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Arithmetic Cheat Sheet

Fundamental Operations, Properties, and Number Theory

1. Number Systems

Natural Numbers ($\mathbb{N}$): $\{1, 2, 3, \dots\}$

Whole Numbers ($\mathbb{W}$): $\{0, 1, 2, 3, \dots\}$

Integers ($\mathbb{Z}$): $\{\dots, -2, -1, 0, 1, 2, \dots\}$

Rational Numbers ($\mathbb{Q}$): Numbers of the form $\frac{p}{q}$ where $p, q \in \mathbb{Z}$ and $q \neq 0$.

Irrational Numbers: Numbers that cannot be expressed as a simple fraction (e.g., $\pi, e, \sqrt{2}$).

2. Fundamental Properties

Let a, b, c be real numbers:

- **Commutative:**

$$a + b = b + a, \quad a \times b = b \times a$$

- **Associative:**

$$(a + b) + c = a + (b + c)$$

$$(a \times b) \times c = a \times (b \times c)$$

- **Distributive:**

$$a(b + c) = ab + ac$$

3. Fractions and Decimals

Addition/Subtraction:

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

Multiplication:

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

Division:

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$$

4. 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.
- **9:** Sum of digits is divisible by 9.
- **10:** Last digit is 0.

5. LCM and GCD (HCF)

For any two positive integers a and b :

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

Methods for GCD/LCM:

- Prime Factorization
- Euclidean Algorithm for GCD

6. Percentages, Ratios, Proportions

Percentage Formula:

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

Percentage Increase/Decrease:

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

Ratio and Proportion:

$$\text{If } \frac{a}{b} = \frac{c}{d}, \text{ then } ad = bc$$

7. Exponents and Radicals

$$a^m \cdot a^n = a^{m+n}$$

$$\frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ab)^n = a^n b^n$$

$$a^{-n} = \frac{1}{a^n}$$

$$a^{1/n} = \sqrt[n]{a}$$

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