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ARITHMETIC CHEAT SHEET

1. Number Systems & Properties

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

Core Properties:

- Commutative: $a + b = b + a$ | $a \cdot b = b \cdot a$
- Associative: $(a + b) + c = a + (b + c)$
- Distributive: $a(b + c) = ab + ac$

4. Exponents & Radicals

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

2. PEMDAS / BODMAS Order of Operations

1. **P/B:** Parentheses / Brackets
2. **E/O:** Exponents / Orders (Powers, Roots)
3. **MD:** Multiplication & Division (Left to Right)
4. **AS:** Addition & Subtraction (Left to Right)

3. Fractions

Fraction Arithmetic:

- **Addition/Sub:** $\frac{a}{b} \pm \frac{c}{d} = \frac{ad \pm bc}{bd}$
- **Multiplication:** $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$
- **Division:** $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$

Percentage Conversion:

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

$$\text{Percentage Change} = \left(\frac{\text{New} - \text{Old}}{\text{Old}} \right) \times 100\%$$

5. 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.
- **9:** Sum of digits is divisible by 9.
- **10:** Last digit is 0.

6. GCD (HCF) & LCM

- **GCD (HCF):** Greatest Common Divisor.
- **LCM:** Least Common Multiple.
- **Key Identity for numbers a, b :**

$$\text{GCD}(a, b) \times \text{LCM}(a, b) = a \times b$$

- **For Fractions:**

$$\text{GCD}\left(\frac{a}{b}, \frac{c}{d}\right) = \frac{\text{GCD}(a, c)}{\text{LCM}(b, d)}$$

$$\text{LCM}\left(\frac{a}{b}, \frac{c}{d}\right) = \frac{\text{LCM}(a, c)}{\text{GCD}(b, d)}$$

7. Ratio

- **Ratio:** $a : b = \frac{a}{b}$
- **Proportion:** $a : b = c : d \implies a \cdot d = b \cdot c$
- **Direct Variation:** $y = kx \implies \frac{y_1}{x_1} = \frac{y_2}{x_2}$
- **Inverse Variation:** $y = \frac{k}{x} \implies x_1 y_1 = x_2 y_2$

8. Commercial Arithmetic**Profit & Loss:**

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

Interest:

- **Simple Interest (SI):** $SI = \frac{P \times R \times T}{100}$
- **Compound Interest (CI):** $A = P\left(1 + \frac{R}{100}\right)^T$
- $CI = A - P$

9. Averages**Average / Mean:**

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

Speed, Distance & Time:

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

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

Work & Time:

$$\text{Work Done} = \text{Rate} \times \text{Time}$$

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