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1. Number Sets & Properties

Number Sets:

- **Natural ($\mathbb{N}$):** $\{1, 2, 3, 4, \dots\}$
- **Whole ($\mathbb{W}$):** $\{0, 1, 2, 3, \dots\}$
- **Integers ($\mathbb{Z}$):** $\{\dots, -2, -1, 0, 1, 2, \dots\}$
- **Rationals ($\mathbb{Q}$):** $\{\frac{a}{b} \mid a, b \in \mathbb{Z}, b \neq 0\}$
- **Reals ($\mathbb{R}$):** Rationals + Irrationals

Basic Properties (for all $a, b, c \in \mathbb{R}$):

- **Commutative:** $a+b = b+a \mid ab = ba$
- **Associative:** $(a+b) + c = a + (b+c)$
- **Distributive:** $a(b+c) = ab + ac$
- **Identity:** $a+0 = a \mid a \cdot 1 = a$
- **Inverse:** $a+(-a) = 0 \mid a \cdot \frac{1}{a} = 1 (a \neq 0)$

2. Order of Operations & Fractions

PEMDAS / BODMAS Rule:

1. Parentheses / Brackets
2. Exponents / Orders
3. Multiplication & Division (Left to Right)
4. Addition & Subtraction (Left to Right)

Fraction Rules:

- **Addition:** $\frac{a}{b} \pm \frac{c}{d} = \frac{ad \pm bc}{bd}$
- **Multiplication:** $\frac{a}{b} \cdot \frac{c}{d} = \frac{ac}{bd}$
- **Division:** $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \cdot \frac{d}{c} = \frac{ad}{bc}$
- **Simplification:** $\frac{ka}{kb} = \frac{a}{b} \quad (k \neq 0)$

3. Exponents & Radicals

Laws of Exponents:

$$\begin{aligned} a^m \cdot a^n &= a^{m+n} & (a^m)^n &= a^{mn} \\ \frac{a^m}{a^n} &= a^{m-n} & (ab)^n &= a^n b^n \\ a^0 &= 1 (a \neq 0) & a^{-n} &= \frac{1}{a^n} \end{aligned}$$

Radical Rules:

$$\begin{aligned} a^{m/n} &= \sqrt[n]{a^m} = (\sqrt[n]{a})^m \\ \sqrt{ab} &= \sqrt{a} \cdot \sqrt{b} \mid \sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}} \end{aligned}$$

4. Percentages

Percentages:

- $P\%$ of $X = X \times \frac{P}{100}$
- **% Change:** $\frac{\text{New}-\text{Old}}{\text{Old}} \times 100\%$
- **Profit %:** $\frac{\text{Profit}}{\text{Cost Price}} \times 100$

Ratios & Proportions:

- Ratio $a : b$ is equivalent to fraction $\frac{a}{b}$.
- If $\frac{a}{b} = \frac{c}{d}$, then $ad = bc$ (Cross-multiplication).
- **Direct Variation:** $y = kx$
- **Inverse Variation:** $y = \frac{k}{x}$

5. Divisibility & Prime Properties

Divisibility Rules:

- **2:** Ends in 0, 2, 4, 6, 8.
- **3:** Sum of digits divisible by 3.
- **4:** Last 2 digits divisible by 4.
- **5:** Ends in 0 or 5.
- **6:** Divisible by both 2 and 3.
- **9:** Sum of digits divisible by 9.

GCD & LCM:

- $\text{GCD}(a, b) \times \text{LCM}(a, b) = a \times b$
- **Primes:** 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, ...

6. Simple & Compound Interest

Simple Interest (SI):

$$SI = \frac{P \cdot r \cdot t}{100}$$

Total Amount (Simple): $A = P + SI = P(1 + \frac{rt}{100})$

Compound Interest (CI):

$$A = P(1 + \frac{r}{n})^{nt}$$

- P = Principal Amount
- r = Annual Interest Rate (decimal)
- n = Compounding frequency per year
- t = Time in years

7. Visual Representation: Number Hierarchy

