Making Measurements

Precision -> The agreement between multiple measuring trials.

Accuracy -> The agreement of the measurement with the accepted value.

Formula for finding the percent error:

Error = Experimentally determined value – Accepted Value

Percent Error = the absolute value of the error divided by the accepted value, multiplied by 100.

There is no such thing as an exact measurement. The actual value lies in a range that appears below and above the actual reading.

This range = uncertainty.

Every time you take a measurement the **LAST DIGIT** represents a guess.

Uncertainty **can be reduced,** but **cannot be eliminated.**

Types of Errors:

Random Errors -> Due to the accuracy of the equipment.

Systematic Errors -> How well the equipment was used and how well the experiment was controlled.

(This is counter-intuitive. Mnemonic device – when you see systematic, think of the nervous system, and how well people can carry out psychomotor activity).

Desciptions of Systematic Errors

- Sources can be traced.

- **Accuracy a measure of systematic error**

- Systematic errors can cancel each other out.

- Systematic errors **AFFECT ALL RESULTS EQUALLY.** Should you be looking for some sort of difference in quantity, systematic errors will not make your data entirely invalid.

-Examples: Microscope Calibration,

Thermometer calibration,

random changes in external conditions that can affect the volume of gas

reading the pipette wrong

unaccounted loss of heat

liquid evaporation

spatter of chemicals

Instrumental Systematic Errors refer to all errors that involve the calibration of the equipment used.

Observational Systematic Errors refer to all errors that involve human fault. These include misreads

Method Errors pertain to the idea that **you should really only have one manipulated independent variable.**

Description of Random Errors

-Sources cannot always be traced.

-They cannot be avoided.

-Uncertainties and precisions are a measure of random error. They should be calculated.

Process of Measurement

A measurement of 121.5 was taken with a more **precise tool** than a measure of 121 was.

NOTE: If you report a value of 121, you’re saying that you were only able to measure the value to the ones place. Always report the most precise value.

Reporting Measurements involves three parts:

-The measurement

-The uncertainty

-The unit

The general rule for measuring is that the last digit that you record represents the range or the uncertainty. Therefore if you record with a ruler in cm, your measurement has an uncertainty of ±0.1 cm.

Measuring liquids is slightly different in that the surface tension produces the meniscus. The liquid measure has to be read at the bottom of the meniscus. Depending on your measuring equipment you will have a recorded value and an uncertainty of between 0.01 and 0.001 mL.