# **Lesson Objectives**

1. Classify real numbers
2. Convert a number from standard notation to scientific notation
3. Convert a number from scientific notation to standard notation
4. Use a calculator for computations involving scientific notation
5. Calculate Percent Change

# **Classifying Real Numbers**

## **Natural** numbers – the **counting** numbers {1, 2, 3,…, ∞}

* + Includes any number that can **simplify** to a natural number
    - * Examples: etc.

## **Whole** numbers – include **zero** and the **natural** numbers {0, 1, 2, 3, …, ∞}

* + Think “wh0le” – write the “o” in the word “whole” with a zero instead
  + Includes any number that can **simplify** to a whole number

## **Integers** – **whole** numbers and **opposites** (negatives) {–∞, …, –3, –2, –1, 0, 1, 2, 3, …, ∞}

* + Sort of like “mile markers” on a number line; often used for reference in graphing
  + Includes any number that can **simplify** to an integer
    - * Examples: etc., or examples from **natural** numbers
  + CAUTION! Just because a number is *negative* doesn’t necessarily mean it’s an integer!
  + They’re “pretty” numbers. With integers, remember “ahh!,” not “eww!”

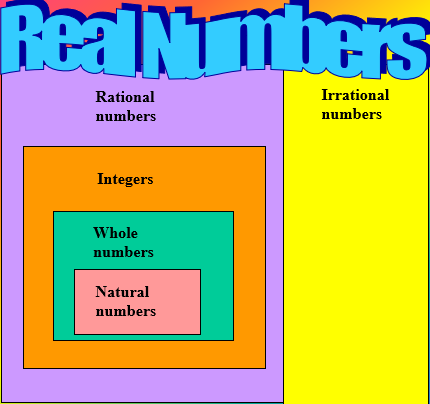
## **Rational** numbers – can be written as a **ratio** (fraction, denominator not zero)

* + Includes all **integers**
  + Includes some (not all!) of the numbers *in between* the integers
  + Includes **all** forms of **fractions** (that don’t contain irrational numbers), positive or negative
    - Proper fraction (smaller/larger) – Examples: , etc.
    - Improper fraction (larger/smaller) – Examples: etc.
    - Mixed number – Examples: etc.
  + Includes some (not all) types of decimal numbers, positive or negative
    - All **terminating decimals** – they stop eventually
      * Examples: -12.93, -6.1, -0.4556, 0.23, 4.51, 67.88421, etc.
    - All **repeating decimals** – go on forever, but in a repeatable pattern
      * Examples: etc.

## **Irrational** numbers – number that is **not** rational (can’t be written as a fraction)

* + Includes any **root that doesn’t “work,” or simplify** to a rational number, positive or negative
    - * Examples: etc.
  + Includes other numbers, like the golden ratio (called “phi” or ), and anything that includes them, positive or negative.
    - * Examples: etc.
  + Includes decimals that are both non-terminating AND non-repeating, positive or negative
    - * Examples: 0.1010010001…, or 0.101101110…, etc.

|  |
| --- |
| **A Real number has more than one “nested” category:** |
|  |
| Natural-Whole-Integer-Rational-Real |
|  |
| Whole-Integer-Rational-Real |
|  |
| Integer-Rational-Real |
|  |
| Rational-Real |
|  |
| Irrational-Real |



* **EXAMPLE:** Classify each real number as one or more of the following: natural number, whole number, integer, rational number, or irrational number. [1.1.7]

Let’s go through this list of numbers one at a time, considering all the categories.

|  |  |  |
| --- | --- | --- |
| **Number** | **Does it Simplify?** | **Categories of Numbers it’s Classified** |
|  | simplifies to 6 | **Natural, whole, integer, rational, real** |
|  | doesn’t simplify | Fraction = **rational, real** |
|  | doesn’t simplify | Root that doesn’t simplify = **irrational, real** |
|  | doesn’t simplify | Repeating decimal = **rational, real** |
|  | doesn’t simplify | Has = **irrational, real** |

* **EXAMPLE:** Choose to which group of sets the following number belongs. Be sure to account for ALL sets. Choose the correct answer below. [1.1.1]

A. real numbers, rational numbers

B. real numbers, irrational numbers

C. real numbers, rational numbers, natural numbers

D. rational numbers, natural numbers, integers

E. irrational numbers, natural numbers

Common error: “Since is negative, then it is an integer.” (INCORRECT)

Remember that an integer can be either positive or negative, but they are “pretty” numbers, not fractions like this one. So, Answer D is incorrect.

Notice that Answers C and E include natural numbers, but those are just the basic counting numbers 1, 2, 3, …. But is definitely not a counting number!

