Metric System Unit System of Measurement

Compiled from http://cmdept.unl.edu/publicfile/SIunits.rtf and
http://www.ex.ac.uk/cimt/dictunit/dictunit.htm#temp

The Metric system was developed in France during the Napoleonic reign of France in the 1790's. The metric system has several advantages over the English system which is still in place in the U.S. However the scientific community has adopted the metric system almost from its inception. In fact, the metric system missed being nationalized in this country by one vote in the Continental Congress in the late 1700's or early 1800's. The advantages of the Metric system are:

It was based on a decimal system (ie: powers of ten). Therefore, it simplifies calculations by using a set of prefixes which we will discuss in a few minutes.

It is used by most other nations of the world, and therefore, it has commercial and trade advantage. If an American manufacturer that has domestic and international customers is to compete, they have to absorb the added cost of dealing with two systems of measurement.

Let's now take a few minutes and speak of the useful set of "prefixes" used in the metric system sometimes referred to as the System Internationale (SI). One of the mathematical advantages of the metric system is its combination of metric terminology with its decimal organization. There are several prefixes that are associated with a decimal position and can be attached to the base metric unit in order to create a new metric unit. The knowledge of the decimal meaning of the prefix establishes the relationship between the newly created unit and the base unit.

For example: the prefix "kilo" means 10^3 or 1000 so if I take a mythical base unit like the "bounce" and I attach the kilo prefix in front, I create a new unit called the "kilobounce".

In addition, the relationship between the two units is now well established. Since I know that "kilo" means 1000 then one kilobounce unit is the same as (or equal to) 10^3 bounce units. The prefixes that are most important are listed below along with their decimal and exponential equivalents:

Prefix		decimal equivalent	exponential equivalent
Pico	(p)	0.000000000001	10^{-12}
Nano	(n)	0.000000001	10^{-9}
Micro	(μ)	0.000001	10^{-6}
Milli	(m)	0.001	10^{-3}
Centi	(c)	0.01	10^{-2}
Deci	(d)	0.1	10^{-1}
no prefix		1.0	10^{0}
Deka	(dk)	10.0	10^{1}
Hecto	(h)	100.0	10^{2}
Kilo	(k)	1000.0	10^{3}
Mega	(M)	1,000,000.	10^{6}
Giga	(G)	1,000,000,000.	10^{9}

There are several dozen prefixes used but these above are most commonly used in science measurements. Today, we will be looking at the metric units of measurement in five separate areas of measure. The abbreviations of each unit will appear in parentheses.

1. Length
2. Volume
3. Time
4. Temperature

Mass Measurement

The measure of mass in the metric system has several units that scientist's use most often. The gram is the standard unit of mass in the metric or SI system. The gram (g or gm) is roughly analogous to the English dry ounce. It takes about 29 grams to equal one dry ounce.

A larger mass unit analogous to the English pound is the kilogram. The kilogram is the same as 1000 grams and represents 2.2 pounds in mass.

The basic instrument used to measure mass is the three beam balance. There are some digital balances today that can display the mass of an object in several different mass units both in the English and Metric systems.

Measurement of Length

Now let us go over length measurements. The basic metric unit of dimension (length) is the meter (m). The meter is analogous to the English yard. A meter is equal to slightly more than a yard (about 10% larger).

One meter is equal to 1.09 yards or 39.36 inches.

A larger metric unit used often is the kilometer (km) which is analogous to the English mile. One kilometer is equal to 0.62 miles. In countries where the metric system is the national standard, signposts and posted speed limits are in km or km per hour. For example, the most common speed limit in Mexico is 100, but that is 100 km/hr or about 60 miles per hour!!

The main instrument in the science lab that measures dimension is the metric ruler. The metric ruler comes in various sizes. There is the 150 mm ruler and a metric meter ruler which are used most. However, all metric rulers are calibrated the same. The numerically numbered positions (major calibrations) are equal to centimeter marks, and then there are ten equally spaced positions(minor calibrations) in between each of the numbered positions each of which are equal to 0.1 cm(1 mm). According to this calibration, one can record measurements with one position of estimation to the nearest 0.01 cm.

Another instrument most often used in Physics labs is called a micrometer. It is used for very precise measurements of diameters. When measuring small distance the centimeter (cm) is used It is analogous to the English inch. One inch is equal to 2.54 centimeters.

Measurement of Fluid Volumes

Let's now discuss measure of fluid volume. There are several instruments used to directly measure fluid volumes. The graduated cylinder is the most commonly used in the lab. However, there are several others. The pipet, beaker, and Flask also measure fluid volumes.

The basic metric unit of measure for volume is the liter (l) unit. The liter is analogous to the English quart. One liter is the same as 1.06 quarts. It is basically a fluid volume unit as is the smaller metric unit called the milliliter (ml). The milliliter is analogous to the English fluid ounce. One fluid ounce is equal to about 30 ml.

Other metric units of volume that are more often associated with volumes of solids is the cubic centimeter (cc or cm^3) which is equal to a milliliter. To a careless observer the cc may look like a dimensional unit since it has the word "centimeter" in it. However, it also has the word "cubic" which always indicates a volume unit.

You can think of a cubic centimeter as a cube 1 cm on each edge. The volume of such a cube would be 1cm X 1cm X 1cm or 1 cm^3.

We also use the cubic meter (m^3) often in science to measure large volumes in space.

Temperature

Thermometers measure temperature by using materials that change in some way when they are heated or cooled. In a mercury or alcohol thermometer the liquid expands as it is heated and contracts when cooled. This results in the length of the liquid column increasing when the liquid is heated and shorting when cooled. There are three main temperature scales, each one being named after the person who invented them.

Daniel Gabriel Fahrenheit (1686-1736) a German physicist, in 1714 proposed the first scale for temperature measurement. He designated the freezing point of water to be 32 degrees (so as to avoid negative numbers) and the boiling point was set at 212 degrees. This scale is used in the United States.

The SI unit of temperature is the Celsius scale. It was created by Anders Celsius (1701-1744), a Swedish astronomer. He proposed a 100-degree scale in 1742. Water freezes at 0 degrees and boils at 100 degrees. The scale was initially called the centigrade scale. Since grades and centigrade are also used to measure angles, in 1947 the name was officially named the Celsius scale.

William Thomson, 1st Lord Kelvin (1824-1907) a Scottish mathematician and physicist worked with J P Joule to produce an absolute scale of temperature. It was developed about 1862. It was based on the laws of heat rather than freezing/boiling points of water. Their work produced the idea of "absolute zero." Absolute zero is the temperature in which all molecular motion ceases. It is deemed to be a temperature below it is not possible to go. The value is –273.15 degrees on the Celsius scale.

To change temperature given in Fahrenheit (*F*) to Celsius (*C*)

Start with (*F*); subtract 32; multiply by 5; divide by 9; the answer is (*C*)

To change temperature given in Celsius (*C*) to Fahrenheit (*F*)

Start with (*C*); multiply by 9; divide by 5; add on 32; the answer is (*F*)

Assignment:

Here are some questions you should be able to now answer:

1. The instrument designed to measure length is the _____ _____
2. The graduated cylinder is an instrument that measures _____.
3. The prefix that signifies 0.001 is _____
4. The prefix that signifies 1×10^6 is _____
5. The English unit associated with the meter is _____
6. 1 meter = _____mm
7. A cubic centimeter is a unit of _____
8. The kilogram is associated with the English unit _____
9. Giga prefix signifies what decimal equivalent _____