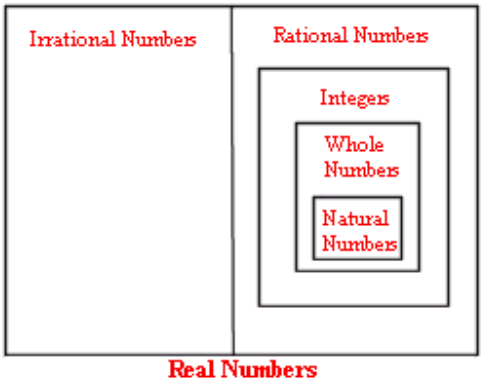
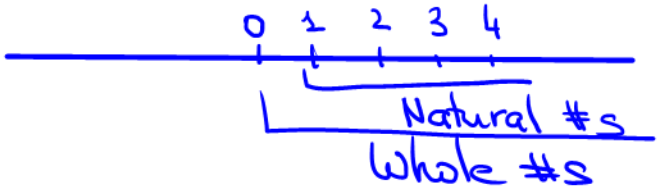
1.1 The Real Number System

Types of Numbers:
The following diagram shows the types of numbers that form the set of real numbers.





Definitions

1. The **natural numbers** are the numbers used for counting.
   1, 2, 3, 4, 5, . . .

A natural number is a **prime number** if it is greater than 1 and its only factors are 1 and itself.
A natural number is a **composite number** if it is greater than 1 and it is not prime.

Example: 5, 7, 13,29, 31 are prime numbers. 8, 24, 33 are composite numbers.

2. The **whole numbers** are the natural numbers and zero.
   0, 1, 2, 3, 4, 5, . . .

3. The **integers** are all the whole numbers and their additive inverses. No fractions or decimals.
   . . . , -3, -2, -1, 0, 1, 2, 3, . . .

An integer is **even** if it can be written in the form $2n$, where n is an integer (if 2 is a factor).
An integer is **odd** if it can be written in the form $2n-1$, where n is an integer (if 2 is not a factor).

Example: 2, 0, 8, -24 are even integers and 1, 57, -13 are odd integers.

4. The **rational numbers** are the numbers that can be written as the ratio of two integers. All rational numbers when written in their equivalent decimal form will have terminating or repeating decimals.

$$\frac{1}{5},\quad 3.25,\quad 0.8125252525\ldots,\quad 0.\overline{6}\quad ,\ 2\ (=\frac{2}{1})$$

$0.\overline{6} \Leftrightarrow 0.66666$

5. The **irrational numbers** are any real numbers that can not be represented as the ratio of two integers. The numbers usually are imperfect roots. Pi is also an irrational number. Irrational numbers when written in their equivalent decimal form have non-terminating and non-repeating decimals. The square root of a prime number is irrational.

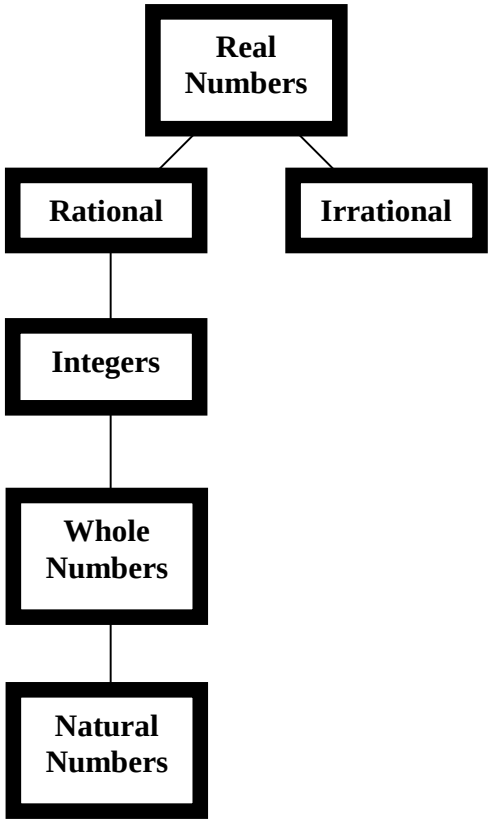
$$\sqrt{13},\ 2.236067978\ldots,\ \pi\ (\approx 3.142),\ \sqrt{2}\ (\approx 1.414),\ \sqrt{3}\ (\approx 1.732)$$

6. A real number is either a rational or an irrational number.

A real number is **positive** if it is greater than 0, **negative** if it is less than 0.

7. **Undefined numbers** are numbers in the form $\frac{k}{0}$

Why
12 divided by 3 is 4
because (3)(4) = 12



Undefined

12 divided by 0 is x
(0)(x) = 0 !

Example 1: Circle all of the words that can be used to describe the number 25.

Even, Odd, Positive, Negative, Prime, Composite, Natural, Whole, Rational, Irrational, Real

Example 2: Classify each of the following numbers:

24 Even, Positive, Composite, Natural, Integer, Whole, Rational, Real

-12 Even, Negative, Composite, Rational, Integer, Real $\frac{-12}{1}$

2.5 Positive, Rational, Real

$\frac{5}{3}$ Positive, Rational, Real

$\sqrt{7}$ Positive, Irrational, Real

5.789127678...

Example 3: $\left\{-10.2,\ -8,\ -5,\ 0,\ \frac{7}{5},\ 1.\overline{23},\ \sqrt{11},\ 23,\ 25\frac{1}{4},\ 35\right\}$

Give the list of all

Rational numbers: $-10.2, -8, -5, 0, \frac{7}{5}, 1.\overline{23}, 23, 25\frac{1}{4}, 35$

Irrational numbers: $\sqrt{11}$

Even integers: $-8, 0$

Odd natural numbers: $23, 35$

Whole numbers: $0, 23, 35$

Negative real numbers: $-10.2, -8, -5$

Prime numbers: $\rightarrow 23$

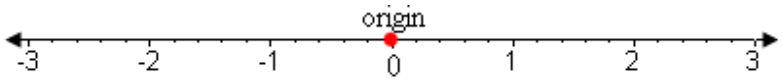
Composite numbers: $\rightarrow 35$

Real numbers: All

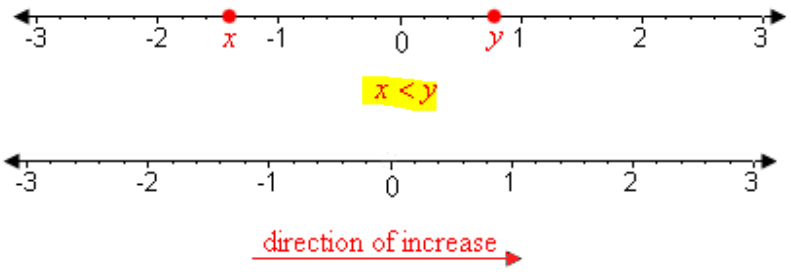
Undefined numbers: none

Order on a Number Line

The real number line: We can graph real numbers on a number line. For each point on the number line there corresponds exactly one real number, and this number is called the coordinate of that point.



If a real number **x** is less than a real number *y*, we write $x < y$. On the number line, *x* is to the left of *y*.



Example 4: For each pair of real numbers, place one of the symbols < , =, or > in the blank.

a) $2 \_\_\_ \sqrt{2}$ ≥

b) $-5 \_\_\_ -6$ >

c) $\frac{1}{4} \_\_\_ \frac{1}{5}$ >

d) $\frac{5}{2} \_\_\_ 2.1$

e) $\frac{9}{2} \_\_\_ 4\frac{1}{2}$