Your name: _____ Partner's names: _____

Lab Activity: Precision in Measurements

Part I: What makes a measuring device precise?

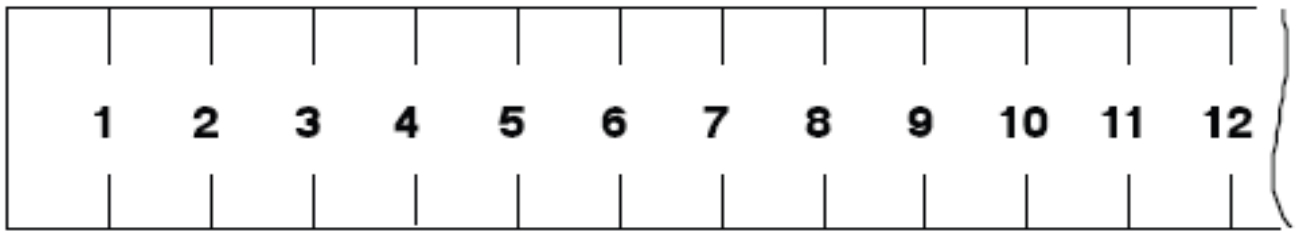
1. A. Cut out the two "rulers" at the bottom of this page.

   B. Use these rulers to measure the length of each of the lines on the next page but before you start, make sure you understand the guidelines for measuring as stated below. The units for these two rulers are not known.

Guidelines for taking measurements:

- In recording measurements, include all the digits you know for sure plus one estimated digit.
- Your estimated digit should be one-tenth of the smallest division on the measuring device.
    - For example, when you use Ruler A to take measurements, the smallest division is in the ones place, and therefore, you should measure to the nearest tenth. All of your measurements with Ruler A should have one decimal place.
    - When you use Ruler B to take measurements, the smallest division is in the tenths place, and therefore, you should measure to the nearest one-hundredth. All of your measurements with Ruler B should have two decimal places.
- All digits you record in a measurement are considered significant figures.

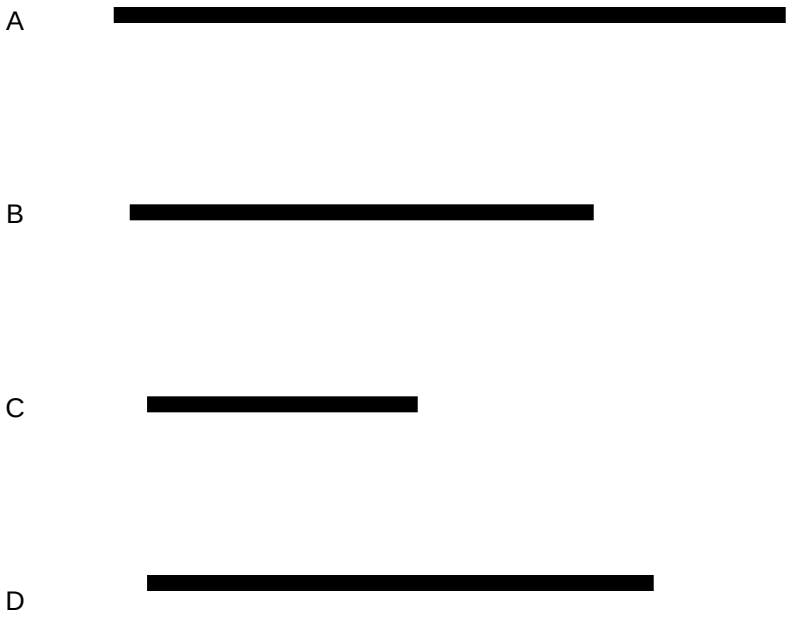
Ruler A



Ruler B

Blank Page

2. Use each ruler to measure the length of each line. Yes, you will be measuring each length twice. Be sure to report measurements with Ruler A to one decimal place and measurements with Ruler B to two decimal places.



	Ruler A	Ruler B
A		
B		
C		
D		

3. If you compared your measurements with another lab group, which set of measurements would you expect to be most similar—measurements with Ruler A or measurements with Ruler B? Why?

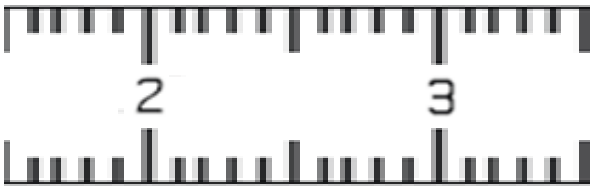
4. A measurement is considered **precise** if the measurement can be consistently reproduced. Which ruler will yield more precise measurements? Explain?

