Measurement & Significant Figures Handout

❖ **All measurements must be written as DECIMALS and include correct UNITS.**

<u>Measuring Mass</u>

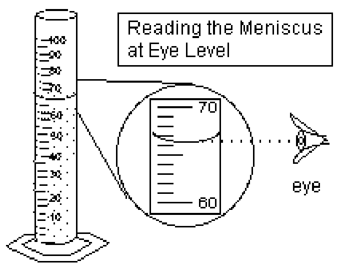
We will use a triple beam balance to measure mass. Some important points about the balance:

- Confirm that it balances when set to 0.00g BEFORE you begin
- You can calibrate the balance with the adjuster that is under the metal plate
- Never weigh a chemical directly on the metal plate—it could react! Instead, place the chemical on paper or in a plastic cup.

Record <u>mass</u> measurements to <u>2 decimal places</u> and use <u>grams (g)</u> for units.

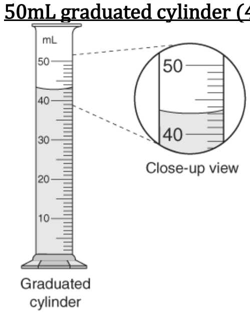
<u>Measuring Volume</u>

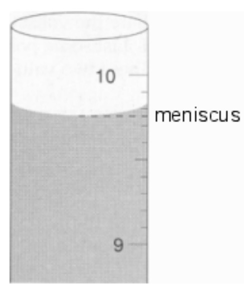
We will use a graduated cylinder to measure volume. Graduated cylinders have the most divisions to make the most accurate and precise measurements. Beakers and flasks are used to measure *approximate* amounts. When you measure volume of a liquid, always read the liquid level from the bottom of the meniscus. The meniscus is the curve that is formed because water is attracted to the sides of the graduated cylinder and is also being pulled down in the middle by the other water molecules.



We will usually use **100mL graduated cylinder** to measure volume. **Record these <u>volume</u> measurements to <u>1 decimal place</u> and use <u>milliliters (mL)</u> for units**. If the meniscus is on a line, add a zero after the decimal point. If the meniscus is between two lines, estimate the volume to the nearest 0.1mL.

Examples: <u>50mL graduated cylinder (43.0 mL)</u> <u>10mL graduated cylinder (9.75 mL)</u>

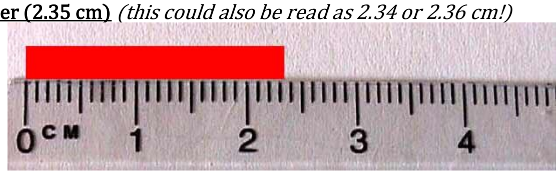




<u>Measuring Length</u>

We will use a metric ruler to measure length. There are 10 lines (divisions) between each centimeter marking on the ruler. Therefore, we should measure length to 2 decimal places. If the measurement falls directly on a line, record your measurement with a zero in the hundredths place. If your measurement falls between two lines, estimate the hundredths place to show that it is between two measurements. **Record <u>length</u> measurement to <u>2 decimal places</u> and use <u>centimeters (cm)</u> for units.**

Example: <u>Metric Ruler (2.35 cm)</u> *(this could also be read as 2.34 or 2.36 cm!)*



<u>Accuracy and Precision</u>

In science, we want to make accurate and precise measurements. Measurements that are ***accurate*** are close to the true or actual value of what is being measured. If you measure the same thing several times and get numbers that are close to one another, you have good ***precision***. The measuring device that you use often determines how accurate and precise your measurements can be. Your ability to use the measuring device correctly also impacts the accuracy and precision of your measurements.

Every measurement has some degree of uncertainty. This uncertainty (or margin of error) is the result of the last decimal place that we estimate (is it directly on the line OR is it between two lines?). You are *estimating* that last digit. The more lines (divisions) an instrument has, the more digits you know for *certain*. Therefore, the instrument is ***more precise***. Precision is how close several measurements are together.

Percent error is used to evaluate the accuracy of experimental data. Percent error is calculated by the following formula:

% error = (error / accepted value) x 100

The ***error*** is determined by finding the difference between your experimental value (what you got) and the accepted value (what you should have gotten). This is always a positive value.

Example:

The accepted length of a steel pipe is 5.5 m. You measure the length of the pipe to be 5.2 m. What is the percent error?

% error = [(5.5 – 5.2)/5.5] x 100 = (0.3/5.5) x 100 = 5.5%

<u>Significant Figures</u>

Rules for Significant Figures:

1. Nonzero integers are always significant.
2. Zeros:
   a. Leading zeros are <u>not</u> significant.
   b. Captive zeros are significant.
   c. Trailing zeros are significant <u>only if</u> the number contains a decimal point.
3. Exact numbers (determined by counting, not measuring) have an infinite number of significant figures.

Rules for Significant Figures in Mathematical Operations:

1. For ***multiplication and division***, round the final answer so that it has the same number of <u>significant figures</u> as the measurement with the least number of significant figures.
2. For ***addition and substraction***, round the final answer so that it has the same number of <u>decimal places</u> as the measurement with the least number of decimal places.

<u>SI System of Prefixes</u>

Mega	M	10^{6}
Kilo	**k**	10^{3}
Deci	d	10^{-1}
Centi	**c**	10^{-2}
Milli	**m**	10^{-3}
Micro	**μ**	10^{-6}
Nano	**n**	10^{-9}
Pico	p	10^{-12}