frac{\text{P}}{\text{CP}}\right) \times 100\%$
- Loss% = $\left(\frac{\text{L}}{\text{CP}}\right) \times 100\%$
- Discount = MP − SP

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6. Simple & Compound Interest

Simple Interest (SI):

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

P = Principal, R = Rate/annum, T = Time in years.**Compound Interest (CI)**:

$$= P\left(1 + \frac{R}{100}\right)^n$$

$$\text{CI} = A - P$$

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7. Speed, Time & Distance

Relations:

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

Average Speed:

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

Relative Speed:

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