

# Sets of Real Numbers

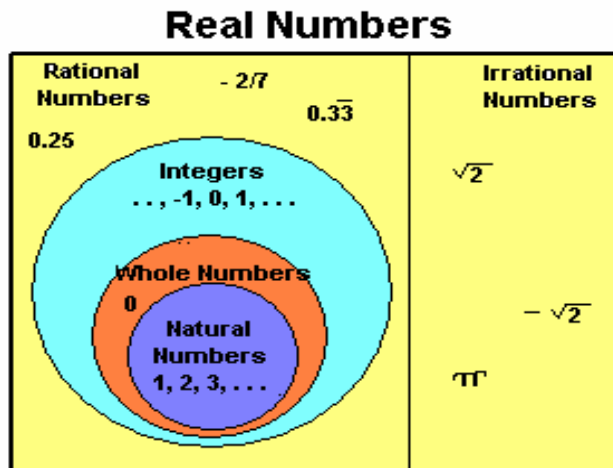
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## Real Number System

**Venn Diagrams** are a graphic representation of the relationship of sets of numbers. Subsets are represented as interior circles. Every natural number is a whole number, an integer, a rational number and a real number.



**Real numbers** are all the rational numbers and all the irrational numbers shown graphically above and defined in the chart below. The real numbers include the positive numbers, the negative numbers, and zero which can all be represented on the real number line.

Name of Set	Word Definition	Set Expression or Examples
Natural numbers	The counting numbers	$\mathbf{N} = \{1,2,3,4,\dots\}$
Whole numbers	The natural numbers and zero	$\mathbf{W} = \{0,1,2,3,\dots\}$
Integers	Positive and/or negative whole numbers	$\mathbf{I} = \{\dots,-1,0,1,2,\dots\}$
Rational numbers	Any integer that can be expressed as a fraction as long as the denominator is not 0	$\mathbf{Q} = \left\{ \frac{a}{b} \mid b \neq 0 \right\}$
Irrational numbers	Numbers that cannot be expressed as one integer divided by another	$\Pi, \sqrt{2}, -\sqrt[3]{18}$

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**Table of Products 1 – 12**

x	1	2	3	4	5	6	7	8	9	10	11	12
1	1	2	3	4	5	6	7	8	9	10	11	12
2	2	4	6	8	10	12	14	16	18	20	22	24
3	3	6	9	12	15	18	21	24	27	30	33	36
4	4	8	12	16	20	24	28	32	36	40	44	48
5	5	10	15	20	25	30	35	40	45	50	55	60
6	6	12	18	24	30	36	42	48	54	60	66	72
7	7	14	21	28	35	42	49	56	63	70	77	84
8	8	16	24	32	40	48	56	64	72	80	88	96
9	9	18	27	36	45	54	63	72	81	90	99	108
10	10	20	30	40	50	60	70	80	90	100	110	120
11	11	22	33	44	55	66	77	88	99	110	121	132
12	12	24	36	48	60	72	84	96	108	120	132	144

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## Place Value

Place value is the position of a digit in a number to denote its value. Note that commas are used for groups of threes, but are only used for numbers of five or more digits. The period in decimal notation is known as the decimal point. The number of digits in a number to the right of the decimal point is known as the number of decimal places of the number.

millions	100 thousands	10 thousands	thousands	hundreds	tens	units	tenths	hundredths	thousandths	10 thousandths			
2	,	9	5	3	,	6	0	1	.	4	0	7	8

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## Procedure for Rounding Numbers

- Step 1: Underline the digit in the place being rounded off
- Step 2: a) If the digit to the right is less than 5, replace all digits to the right by 0 and leave the underlined digit as it is.  
b) If the digit to the right is 5 or greater, replace all digits to the right by 0 and add 1 to the underlined digit.

(Hint: trailing 0's in decimal numbers are not necessary or expected)

*For example:* Round to the nearest hundred:      35,634  
   35,634    underline the hundreds  
   35,600    the 3 < 5, so the 6 remains

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## Averaging

To average two or more data items, apply the following formula:  $\frac{\text{sum of data}}{\text{number of data}}$

*For example:* Find the average of 15, 32, 7, and 16.

$$\frac{15 + 32 + 7 + 16}{4} = \frac{70}{4} = 17.5 \text{ which is called the average}$$

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## Exponents

The numbers that you use in multiplication are called **factors**. If the same factor is repeated more than once, there is shorthand method of notation called **exponential notation**.

$$b^x = b \cdot b \cdot b \cdot \dots \cdot b$$

The repeating factor **b** is called the **base** and the **x** is called the **exponent** or **power**.

*For example:* 1)  $7^2 = 7 \cdot 7 = 49$

$$2) \quad 2^3 \cdot 3^2 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 = 8 \cdot 9 = 72$$

$$3) \quad -2^2 = -2 \cdot 2 = -4$$
$$(-2)^2 = (-2)(-2) = 4$$

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## Square Roots

The symbol  $\sqrt{a}$  implies that you are looking for the number that multiplied by itself has a product equal to  $a$ . We refer to that number as the square root of  $a$ . (i.e. 3 is the square root of 9 because  $3 \cdot 3 = 9$ )

Here is a list of the common perfect square numbers you will be using in this course:

$$\sqrt{1} = 1$$

$$\sqrt{4} = 2$$

$$\sqrt{9} = 3$$

$$\sqrt{16} = 4$$

$$\sqrt{25} = 5$$

$$\sqrt{36} = 6$$

$$\sqrt{49} = 7$$

$$\sqrt{64} = 8$$

$$\sqrt{81} = 9$$

$$\sqrt{100} = 10$$

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## Absolute Value

The absolute value of a number is the distance between that number and 0 on the number line irrespective of direction. The number 4 is 4 units away from 0, so the absolute value of 4 is 4. We represent this as follows:

$$| 4 | = 4$$

The two vertical lines are the symbol for absolute value.

Another number that is 4 units away from 0 is -4, so the absolute value of -4 is 4.

$$| -4 | = 4$$

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## Order of Operations

In order to simply mathematical expressions, the following sequence must be observed:

- 1<sup>st</sup> Perform all operations within the grouping symbols.
- 2<sup>nd</sup> Evaluate all exponents and roots.
- 3<sup>rd</sup> Perform multiplication/division in the order they appear, from left to right.
- 4<sup>th</sup> Perform addition and/or subtraction in the order they appear, from left to right.

*For example:* Evaluate each of the expressions below:

$$\begin{aligned} 1) \quad & 18 - 6 \div 3 \cdot 7 + 4 \\ & 18 - 2 \cdot 7 + 4 \\ & 18 - 14 + 4 \\ & 4 + 4 = 8 \end{aligned}$$

$$\begin{aligned} 2) \quad & 5^3 - 3(8 - 2)^2 - \sqrt{16} \\ & 5^3 - 3(6)^2 - \sqrt{16} \\ & 125 - 3(36) - 4 \\ & 125 - 108 - 4 \\ & 17 - 4 = 13 \end{aligned}$$

$$\begin{aligned} 3) \quad & 14 - 2(1 + 5) \\ & 14 - 2 \times 6 \\ & 14 - 12 = 2 \end{aligned}$$