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RATIONAL NUMBERS: PROPERTIES, APPLICATIONS, AND IMPORTANCE IN MATHEMATICS

Husenova Dilora

Teacher of mathematics at the Academic Lyceum "International Business" of the Tashkent State University of Economics

Abstract. Rational numbers play a fundamental role in mathematics as they form the bridge between whole numbers and real numbers. They are defined as numbers that can be expressed as the quotient of two integers, where the denominator is not zero. This article explores the definition, history, properties, classification, and applications of rational numbers, while also examining their role in everyday life and mathematical problem-solving. The importance of rational numbers lies not only in theoretical mathematics but also in their practical applications, ranging from financial calculations to scientific measurements. This paper also provides an overview of the relationship between rational and irrational numbers, emphasizing their collective role in forming the set of real numbers.

Keywords. Rational numbers, integers, fractions, mathematics, real numbers, number theory.

Rational numbers are a central concept in mathematics, providing the basis for many essential calculations and applications. They are defined as numbers that can be expressed in the form p/q, where p and q are integers and $q \neq 0$. This definition includes both positive and negative fractions, whole numbers, and terminating or repeating decimals. The term 'rational' derives from 'ratio,' reflecting their foundation in the concept of proportion and comparison.

A rational number is any number that can be written as a fraction p/q, where p and q are integers and $q \neq 0$. For example, 3/4, -5/2, and 7 are all rational numbers. Whole numbers and integers are subsets of rational numbers since they can be expressed with denominator 1 (e.g., 7 = 7/1). Decimals that terminate (0.25 = 25/100) or repeat (0.333… = 1/3) are also rational.

The concept of rational numbers has been present since ancient mathematics. The Greeks, particularly the Pythagoreans, were among the first to study ratios and fractions. They believed that all numbers could be expressed as ratios of whole numbers. However, the discovery of irrational numbers such as √2 challenged this belief, leading to deeper developments in number theory. Despite this, rational numbers remained crucial in arithmetic and algebra.

Rational numbers share several properties that make them significant in mathematics:

1. Closure: The set of rational numbers is closed under addition, subtraction, multiplication, and division (except division by zero).
2. Commutativity: Addition and multiplication of rational numbers are commutative.
3. Associativity: Addition and multiplication are associative.
4. Distributivity: Multiplication distributes over addition.
5. Identity elements: 0 is the additive identity, and 1 is the multiplicative identity.
6. Inverses: Every rational number has an additive inverse, and every non-zero rational number has a multiplicative inverse.

Rational numbers can be classified into several categories:

- Positive rational numbers: Numbers greater than zero (e.g., 2/3, 5).
- Negative rational numbers: Numbers less than zero (e.g., -4/7, -2).
- Proper fractions: Numerator is less than the denominator (e.g., 3/8).
- Improper fractions: Numerator is greater than or equal to the denominator (e.g., 7/4).
- Mixed numbers: Combination of a whole number and a fraction (e.g., 2 1/3).

Rational vs Irrational Numbers

Rational numbers differ from irrational numbers in that they can always be expressed as fractions of integers, while irrational numbers cannot. Examples of irrational numbers include π, e, and √2. Together, rational and irrational numbers form

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the set of real numbers, which are essential in representing quantities on the number line.

Rational numbers are widely applied in daily life and academic fields:
- In finance, they are used for interest rates, ratios, and percentages.
- In science, rational numbers appear in measurements, experiments, and formulas.
- In technology, they are applied in computer algorithms and data representation.
- In education, rational numbers form the basis of fractions and decimal learning in primary and secondary schools.

Rational numbers are significant because they provide a systematic way of representing and manipulating quantities. They serve as a bridge between integers and real numbers, allowing precise representation of values that are not whole. Moreover, rational numbers play a foundational role in algebra, geometry, trigonometry, and calculus.

Rational numbers form a crucial component of mathematics, combining the simplicity of integers with the flexibility of fractions. Their historical significance, well-defined properties, and wide-ranging applications make them one of the most important subsets of real numbers. Understanding rational numbers is not only essential for theoretical mathematics but also for solving practical problems in daily life. Together with irrational numbers, they complete the structure of real numbers, ensuring that every point on the number line is represented.

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