Since is a simplified fraction, it MUST be a *rational* number.

# **Scientific Notation**

## Format for scientific notation: *c* × 10*n* (“stem” times “power of 10”)

* For the “stem,” *c* is somewhere between 1 (included) and 10 (excluded).
  + Written more simply: 1 ≤ *c* < 10
* For the “power of 10”, *n* is an integer.

## Convert standard notation (“regular” number) to scientific notation

* **EXAMPLE:** Write the following number in scientific notation 276,000 [1.1.29]
  + Step 1. Start with all the leading nonzero digits; ignore trailing zeros: 276
  + Step 2. Insert a decimal point to create a stem between 1 and 10: 2.76
  + Step 3. Move from the *stem* decimal location to the *actual* decimal location.
    - Count the **number** of positions moved: 5 places
    - Note the **direction** moved: to the RIGHT (positive)
  + Step 4. Value of *n* (exponent on base 10) comes from Step 3: *n* = +5 or just 5
  + Step 5. Write the number in scientific notation: 2.76 × 105
* **EXAMPLE:** Convert to scientific notation 0.000000051 [1.1.31]
  + Follow the same steps in a similar fashion as previous example.
  + Stem: 5.1; move 8 places LEFT to get to actual decimal point. (ignore zero to left of decimal)
  + In scientific notation: 5.1 × 10 – 8

## Convert scientific notation to standard notation (“regular” number)

* **EXAMPLE:** The distance from the planet Drendal to its moon Kronotor is about 9 × 105 meters. Express this distance in standard form. [1.1.43]
  + Step 1. Write down just the “stem” number. 9
  + Step 2. Use *n* (the “power of 10”) to move (or “hop”) the corresponding direction (positive RIGHT, negative LEFT) and number of decimal places. “hop” 5 places to the RIGHT
  + Step 3. Drop a decimal point after completing Step 2.
  + Step 4. Fill in any vacant place values with a zero.
  + Step 5. Remove (“kill”) the decimal point from the original stem.
  + In standard notation: 900,000.
* **EXAMPLE:** Write the number in standard form. 7.902 × 10 -6 [1.1-25]
  + Follow the same steps in a similar fashion as previous example.
  + From decimal point between 7 and 9, move 6 places to the LEFT, then fill with zeros.
  + In standard notation: 0.000007902

(note that the zero to the left of decimal point is a matter of visual clarity only)

## Calculator computations involving scientific notation

* **EXAMPLE:** Use a calculator to approximate the expression. Write the result in scientific notation.

(Round to two decimal places as needed. Use scientific notation. Use the multiplication symbol in the math palette as needed.) [1.1.61]

* + TI-84 has fraction feature: press ALPHA, Y=, ENTERShows the calculator buttons in order:
    ALPHA
    Y=
    ENTERScreenshot from TI-84 calculator after pressing ALPHA, Y=

    Shows the FRAC menu highlighted on item number 1: n/d for numerator/denominator

screenshot from TI-84 with the following calculation:
numerator:  8.747*10^9
denominator:  0.00094
that fraction then multiplied by:
(4.5*10^6)
output reads:
4.187393617 E19

* + TI-83 should use extra parentheses with fraction. Best to use separate ones for numerator, for denominator, and for entire fraction itself, so BE CAREFUL!

screenshot from TI-83 with the following calculation:
((8.747*10^9)/(0.00094)(4.5*10^6)
output reads:
4.187393617 E19

* + The short capital letter E with 18 at end is the power of 10, so “e19” means “× 1019 ”
  + Rounded to two decimal places: 4.19 × 1019

# **Percent Change** – formula: Percent Change =

* **Example:** Find the percent change if a quantity changes from P1 to P2.

P1 = 1.4 and P2 = 0.74 (round to the nearest tenth as needed) [App.D.3]

* + Since from P1 to P2 is **decreasing**, we expect the percent change to be NEGATIVE.
  + Use formula:

Percent Change =

* + - Use calculator:

TI-84screenshot from TI-84 calculator of the following calculation:
numerator: 0.74-1.4, denominator: 1.4
that fraction multiplied by 100
output reads:
- 47.14285714 TI-83screenshot from TI-83 calculator of the following calculation:
((0.74-1.4)/(1.4))*100
output reads:
- 47.14285714

* + - Rounded to the nearest tenth (one decimal place): -47.1 %

Sources used:

1. Pearson MyMathLab *College Algebra with Modeling and Visualization, 6th Edition*, Rockswold
2. Wabbitemu calculator emulator version 1.9.5.21 by Revolution Software, BootFree ©2006-2014 Ben Moody, Rom8x ©2005-2014 Andree Chea. Website <https://archive.codeplex.com/?p=wabbit>