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5 Understanding Rational and Irrational Numbers



Introduction

A **rational number** is any number that can be written as a fraction of two integers. All whole numbers, integers, fractions, improper fractions, and mixed numbers are rational numbers. The following numbers are rational.

$$\frac{1}{3} \quad 0.25 = \frac{1}{4} \quad 2\frac{1}{5} = \frac{11}{5} \quad 0 = \frac{0}{1}$$

Every rational number can be written as a decimal that terminates or repeats. A **terminating decimal** is a decimal number with digits that end. A **repeating decimal** is a decimal number with digits that repeat in a pattern. To convert a fraction to a decimal, divide the numerator by the denominator.

$$\frac{2}{5} = 0.4$$

Terminating

$$\frac{1}{3} = 0.333\dots = 0.\overline{3}$$

Repeating

A decimal is rational if it either terminates or repeats. So, both $\frac{2}{5}$ and $\frac{1}{3}$ are rational.

You can write a repeating decimal as a fraction.

Write 0.454545... as a fraction.

Let $n = 0.454545\dots$. Raise 10 to the number of repeating decimal places: 10^2 or 100.

Multiply the decimal (n) by the power of 10.

$$100n = 45.454545\dots$$

Write an equation that relates the difference between $100n$ and n and the decimals they represent.

$$100n - n = 45.454545\dots - 0.454545\dots$$

Combine like terms and solve for n :

$$99n = 45$$

$$n = \frac{45}{99} = \frac{5}{11}$$

Whole numbers:

0, 1, 2, 3, ...

Integers:

..., -3, -2, -1, 0, 1, 2, 3, ...

An ellipsis (...) indicates that a number continues. A bar above a digit or digits show that they repeat.

Write a terminating decimal as a fraction by using the value of the decimal places. Write the decimal part as the numerator over a denominator of 10 raised to the number of decimal places. Then simplify.

$$0.75 = \frac{75}{10^2} = \frac{75}{100} = \frac{3}{4}$$

An **irrational number** is any number that cannot be written as either a terminating or a repeating decimal. The square roots of perfect squares are rational numbers, and all other square roots are irrational numbers.

Real numbers include the set of rational numbers and the set of irrational numbers.

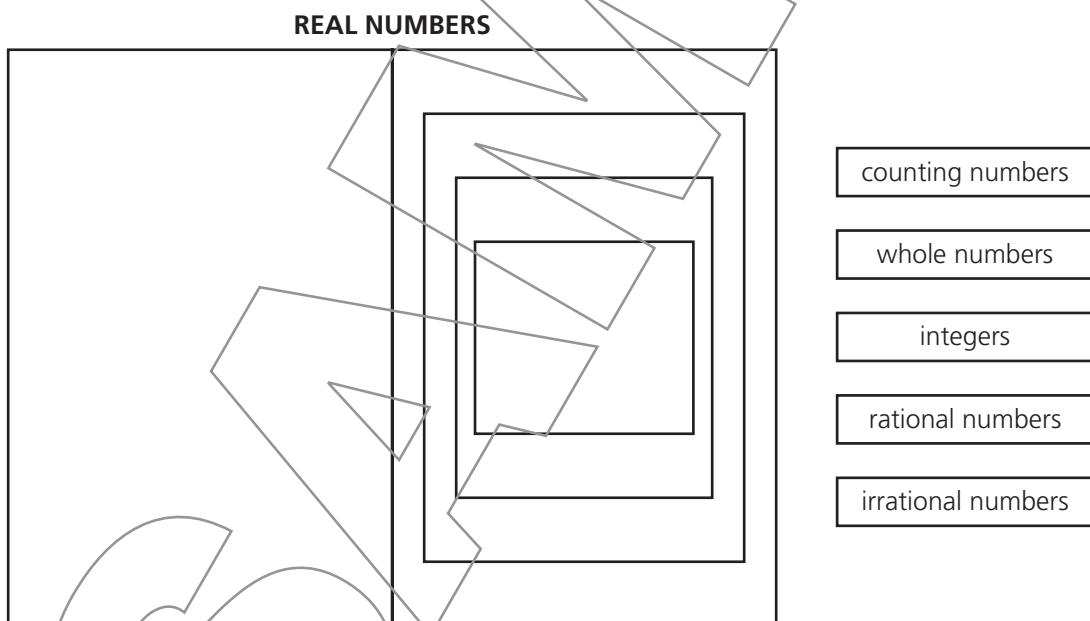
Think About It

Which type of numbers do you think you will use the most in your everyday life?
When might you use irrational numbers?