5. A. Consider the measurements taken with Ruler A, how many significant figures do each of these measurements have? ☐

   B. Consider the measurements taken with Ruler B, how many significant figure do each of these measurements have? ☐

6. Since all measurement includes an estimated digit, any reported measurement is not an exact measurement; it is a range of possible values.

Let's say a student measured a line and recorded 2.5 units with the ruler below. The line could really be anywhere between 2.45 and 2.54 units. Therefore, we say the range of measurements is between 2.45 and 2.54 units.	Let's say a student measured a line and recorded 2.50 units with the ruler below. What is the possible range of measurements for this ruler?



7. A. Would you consider the number 2.5 and 2.50 to be the same number?

   B. Would you consider 2.5 units and 2.50 units to be the same measurement? What does the zero in 2.50 tell you about the measuring device used?

8. A. How many significant figures are in the measurement 2.5 units?

   B. How many significant figures are in the measurement 2.50 units?

Part II: When is a zero not a significant figure?

Not all zeros are considered significant figures. When a zero is a place holder it is not considered a significant figure. Consider the following example:

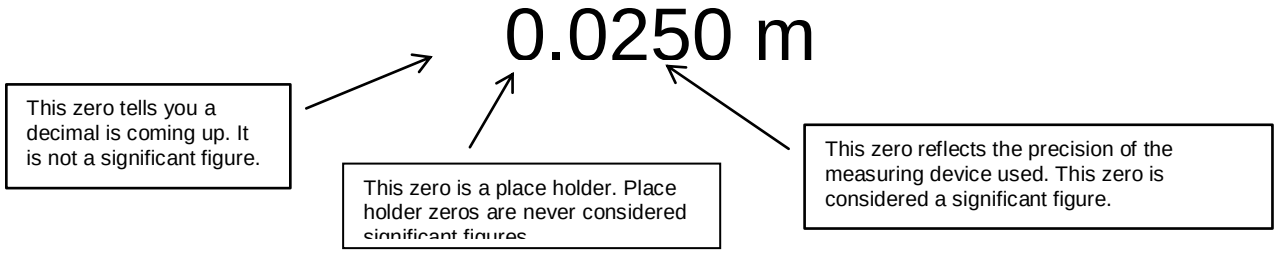
A student measures the length of a line to be 2.50 centimeters but the student is asked to convert the measurement into meters.

2.50 centimeters = 0.0250 meters

How many significant figures does this number have now? Four significant figures? Five significant figures? No! Remember that the number of significant figures has to do with the measuring device used to take measurements. You can't have more or less significant figures just because you changed from one unit, centimeters, to another unit, meters.

Did you notice that when we converted from centimeters we had to add zeros? The zeros you add to move the decimal place are called "place holders". Place holder zeros, although important to the number reported, are not considered significant figures.

Let's consider examine the zeros in the measurement 0.0250 meters more closely.



There is a simple test for trailing zeros to determine if a zero is significant or not. Take the zero away from the number and see what happens. Removing a zero that is a significant figure will not change the value of the measurement. Removing a zero that is a place holder will change the value of the measurement. Consider the following examples:

How many significant figures in each of the following measurements?

Example 1: 4.500 meters Answer: Four significant figures

If the zeros are removed from 4.500, the value does not change. 4.5 and 4.500 are considered the same value—not the same measurement but they are the same value. Therefore both of these zeros are considered significant figures.

Example 2: 0.00045 kilometers Answer: Two significant figures

If the zero are removed from 0.00045, the value does change. 0.00045 and 0.45 are not at all the same value. Therefore, these zeros are considered place holders and are not considered significant figures.

9. A. Consider this measurement, 2500 meters.

   i. If the zeros are removed from 2500 what is the new number? _____

   ii. Are the zeros in 2500 considered place holders? _____

   iii. How many significant figures in 2500 meters? _____

   B. Consider this measurement 112.300 grams?

   i. If the zeros are removed from 112.300 what is the new number? _____

   ii. Are the zeros in 112.300 considered place holders? _____

   iii. How many significant figures in 112.300 meters? _____

10. How many significant figures are in each of the following measurements?

    a. 1.26 cm _____

    b. 25.0^{o} C _____

    c. 0.035 m _____

    d. 156.00 g _____

    e. 2500 mm _____

    f. 206 cm _____ (Note: This is an exception to the rule. Sandwiched zeros—zeros between two significant digits--are always significant.)

    g. 120.005 g _____