Significant Figures

Significant figures are the digits in a measured number that indicate the measuring equipments degree of precision. Generally, when writing down a measurement, you should write all of the digits that you obtained directly with the measuring device and add a final digit that you've estimated. For example, if you have a ruler that can measure length in millimeters, you should write the lengths of objects you've measured to tenths of millimeters.

Rules for Writing Significant Figures:
1) **All nonzero digits are significant.** For example, "3.4 grams" has two significant figures.

2) **Zeros that are between nonzero digits are significant.** For example, "3.04 grams" has three significant figures.

3) **Zeros written to the left of all nonzero digits are not significant**. For example, "0.0034 grams" has two significant figures.

4) **Zeros written to the right of all nonzero digits are only significant if a decimal point is written in the number.** For example, "1000 grams" has one significant figure, while "1000.0 grams" has five. The zeros in the second number indicate that a value can be measured accurately to the nearest tenth of a gram, while writing simply "1000 grams" indicates that the measurement has been rounded to the nearest thousand grams.

While both mean the same thing to your calculator, they don't mean the same thing to a reader.

5) **Numbers in scientific notation have the same number of significant figures as the portion of the number that's before the "x 10^n" part of the number.** For example, "4.30×10^5 grams" has three significant figures.

Rules for Using Significant Figures in Calculations:

1) **When adding or subtracting, the answer should have the same number of figures to the right of the decimal as the value with the fewest decimal places.** For example, 3.4 + 5.023 = 8.423 → Round this to 8.4, because 3.4 has only one digit to the right of the decimal.

2) **When multiplying or dividing, the answer should have the same number of significant figures as the value with the fewest significant figures.** For example, 1.220 x 3.4870 = 4.25414 → Round this answer to 4.254, because 1.220 has only four significant figures.

Significant Figures Lab

In chemistry, we try to get the most information we can out of every measurement. Whenever we write down a number we've measured, the number of digit the number has reflects the precision of the instrument we used to get it. This is important in science because when we read somebody else's data we like to know how precise their data really is. If we use the wrong number of digits in our answers, we might fool people into believing that imprecise data is really precise, or vice versa.

When taking measurements, you should always write all values so they show the smallest marking on the instrument, plus an extra digit that you estimate. For example, if you use a ruler that has lines for millimeters, you should write your answers to the nearest tenth of a millimeter because you can estimate the last digit. The exception to this rule is digital equipment, such as an electronic balance. Because you can't estimate the last digit on a digital balance, simply write down the answer on the readout.

In this lab, you will be measuring length, volume, and mass using common laboratory instruments. For each of these tools, you must write down your answer with the correct number of significant digits! Remember, the number of digits you write depends on the instrument you used to take the measurement.

Station 1: Measuring volume with a 50 mL graduated cylinder

Use the 50 milliliter graduated cylinder at this station to find the following volumes. Be sure to use the proper number of significant figures in your answer!

1) What is the maximum volume of the pipet? _____

2) What is the maximum volume of the pen cap? _____

Station 2: Measuring volume with a 10 mL graduated cylinder

Use the 10 milliliter graduated cylinder at this station to find the following volumes. Be sure to use the proper number of significant figures in your answer!

1) What is the maximum volume of the pipet? _____

2) What is the maximum volume of the pen cap? _____

Station 3: Measuring mass with an electronic balance

Use the electronic balance at this station to find the following weights. Be sure to use the proper number of significant figures in your answer!

1) What is the mass of the penny? _____

2) What is the mass of the paper clip? _____

Station 4: Measuring mass with a triple beam balance

Use the triple beam balance at this station to find the following weights. Be sure to use the proper number of significant figures in your answer!

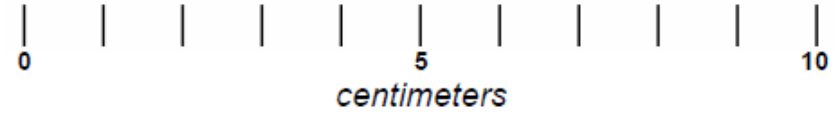
1) What is the mass of the penny? _____

2) What is the mass of the paper clip? _____

Station 5: Measuring distance with a ruler

Using the ruler printed below, find the following lengths. Be sure to use the proper number of significant figures in your answer!

Ruler:



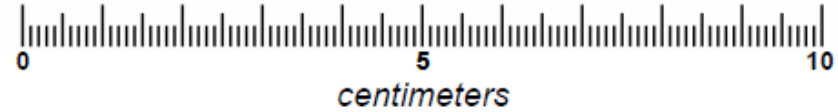
1) What is the length of the post-it note? _____

2) What is the length of the paper clip? _____

Station 6: Measuring distance with a ruler

Using the ruler printed below, find the following lengths. Be sure to use the proper number of significant figures in your answer!

Ruler:



1) What is the length of the post-it note? _____

2) What is the length of the paper clip? _____

Post-lab questions:

1) Why can't we write numbers with as many significant figures as we want? For example, if we measure something with an ordinary ruler, why is it wrong to write our measurement as "0.928772662 centimeters"? Explain.

2) If we had an accurate enough instrument, is there any reason we couldn't write down a value to 15 decimal places (as in the number 0.123456789012345)? Explain.

3) In your own words, what's the difference between precision and accuracy?

Significant Figures Worksheet

For problems #1-14, write down how many significant figures each number has:

1) 4.53 _____

2) 2.30 _____

3) 1.02 _____

4) 4500 _____

5) 3200**.** _____

6) 0.002 _____

7) 1.000 _____

8) 0.070 _____

9) 0.707 _____

10) 7.070 _____

11) 7070 _____

12) 0.700 _____

13) 3.4×10^4 _____

14) 1.02×10^2 _____

Please answer the following questions:

15) Under what circumstances might a very precise measurement not be accurate? Explain.

16) Are there any circumstances under which an accurate measurement may not be precise? Explain.

17) I measured the length of my thumb and found that it is 7.50 centimeters long. When I used another ruler, I found that the length was 7.5 centimeters. Explain the difference between these two measurements.

Using Significant Figures in Calculations

Solve each of the following math problems and write their answers with the correct number of significant figures:

1) 4.5 + 2.34 = _____

2) 4.5 – 5 = _____

3) 6.00 + 3.411 = _____

4) 3.4 x 2.32 = _____

5) 7.77 / 2.3 = _____

6) 3.890 / 121 = _____

7) 1200 x 23.4 = _____

8) 120 x 0.0002 = _____

9) 78.5 + 0.0021 + 0.0099 = _____

10) (3.4 x 8.90) x (2.3 + 9.002) = _____

11) $(2.31 \times 10^3) / (3.1 \times 10^2)$ = _____

12) 0.0023 + 65 = _____

Ad*vanced problems:*

13) $(3.4 \times 10^6) + 210{,}349$ = _____

14) 1.09 x 3.498 + 2.45001 – 2.123 / 0.0023 = _____

15) Why is it important to always use the correct number of significant figures when solving a problem?