Section 1 – 1: The Real Number System

We often look at a **set** as a collection of objects with a common connection. We use brackets like { } to show the set and we put the objects in the set inside the brackets { }. The actual objects in the set can be listed inside the brackets or they can be described with a written description.

Example 1

The set of the sons
in my family
{ Tom, John, David }

Example 2

The set of the ages
of the children in my family
{ 27, 24, 21, 19 }

Example 3

The set of the sites
for Folsom Lake College
{ FLC, EDC, RCC }

In this course we are interested in sets of numbers.

The set of Counting Numbers

Counting Numbers, sometimes called Natural Numbers, are the numbers used to count physical objects. **0 is not a counting number**. We do not start counting things until there is at least one object. The .... at the end of the list indicates that the list of numbers continues on and on with out end in the same pattern as the numbers listed before the ...

The set of Counting Numbers = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 .... }

The set of Whole Numbers

The set of **Whole Numbers** contains all of the counting numbers but also includes the number 0.

The set of Whole Numbers = { 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 .... }

Note: if a number reduces to a whole number then it is a whole number.

$\frac{6}{2}$ reduces to a 3 so it is a whole number

$\sqrt{25}$ reduces to a 5 so it is a whole number

The set of Integers

The set of **Integers contains the set of Counting Numbers, the negatives (or opposites) of the counting numbers and the number 0.**

The set of Integers contains $\{\ 1,\ 2,\ 3,\ 4,\ 5\ \ldots\ldots\ \}$ and $\{\ldots\ -5, -4, -3, -2, -1\ \}$ and $\{\ 0\ \}$

The set of Integers = $\{\ \ldots -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9\ \ldots\ \}$

The set of Counting Numbers are called the **Positive Integers** $\{\ 1,\ 2,\ 3,\ 4,\ 5\ \ldots\ldots\ \}$

The the negatives , or opposites of the counting numbers are called the **Negative Integers** $\{\ldots\ -5, -4, -3, -2, -1\ \}$

Zero is neither positive or negative

Positive numbers are defined as being greater than zero. Negative numbers are defined as being less than zero. **This means that the zero is neither positive or negative.**

Note: if a number reduces to an Integer then it is an integer.

$\frac{-12}{3}$ reduces to a –4 so it is an Integer

$\frac{-22}{-2}$ reduces to an 11 so it is an Integer

The set of Rational Numbers

The set of **Rational Numbers** is the set of **all numbers** of the form $\frac{a}{b}$ where a is any integer and b is any integer except 0.

Every rational number expressed as a fraction can also be expressed
as a decimal number whose digits end (terminate) or start to

The decimal form of a fraction can be found by **dividing the denominator into the numerator** until the division is complete or the digits in the answer begin to repeat.

Examples of Rational Numbers

$\frac{5}{2}$ or 2.5

$\frac{23}{4}$ or 5.75

$\frac{7}{3}$ or $2.33\overline{3}$

$\frac{5}{11}$ or $\overline{.45}$

$\frac{0}{5}$ or 0 or 0.0

$\frac{-6}{1}$ or -6 or -6.0

$\frac{10}{2}$ or 5 or 5.0

$-\sqrt{81} = -9 = -9.0$

$\sqrt{\frac{9}{4}} = \frac{3}{2} = 1.5$

Almost every number that you have worked with in past math courses has been a Rational Number.

Subsets

A **subset** is a set that contains some of the members of a set.

The set of Whole Numbers is a subset of the Rational Numbers

Every fraction of the form $\frac{a}{b}$ where a is any integer and b is any integer except 0 is a Rational Number. Every Whole Number fits this description also, so every Whole Number is a Rational Number. Not every Rational Number is a whole number. $\frac{3}{4}$ is a Rational Number but not a Whole Number. The set of Whole Numbers is a subset of the Rational Numbers but the set of Rational Numbers is not a subset of the Whole Numbers.

