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Rational and Irrational Numbers

IGCSE Mathematics

The Panda Math Tutor

Prepared by

Nikolas Agisilaou

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1 Introduction

Note

Rational and irrational numbers are fundamental concepts in IGCSE Mathematics. Together, they make up the entire set of **real numbers** — every point on the number line is either rational or irrational. Understanding the difference between these two types of numbers is essential for working with surds, decimals, fractions, and many algebraic topics.

In this chapter, we will explore:

- The number system and how different types of numbers relate to each other
- The definition and properties of rational numbers
- The definition and properties of irrational numbers
- How to identify whether a number is rational or irrational
- Converting between fractions and decimals (including recurring decimals)
- Operations with rational and irrational numbers and their closure properties

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2 The Number System

Definition

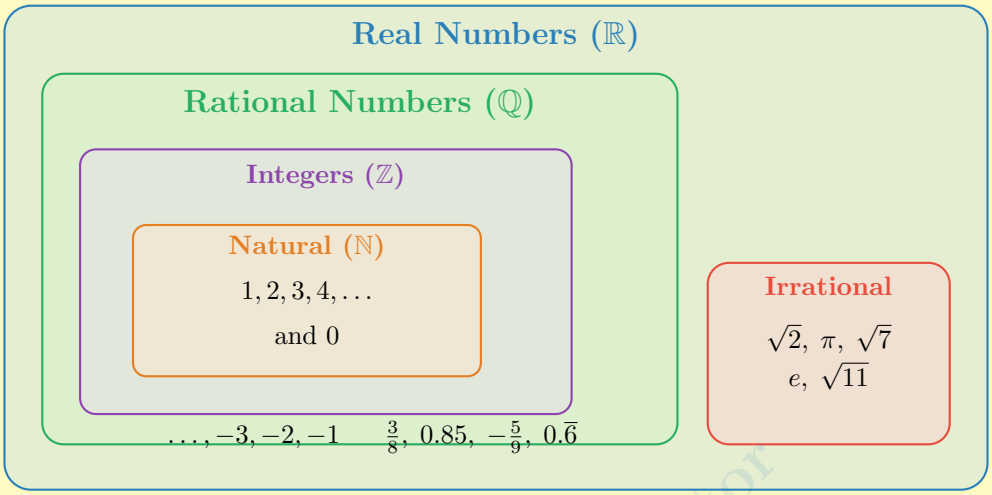
The **real numbers** ($\mathbb{R}$) consist of every number that can be placed on the number line. The real numbers are divided into two categories:

- **Rational numbers** ($\mathbb{Q}$) — numbers that can be written as fractions
- **Irrational numbers** — numbers that **cannot** be written as fractions

Every real number is either rational or irrational — there is no overlap and no gap between them.

Note

The number system hierarchy:



Each set is contained within the next larger set: $\mathbb{N} \subset \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R}$.

Definition

The main number sets you need to know are:

- **Natural numbers** ($\mathbb{N}$): The counting numbers $0, 1, 2, 3, 4, \ldots$ (some definitions start at 1)
- **Integers** ($\mathbb{Z}$): All whole numbers, including negatives: $\ldots, -3, -2, -1, 0, 1, 2, 3, \ldots$
- **Rational numbers** ($\mathbb{Q}$): All numbers that can be written as $\frac{p}{q}$ where p and q are integers and $q \neq 0$
- **Irrational numbers**: Numbers that cannot be written as $\frac{p}{q}$ for any integers p and q
- **Real numbers** ($\mathbb{R}$): All rational and irrational numbers combined

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