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ARITHMETIC ULTRA CHEAT SHEET

Comprehensive Reference for Quick Revision & Problem Solving

1. Number Systems & Classifications

- **Natural Numbers ($\mathbb{N}$):** $\{1, 2, 3, 4, \dots\}$
- **Whole Numbers ($\mathbb{W}$):** $\{0, 1, 2, 3, \dots\}$
- **Integers ($\mathbb{Z}$):** $\{\dots, -2, -1, 0, 1, 2, \dots\}$
- **Rational ($\mathbb{Q}$):** Can be expressed as $\frac{p}{q}$ ($q \neq 0$, $p, q \in \mathbb{Z}$).
- **Irrational ($\mathbb{I}$):** Non-repeating, non-terminating decimals (e.g., $\sqrt{2}, \pi, e$).
- **Real Numbers ($\mathbb{R}$):** $\mathbb{Q} \cup \mathbb{I}$
- **Prime Numbers:** Integers > 1 with only two factors: 1 and itself. *Smallest prime:* 2.
- **Composite Numbers:** Integers > 1 with more than two factors.

3. Quick Divisibility Rules

- 2** Last digit is even (0, 2, 4, 6, 8).
- 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.
- 6** Divisible by both 2 and 3.
- 8** Last three digits divisible by 8.
- 9** Sum of digits is divisible by 9.
- 11** Difference between sum of odd position digits and sum of even position digits is a multiple of 11 or 0.

4. HCF (GCD) & LCM

- **Product Relation:**
 $\text{HCF}(a, b) \times \text{LCM}(a, b) = a \times b$
- **HCF of Fractions:** $\frac{\text{HCF of Numerators}}{\text{LCM of Denominators}}$
- **LCM of Fractions:** $\frac{\text{LCM of Numerators}}{\text{HCF of Denominators}}$

2. Operational Laws & Order

PEMDAS / BODMAS Hierarchy:

1. Parentheses / Brackets $[(), \{ \}, []]$
2. Exponents / Orders $x^a, \sqrt{x}$
3. Multiplication & Division (Left to Right)
4. Addition & Subtraction (Left to Right)

Algebraic Laws of Arithmetic:

- **Commutative:** $a + b = b + a$ — $a \times b = b \times a$
- **Associative:** $(a + b) + c = a + (b + c)$
- **Distributive:** $a(b + c) = ab + ac$
- **Identity:** $a + 0 = a$ — $a \times 1 = a$

5. Percentages

- **Percentage Conversion:** $P\% = \frac{P}{100}$
- **% Increase/Decrease:** $\frac{\text{Change}}{\text{Original Value}} \times 100\%$
- **Profit (P) = $SP - CP$ — Loss (L) = $CP - SP$**
- **Profit %:** $(\frac{P}{CP}) \times 100$
- **Selling Price:** $SP = (\frac{100 + P\%}{100}) \times CP$
- **Discount:** $\text{Marked Price}(MP) - SP$
- **Discount %:** $(\frac{\text{Discount}}{MP}) \times 100$

6. Ratios

- **Ratio:** $a : b = \frac{a}{b}$
- **Proportion:** $a : b :: c : d \implies a \cdot d = b \cdot c$
- **Average (Arithmetic Mean):**
$$\bar{x} = \frac{\sum x_i}{n} = \frac{\text{Sum of Observations}}{\text{Total Number of Observations}}$$
- **Weighted Average:** $\bar{x}_w = \frac{w_1 x_1 + w_2 x_2 + \dots + w_k x_k}{w_1 + w_2 + \dots + w_k}$
- **Rule of Alligation:**
$$\frac{\text{Cheaper Quantity}}{\text{Dearer Quantity}} = \frac{d-m}{m-c} \quad (\text{where } d=\text{dearer price, } c=\text{cheaper, } m=\text{mean})$$

7. Exponents & Radicals

$$\begin{aligned} x^a \cdot x^b &= x^{a+b} & \frac{x^a}{x^b} &= x^{a-b} \\ (x^a)^b &= x^{a \cdot b} & (xy)^a &= x^a y^a \\ x^{-a} &= \frac{1}{x^a} & x^0 &= 1 \quad (x \neq 0) \\ \sqrt[n]{x} &= x^{1/n} & \sqrt[n]{xy} &= \sqrt[n]{x} \cdot \sqrt[n]{y} \end{aligned}$$

8. Simple & Compound Interest

- **Simple Interest (SI):**

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

Where P = Principal, R = Annual Rate, T = Time in years.

- **Compound Interest (CI):**

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

$$CI = A - P$$

Where n = number of compounding periods per year.

9. Speed

- **Speed Formula:** $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$
- **Unit Conversion:** $1 \text{ km/h} = \frac{5}{18} \text{ m/s}$ —
 $1 \text{ m/s} = \frac{18}{5} \text{ km/h}$
- **Average Speed:** $\frac{\text{Total Distance}}{\text{Total Time}}$
- **Equal Distance Average Speed:** $\frac{2xy}{x+y}$ (for speeds x, y)
- **Time & Work:** If A completes work in n days,
 A 's 1-day work = $\frac{1}{n}$.