Focused Instruction

A Venn diagram can help you organize categories. Look at the Venn diagram of real numbers. Work with a partner to complete the diagram by writing the labels below in the correct places.



Real numbers can be rational or irrational. Which group of numbers has additional subsets? _____

A subset is a smaller category that is part of a bigger category.

In the chart on page 45, label the section on the left with the set of real numbers that does not have subsets. Label the section on the right with the set of real numbers that does have subsets.

What is an integer? _____

What is a whole number? _____

What is a counting number? _____

Which of these sets of numbers includes the other two?

Whole numbers Integers Counting numbers

Add this label to the largest subset in the diagram.

Which of these sets of numbers includes the other one?

Counting numbers Whole numbers

Add this label to the next largest subset in the diagram. Add the other label to the smallest subset in the diagram.

To change a repeating decimal to a fraction, set up an equation and solve it. Look at the number of digits that repeat.

- Convert the repeating decimal $0.55555\dots$ to a fraction.

How many decimal places repeat?

Use the number of repeating decimal places as a power of 10. What is the power of 10? _____

Let n represent the decimal. What number is equal to $10n$? _____

Write an equation that relates the difference between $10n$ and n to the decimal numbers they represent.

Simplify each side of the equation by combining like terms.

Solve the equation for n . _____

This equation should eliminate the decimal places of the decimal after you combine like terms.

Can you simplify the fraction any further? _____

The repeating decimal $0.55555\dots$ is equal to the fraction _____.

You can check your answer with a calculator. Divide the numerator by the denominator.

Use what you know about rational and irrational numbers to find these fractions. Write your answers in lowest terms.

- 1 Convert the repeating decimal $0.444\dots$ to a fraction.

- 2 Convert 0.444 to a fraction.

SAMPLE

Solve the following problems.

- 1 Express $\frac{2}{7}$ as a decimal. Show your work.

The fraction bar also shows division. Divide the numerator by the denominator.

Answer _____

Does the decimal terminate or repeat?

Answer _____

- 2 Express $\frac{3}{8}$ as a decimal. Show your work.

Continue dividing until the decimal ends or the digits begin to repeat.

Answer _____

Does the decimal terminate or repeat?

Answer _____

- 3 Express 0.36 as a fraction in simplest form. Show your work.

Use what you know about place value to write the decimal as a fraction.

Answer _____

Solve the following problems.

- 1 Select the correct column to show whether each fraction can be expressed as a terminating or a repeating decimal.

Number	Terminating Decimal	Repeating Decimal
$\frac{4}{5}$		
$\frac{5}{16}$		
$\frac{7}{11}$		
$\frac{2}{15}$		
$\frac{62}{155}$		

- 2 Mark True or False for each statement.

	True	False
All integers are whole numbers.	<input type="checkbox"/>	<input type="checkbox"/>
All rational numbers are real numbers.	<input type="checkbox"/>	<input type="checkbox"/>
All decimals are rational numbers.	<input type="checkbox"/>	<input type="checkbox"/>
The number 0 is a rational number.	<input type="checkbox"/>	<input type="checkbox"/>

- 3 What fraction is the decimal $0.\overline{639}$ equivalent to in simplest terms?

Answer

4 Which of the following numbers are irrational? Select **all** that apply.

A $0.323232\dots$

B $\frac{3}{17}$

C $0.213568\dots$

D $0.030405\dots$

E 5.738

F $4\frac{8}{31}$

5 Which decimal is equivalent to $\frac{4}{7}$?

A $0.\overline{571248}$

B $0.\overline{574128}$

C $0.\overline{571482}$

D $0.\overline{571428}$

6 Select whether each number is rational or irrational.

Number	Rational	Irrational
$\frac{47}{88}$		
$32.01\overline{256}$		
$0.613842\dots$		
$58.12341234\dots$		
$451.37142\dots$		

7 Circle an option in the set to make the following statement true.

The number $0.\overline{56}$ is [greater than, equal to, less than] 0.56 .