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Arithmetic Master Cheat Sheet

Essential Formulas, Rules, and Quick Calculation Tricks

1. Number Systems Properties

Types of Numbers:

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

Divisibility Rules:

- **2:** Last digit is even.
- **3:** Sum of digits is divisible by 3.
- **4:** Last two digits form a number divisible by 4.
- **5:** Last digit is 0 or 5.
- **9:** Sum of digits is divisible by 9.
- **11:** Alternating sum of digits is divisible by 11.

2. Fractions Decimals

Operations:

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

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

Percentage Conversions:

- **Fraction to %:** Multiply by 100%.
- **% to Fraction:** Divide by 100 and simplify.
- **Common Equivalents:** $\frac{1}{2} = 50\%$, $\frac{1}{4} = 25\%$, $\frac{1}{5} = 20\%$, $\frac{1}{8} = 12.5\%$.

3. Ratio, Proportion Variation

Ratio Proportion: If $a : b = c : d$, then $ad = bc$ (Cross Product).

Variations:

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

Partnership Sharing Profit:

Profit Ratio = $(Capital_1 \times Time_1) : (Capital_2 \times Time_2)$

4. Percentages, Profit Loss

Percentage Change:

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

Profit and Loss:

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

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

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

Discount Marked Price:

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

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

5. Average, Mixture Alligation

Average Formula:

$$\text{Average} = \frac{\text{Sum of Observations}}{\text{Number of Observations}}$$

Weighted Average:

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

Rule of Alligation: For mixing quantity Q_1 at cost C_1 with Q_2 at cost C_2 to form mean price M :

$$\frac{Q_1}{Q_2} = \frac{C_2 - M}{M - C_1}$$

6. Simple Compound Interest

Simple Interest (SI):

$$SI = \frac{P \times R \times T}{100}, \quad \text{Amount } A = P + SI$$

Compound Interest (CI):

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

Half-Yearly / Quarterly Compounding:

$$\text{Rate } r' = \frac{R}{k}, \quad \text{Time } n' = n \times k$$

(where $k = 2$ for half-yearly, 4 for quarterly).

Difference between CI and SI (for 2 years):

$$CI - SI = \frac{PR^2}{100^2}$$

7. Time, Speed Distance

Fundamental Relations:

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

$$\text{Speed Conversion: } 1 \text{ m/s} = \frac{18}{5} \text{ km/h}$$

Average Speed (equal distances):

$$\text{Avg Speed} = \frac{2xy}{x+y}$$

Relative Speed:

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

Boats and Streams: Let downstream speed = u ,
upstream speed = v .

$$\text{Speed of boat in still water} = \frac{u+v}{2}$$

$$\text{Speed of stream} = \frac{u-v}{2}$$

8. Time and Work

Basic Efficiency Concept:

$$\text{Work} = \text{Efficiency} \times \text{Time}$$

If A finishes work in x days, 1 day's work = $\frac{1}{x}$.

Combined Work: If A and B take x and y days respectively:

$$\text{Time Taken Together} = \frac{xy}{x+y}$$

Pipes and Cisterns: Inlet pipe = positive work (+), Outlet leak = negative work (-).