SECTION 1.3
NUMERACY

INTRODUCTION
The word numeracy means numerical literacy. Numeracy is numbers sense. It implies a basic understanding of how we represent numbers, their sizes in relation to one another, estimates, and rounding.

There are many types of numbers. These include whole numbers, integers (positives or negatives of whole numbers), rational numbers (fractions of integers), and irrational numbers (those that can’t be written as rational numbers). These are usually easy to distinguish, except for rational and irrational numbers in decimal form.

CHECK IT OUT!
All numbers can be expressed in decimal form. Irrational numbers have decimal forms that involve an infinite sequence of digits with no repeating pattern. All other numbers are rational.

YOUR TURN!
1. Classify the following numbers. State all categories in which each number resides.
   a. 1.347347347347347347347347347347347...
      Answer: __________________________
   b. \(-\frac{2}{3}\)
      Answer: __________________________
   c. 1.97
      Answer: __________________________
   d. \(\pi = 3.14159265358979323846264338328...\)
      Answer: __________________________
   e. 249,187
      Answer: __________________________
   f. \(\sqrt{2} = 1.4142135623709504880168872421...\)
      Answer: __________________________
   g. \(-3,500,194\)
      Answer: __________________________

MOVING ON!
Next, we establish a collection of rules for rounding. Rounding can be tricky, because it depends on the quality of the measurements that we make, or that others give us. If we are making measurements, keep the following rule in mind.
CHECK IT OUT!

When making your own measurements, record the digits that your device can reliably measure. These reliable digits are called significant. Significant digits can be before or after the decimal point.

YOUR TURN!

1. Suppose you have a device that measures speed in feet per second, accurate to the nearest 1/100th of a foot. The device reads 2.5872.
   a. How should you round this when you write it down?
   b. How many significant digits does this measurement have?

2. A temperature probe reads 18.993 °C, but the probe only gives reliable readings to the nearest tenth.
   a. How should you round this when you write it down?
   b. If you rounded this last number correctly, there should be a zero digit. Is this a significant digit? Should it be recorded? Why?
   c. How many significant digits does this measurement have?

In the scientific community, the way a number is rounded tells the us how many digits are reliable or significant.

3. Think about how the following numbers are rounded and decide how many digits are significant.
   a. 123.010  Answer: ________________________________
   b. 123.01  Answer: ________________________________
   c. 1.00010  Answer: ________________________________
We have said that the position of the decimal point does not influence the number of significant digits in a rounded number. Now listen carefully – we have said that the position of a decimal point does not influence the number of digits that are significant. But the position of this point serves only as an anchor for place value, and thus place value is not a factor in determining which digits are significant. This leads us to make the conclusion that leading zeros should not be considered significant, because they only give information about the place value of the digits that follow these leading zeros.

CHECK IT OUT!

When counting significant digits, remember – leading zeros are not significant.

4. Give the number of significant digits.
   a. 0.009010  Answer: ___________________
   b. 2.10500000  Answer: ___________________
   c. 100000000.01  Answer: ___________________

MOVING ON!

The problem of leading zeros being insignificant gives a hint at why scientists often use scientific notation. When values are recorded in scientific notation, only significant digits are displayed, and place value is recorded separately. Another advantage to scientific notation is that it has the potential of reducing the amount of space needed to record very large or very small numbers.

Before we begin we need to remember a fact about negative exponents. When a number is recorded with a negative exponent, it implies division instead of multiplication.

So, if we raise 10 to the 4th power,

$$10^4 = 10\cdot10\cdot10\cdot10 = 10,000,$$

Raising 10 to the -4th power causes a division,

$$10^{-4} = \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} = \frac{1}{10,000}.$$

This is why multiplying by 10 raised to a positive exponent moves the decimal to the right,

$$1.35291 \times 10^4 = 13529.1,$$

and multiplying by 10 raised to a negative exponent moves the decimal to the left.

$$1.35291 \times 10^{-4} = 0.000135291.$$
CHECK IT OUT!

To convert a number from scientific notation, if the number is multiplied by $10^n$, move the decimal $n$ places to the right, and add zeros as needed. If the number is multiplied by $10^{-n}$, move the decimal $n$ places to the left, filling zeros as needed.

YOUR TURN!

5. Convert the following values to regular notation.
   a. $2.911 \times 10^5$  
      Answer: ______________________
   b. $3.1424 \times 10^{-6}$  
      Answer: ______________________
   c. $8.900 \times 10^{-7}$  
      Answer: ______________________
   d. $6.0001 \times 10^{10}$  
      Answer: ______________________

MOVING ON!

When you convert a number from regular decimal notation to scientific notation, move the decimal after the first non-zero digit, and count the number of digits ($n$) that it was moved. Multiply the value by $10^n$ where $n$ is positive for a large number and $n$ is negative for a small number.

6. Convert the following values to scientific notation.
   a. 15478.23  
      Answer: ______________________
   b. 0.000001750  
      Answer: ______________________
   c. 90909914.99  
      Answer: ______________________
   d. -0.000000000002799  
      Answer: ______________________

YOUR TURN!

Next, we have to learn how to round numbers after a computation involving properly rounded numbers. The rule that we use depends on the computation we’re doing. There are essentially two rules.

CHECK IT OUT!

I. When adding or subtracting, round to the number of places after the decimal that are present in the number with the fewest number of places after the decimal.

II. For any other computation, round to the number of significant digits that are present in the number with the fewest number of significant digits.

III. For both of the rules above, when counting digits, ignore values that are considered exact (like whole numbers).
SECTION 1.3
NUMERACY

7. Perform the following computations on your calculator, rounding appropriately.
   a. $1045.991 + 2.8700 - 128.4653$  
      Answer: __________________________
   b. $\frac{1.29 - 2.689}{2.467}$  
      (assume the 10 is exact).  
      Answer: __________________________
   c. $25.03 \cdot 0.00021$  
      Answer: __________________________
   d. $\sqrt{\frac{231.1 - 45}{45 - 1}}$  
      (assume the 45s and 1s are exact).  
      Answer: __________________________

MOVING ON!

The last part of numeracy that we concern ourselves with is estimates and reasonable results. In each of these cases, we want to develop skills to help us quickly estimate a possible answer to a problem, and with such tools we are able to judge when answers are reasonable.

When we make estimates to solutions of problems, we usually begin with a set of assumptions. In the following problems, this is just what we will do.

8. You have $400. Is this enough money to get you to New York in a car?
   a. What assumptions will you make to answer this question?

      b. Use the space below to decide if you have enough money.
9. An adult dose of ibuprofen is a 200mg tablet. Would it be reasonable to give a 1 year old \( \frac{1}{4} \) of such a tablet?

   a. What assumptions will you make to answer this question?

   b. Use the space below to decide if this dose is reasonable.