


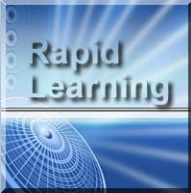
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 **The Real Number System**

Rapid Learning Mathematics Series

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Learning Objectives

By completing this tutorial you will learn how to:



- Recognize the subsets of the real number system.
- Use the rules of real numbers to add, subtract, multiply, and divide real numbers.
- Use order of operations to evaluate math expressions.

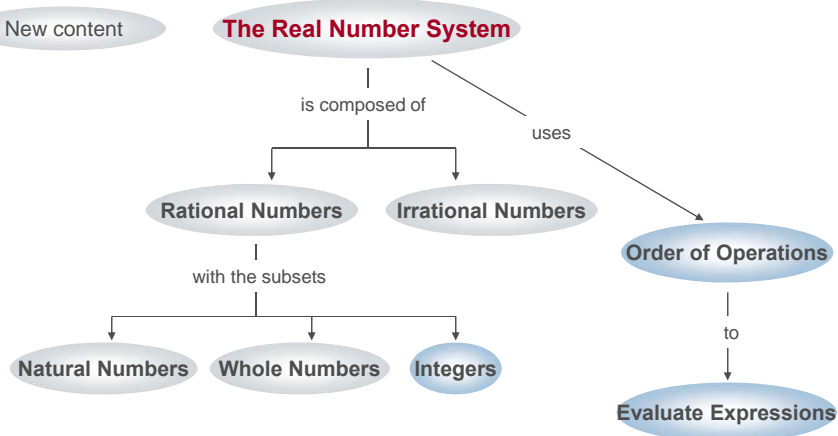
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Concept Map

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Subsets of Real Numbers



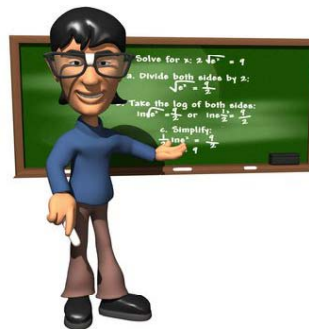
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Subsets of Real Numbers - Outline

By completing this section you will be able to:

- Determine if a given number is irrational or rational.
- Categorize rational numbers into subsets.



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Definition: Real Number

Real Number – A number that is either rational or irrational.

Example: any common number from $-\infty$ to ∞ is a ***real number***.

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Definition: Irrational Number

Irrational Number - A number that cannot be written as the ratio of two integers.

Example: π is an ***irrational number***.

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Example: Irrational Number

The decimal approximation of an irrational number does not terminate or repeat. Examples are shown in the table.

Exact Value	Approximation
π	3.14159 26535 89793...
$\sqrt{2}$	1.41421 35623 73095...
$\sqrt{123}$	11.09053 65064 09417...

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Definition: Rational Number

Rational Number - A number that can be written as the ratio of two integers, a and b , where b cannot be zero.

Example: $\frac{1}{2}$ is a *rational number*.

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Example: Rational Number

The decimal equivalent of a rational number will terminate or repeat.

Terminating		Repeating	
Fraction	Decimal	Fraction	Decimal
$\frac{1}{2}$	0.5	$\frac{1}{3}$	$0.\overline{3}$
$\frac{3}{8}$	0.375	$\frac{2}{7}$	$0.\overline{285714}$
$\frac{2}{5}$	0.4	$\frac{5}{6}$	$0.8\overline{3}$

Note: A line over decimal digits indicates those digits repeat infinitely.

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Subsets of Rational Numbers

There are three important subsets of rational numbers:

Subset	Description
Natural Numbers	$\{1, 2, 3, \dots\}$ The numbers used for counting and ordering.
Whole Numbers	$\{0, 1, 2, 3, \dots\}$ Formed by adding 0 to the set of natural numbers.
Integers	$\{\dots-3, -2, -1, 0, 1, 2, 3, \dots\}$ Formed by adding the negatives of the naturals to the set of whole numbers.

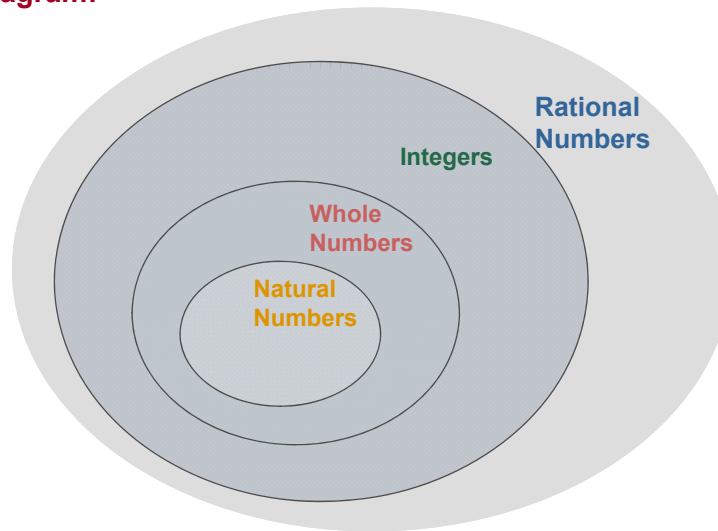
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Venn Diagram: Rational Numbers

The subsets of rational numbers are shown in the diagram:



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Note: Integers as Rational Numbers

An integer can be written as a ratio by **putting it over 1** in a fraction.

