

Class 9 Mathematics – Chapter 1: Number Systems

Number Systems

Introduction

Numbers are used in everyday life for counting, measuring, comparing, and solving mathematical problems. In this chapter, we study different types of numbers, their properties, decimal expansions, and how they are represented on the number line.

Natural, Whole Numbers and Integers

Natural Numbers

Natural numbers are the counting numbers.

Examples: 1, 2, 3, 4, ...

- Smallest natural number is **1**.
- Zero is not a natural number.

Whole Numbers

Whole numbers include all natural numbers along with **0**.

Examples: 0, 1, 2, 3, 4, ...

- Smallest whole number is **0**.

Integers

Integers include positive numbers, negative numbers, and zero.

Examples: ..., -3, -2, -1, 0, 1, 2, 3, ...

Integers are represented on both sides of zero on the number line.

Rational Numbers

Definition

A rational number is any number that can be written in the form $\frac{p}{q}$, where $q \neq 0$ and both p and q are integers.

Examples:

- $\frac{3}{5}$
- $-\frac{7}{4}$
- 2 ($2 = \frac{2}{1}$)
- 0 ($0 = \frac{0}{1}$)

Decimal Expansion

A rational number always has either:

- A **terminating decimal** (e.g., $\frac{1}{4} = 0.25$)
- A **non-terminating recurring decimal** (e.g., $\frac{1}{3} = 0.333\dots$)

Irrational Numbers

Definition

Numbers that cannot be written in the form $\frac{p}{q}$ are called irrational numbers.

Their decimal expansions are **non-terminating** and **non-recurring**.

Examples:

- $\sqrt{2}$
- $\sqrt{3}$
- $\sqrt{5}$
- π (Pi)

Real Numbers

Definition

All rational and irrational numbers together form the set of **real numbers**.

Every point on the number line represents a real number.

Representing Real Numbers on the Number Line

Construction

Real numbers can be represented on the number line. Rational numbers are easy to locate, while irrational numbers such as $\sqrt{2}$ can be represented using simple geometrical constructions.

Laws of Exponents

For any non-zero number **a**:

- $a^m \times a^n = a^{m+n}$
- $a^m \div a^n = a^{m-n}$
- $(a^m)^n = a^{mn}$
- $(ab)^m = a^m \times b^m$
- $(a/b)^m = a^m/b^m$
- $a^0 = 1$
- $a^{-n} = 1/a^n$

These laws simplify calculations involving powers and exponents.

Key Points

- Natural numbers start from **1**.
- Whole numbers start from **0**.
- Integers include positive numbers, negative numbers, and zero.
- Rational numbers can be written as **p/q**.
- Irrational numbers cannot be written as **p/q**.
- Rational numbers have terminating or recurring decimal expansions.
- Irrational numbers have non-terminating, non-recurring decimal expansions.
- Real numbers include both rational and irrational numbers.

Chapter Summary

In this chapter, we learned about different types of numbers and their properties. We understood the difference between rational and irrational numbers, studied decimal expansions, represented real numbers on the number line, and learned the laws of exponents. These concepts form the foundation for many advanced topics in mathematics.