

Number Systems

Comprehensive Cheat Sheet

1. Set of Numbers

Natural Numbers ($\mathbb{N}$): The counting numbers.

$$\mathbb{N} = \{1, 2, 3, 4, \dots\}$$

Whole Numbers ($\mathbb{W}$): Natural numbers plus zero.

$$\mathbb{W} = \{0, 1, 2, 3, \dots\}$$

Integers ($\mathbb{Z}$): Whole numbers and their negatives.

$$\mathbb{Z} = \{\dots, -2, -1, 0, 1, 2, \dots\}$$

Rational Numbers ($\mathbb{Q}$): Expressible as a fraction p/q , where $p, q \in \mathbb{Z}$ and $q \neq 0$. Terminating or repeating decimals.

Examples: $1/2, -5, 0.\bar{3}$

Irrational Numbers ($\mathbb{I}$ or $\mathbb{Q}'$): Cannot be expressed as a simple fraction. Non-terminating and non-repeating decimals.

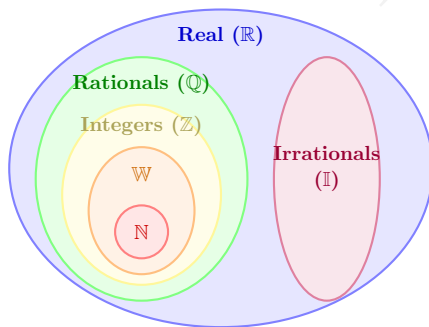
Examples: $\sqrt{2}, \pi, e$

Real Numbers ($\mathbb{R}$): The continuous union of rational and irrational numbers.

Complex Numbers ($\mathbb{C}$): Formatted as $z = a + bi$, where $a, b \in \mathbb{R}$ and $i = \sqrt{-1}$.

- Real part: $\text{Re}(z) = a$
- Imaginary part: $\text{Im}(z) = b$

2. Number Set Hierarchy



Subset Chain: $\mathbb{N} \subset \mathbb{W} \subset \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R} \subset \mathbb{C}$

3. Base Systems

System	Base	Symbols	Example
Binary	2	0, 1	1010_2
Octal	8	0 – 7	12_8
Decimal	10	0 – 9	10_{10}
Hex	16	0 – 9, A – F	A_{16}

4. Fundamental Properties

For any real numbers $a, b, c \in \mathbb{R}$:

• **Commutative Law:**

$$a + b = b + a$$

$$a \cdot b = b \cdot a$$

• **Associative Law:**

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

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

• **Distributive Law:**

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

• **Identities:** Additive (0), Multiplicative (1).

• **Inverses:** Additive ($-a$), Multiplicative ($1/a$, for $a \neq 0$).

5. Euler's Identity

A profound equation connecting five fundamental constants:

$$e^{i\pi} + 1 = 0$$

Features e (irrational), i (imaginary), π (irrational), 1 (natural), and 0 (whole).