Example: $3 = \frac{3}{1}$

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Stop-and-think: Subsets

-7 is an element of which of the following sets?

- Real numbers
- Irrational numbers
- Whole numbers
- Integers

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Rules for Real Numbers



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Rules for Real Numbers - Outline

In this section you will gain knowledge of:

- The double negative rule.
- Rules for adding and subtracting real numbers.
- Rules for multiplying and dividing real numbers.



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Double Negative Rule

Double Negative Rule:

For any real number x ,

$$-(-x) = x$$

Examples:

1. $-(-5) = 5$

2. $7 - (-3) = 7 + 3 = 10$

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Addition Rule: Like Signs

Like Signs

When adding numbers with like signs, add the absolute values of the numbers and keep the sign.

Examples:

$$1. 8 + 5 = 13$$

$$2. -8 - 5 = -8 + -5 = -13$$

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Addition Rule: Unlike Signs

Unlike Signs

When adding numbers with unlike signs, subtract the smaller absolute value from the larger absolute value. Keep the sign of the number with the larger absolute value.


Examples:

$$1. 9 + (-7) = 9 - 7 = 2$$

$$2. 1 + (-4) = -(4 - 1) = -3$$

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 **Note: Adding a Negative Number**

Adding a negative number is the same as subtracting that number.

Example:

$$6 + (-2) = 6 - 2$$

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 **Multiplication Rules**

Multiplication Rules

- negative (negative) = positive
- positive (positive) = positive
- negative (positive) = negative

Examples:

1. $-2(-3) = 6$
2. $2(3) = 6$
3. $-2(3) = -6$

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Division Rules

Division Rules

- negative \div negative = positive
- positive \div positive = positive
- negative \div positive = negative

Examples:

1. $-8 \div -2 = 4$
2. $8 \div 2 = 4$
3. $-8 \div 2 = -4$

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Note: Commutative Property

Addition and multiplication are **commutative**: the value of an expression does not change when the terms are reordered.

Examples:

1. $8 + 1 = 1 + 8 = 9$
2. $3(4) = 4(3) = 12$

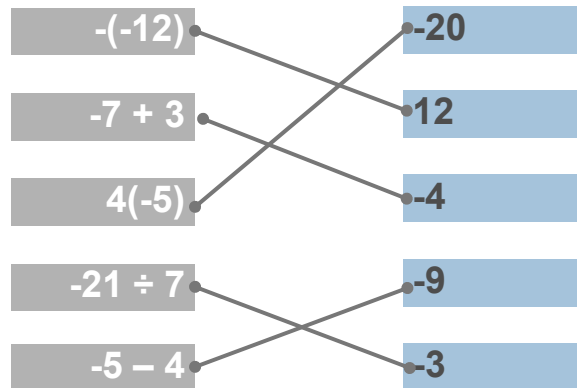
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Stop-and-think: Sign Rules

Match each expression to the left with its evaluated form to the right.



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Evaluating Number Expressions



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Evaluating Number Expressions - Outline

In this section you will learn:

- Order of operations (PEMDAS).
- How to use PEMDAS to evaluate mathematical expressions.



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PEMDAS: Order of Operations

Parentheses
Exponents
Multiplication
Division
Addition
Subtraction




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 **PEMDAS and Aunt Sally**

Memory Tip for **PEMDAS**

Please **E**xcuse **M**y
Dear **A**unt **S**ally.




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 **Note: PEMDAS**

When using PEMDAS to evaluate math expressions, perform multiplication and division from **left to right**.

Also, perform addition and subtraction from **left to right**.

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Example: PEMDAS

Evaluate: $5(8 - 12)^2 + 1$

Solution:

$$\begin{aligned}
 5(8 - 12)^2 + 1 &= 5(-4)^2 + 1 \\
 &= 5(-4)(-4) + 1 \\
 &= 5(16) + 1 \\
 &= 80 + 1 \\
 &= \mathbf{81}
 \end{aligned}$$



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Stop-and-think: PEMDAS

Using PEMDAS, what is the first step in evaluating $4(7 + 3) \div 5 - 2$?

- Subtract 2 from 5
- Divide 3 by 5
- Add 7 and 3
- Multiply 4 and 3

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Learning Summary


The product or quotient of two numbers with like signs is **positive**.

Addition and multiplication are **commutative**.

Perform multiplication and division (addition and subtraction) from **left to right**.

Two consecutive negative signs create a positive.
 $-(-x) = x$

The product or quotient of two numbers with unlike signs is **negative**.


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Congratulations

You have successfully completed
the core tutorial

The Real Number System

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What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)
→ Step 2: Practice – Interactive Problem Drill
Step 3: Recap – Super Review Cheat Sheet

Go for it!



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