The set of Counting Numbers is a subset of the Rational Numbers and the Whole Numbers

The Chart below shows that the set of Counting Numbers is contained in the set of Whole Numbers and the set of Rational Number. The set of **Counting Numbers** is a **subset of the Whole Numbers AND a subset the set of the Rational Numbers.**

Note: The set of **Whole Numbers** is **NOT a subset of the Counting Numbers**

The Chart below shows that the set of Whole Numbers is contained in the set of Rational Numbers. The set of **Whole Numbers** is a **subset of the Rational Numbers.**

Rational Numbers: Fractions of the form $\frac{a}{b}$ where a is any integer and b is any integer except 0 or any decimal number that terminates or repeats

$-5.\overline{1}\ ,\ \frac{-8}{2}\ ,\ -3\ ,\ \frac{-2}{3}\ ,\ -.54\ ,\ 0\ ,\ \frac{1}{3}\ ,\ \frac{5}{4}\ ,\ \frac{6}{2}\ ,\ 3.82\ ,\ 4\ ,\ 4.212121.....$

Whole Numbers = $\{\ 0,\ 1,\ 2,\ 3,\ 4,\ 5,\ 6,\ 7,\ 8,\ 9,\ 10,\ 11,\ 12,\ 13,\ 14\ \ ....\ \}$

Counting Numbers $\{\ 1,\ 2,\ 3,\ 4,\ 5,\ 6,\ 7,\ 8,\ 9,\ 10,\ 11,\ 12,\ 13,\ 14\ \ ....\ \}$

The set of Irrational Numbers

There are many numbers that are **not Rational Numbers**.

Irrational Numbers are numbers that represents **a decimal number that does not terminate or repeat.** Since the digits in the decimal never end or repeat **you cannot write the number as a fraction or a decimal. We use symbols to represent irrational numbers.** One of the most famous irrational numbers is π or pi .

The Irrational numbers that most algebra students will be familiar with involve **certain** square roots. The square root of any positive number that is not a perfect square is an Irrational Number**.** Numbers like $\sqrt{2}$ and $\sqrt{7}$ are Irrational Numbers.

Examples of Numbers that are Irrational Numbers:

$\sqrt{10}$ $\sqrt{35}$ $6\sqrt{17}$ π

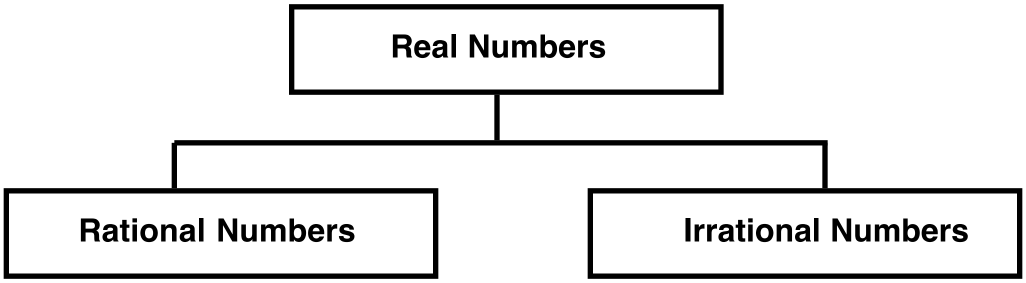
Not all square roots are Irrational Numbers

$\sqrt{9}$ reduces to 3 which is a Rational number. $\sqrt{\frac{25}{16}}$ reduces to $\frac{5}{4}$ which is a Rational number.

The set of Real Numbers

The set of **Real Numbers** is made up of 2 sets of numbers:

Rational Numbers and **Irrational Numbers.**



Rational Numbers are numbers
that can be expressed in fraction form as the ratio of two integers
or as a decimal whose digits terminate or repeat.

Irrational Numbers are numbers
that **CANNOT** be expressed a decimal that terminates or repeats.
Irrational Numbers are numbers that **CANNOT** be expressed as a Rational Number
We use symbols like π to express these numbers

Examples

12 and $\frac{9}{3} = 3$ and 0 and $\sqrt{100} = 10$

are all **Whole**, **Counting, Integer, Rational** and **Real** Numbers

-6 and $\frac{20}{-10} = -2$ and $-\sqrt{49} = -7$

are all **Integer, Rational** and **Real** Numbers

$\frac{4}{5} = .80$ and $\frac{2}{9} = .22222.....$

are all **Rational** and **Real** Numbers

$\sqrt{5}$ and $3\sqrt{17}$ and $-3\sqrt{13}$ and 3π

are all **Irrational** and **Real** Numbers

Is every number a Real Number ?

It would seem like every number would have to be a real number but that is not the case. When we introduced square roots we did not allow **the number under the square root to be negative**. We said that the square root of any negative number is not a Real Number

If $\sqrt{-1}$ is not a real number. What type of number is it?

Chapter 7 will answer that question. We will discover in Chapter 7 that there is **a type of number that is not a real numbe**r. It will be called an **Imaginary Number.**

