Measurement

Measurement is crucial in the science field. Much of science is based on critical thinking, but measurement is used for **making comparisons and placing a quantitative value** on things. (Quantitative means "how much") Measurements are a way of understanding the quantity, or amount of something. For example, you would understand how big something is if someone were to say, " It's as big as a dime." You can relate to how big a dime is, so it is easy to understand how big the object is.

Measurements can be very precise, but are <u>not</u> absolutely accurate. "Precise" means sharply defined or measured. "Accurate" means truthful or correct. Data can be very precise, but inaccurate. There are a couple of reasons for this. The first is, as humans we sometimes make mistakes. We'll call this the "blunder factor." For this reason scientists depend on several measurements to account for human error. (Often times we will take measurements in class and then find an average of all our measurements to account for errors.) Another reason why measurements may not be exactly accurate is the **limited precision of the instrument used to measure with.** For example, the triple beam balances that we use here at Herberg measure to the nearest tenth of a gram. We could all measure the same block of wood in grams using our balances and get slightly different results by having the same block be off by tenths of a gram. The instrument itself is not top quality, and therefore will give you slightly inaccurate readings. Another factor for making measurement not exactly accurate is that **each measuring devise is broken down to a certain fraction.** For example, if you were to measure your desk with a meter stick, you could only measure to the nearest hundredth of a meter, or to the nearest centimeter (cm). The meter stick is broken down into one hundred equal parts, the cm. A more accurate measurement could be given by a more precise measuring tool, which would be a centimeter (cm) ruler. Using a cm ruler would allow us to measure to the nearest millimeter.

When measuring, it is important to specify which measurement you are using. These are called **<u>units</u>. It is a way of labeling. NUMBERS ARE MEANINGLESS WITHOUT UNITS!** It would be meaningless to say that something weighed 40. But, if you were to say the sample weighed 40 grams, it would be better understood what size sample you have. The **grams** would be the **unit** in this case.

As of a couple of hundred years ago, units of measurement were not the same all over the world. Different people used different units: leagues, hands, and even the length of the foot. This of course was not accurate, nor precise. (Whose foot did they rely on anyway?) **A standard is a base measurement in which all other measurements are compared to.** The first unit that became known as an international standard was the **meter**. This length was calculated to be one ten-millionth of the distance from the earth's equator to either pole. (Now

the meter is measured to be the exact wavelength of a certain path of light inside a vacuum!) Everyone around the world understood, and agreed what a **meter** was, as far as **length** goes.

The United States is the only industrialized/technological country that has not completely converted to the metric system. Our speed limits are still in miles per hour, we bake by the teaspoon or cup, and we often measure temperature in Fahrenheit. But, our soda comes in liter bottles and racers run in 5-kilometre or 10- kilometer races. So, we use a little of the old English system (inches, feet, miles) and a little of the metric system. **In science, the metric system is now used exclusively.** This system of measuring is known as the **Systeme International, or SI** (French for International System.) This just means that a standard for measurement has been set up so that everyone around the world can communicate clearly.

Below are some standard, or SI units for measurement.

SI Quantities and Units

Quantity	**Unit**	**Abbreviation**
Length	meter	m
Mass	kilogram	kg
Liquid Volume	liter	l or L

Here are some rules regarding the SI system:

1. **Avoid capitalizing unit names** except for Celsius (C) and Liter which can be l or L
   i.e. gram (g) **not** Gram (G)
2. **Do not use plural form:**
   i.e. 5 kg **not** 5 kgs
3. **Never put a period after the abbreviation except if it appears at the end of a sentence:**
   i.e. cm **not** cm.
4. **Leave a space between the digit and the abbreviation:**
   i.e. 4 km **not** 4km
5. **Do not use a prefix alone:**
   i.e. kilogram **not** kilo
6. **Include a zero before the decimal point when the measure is less than one:**
   i.e. 0.4 cm **not** .4 cm

The metric system is easy to use because it is all **based on multiples of ten.** For example the Celsius scale is based on water freezing at 0° C and boiling at 100° C.