Introduction to the Metric System

Objectives

1. Become familiar with the history and development of the metric system
2. Learn the base units for length, mass and volume in the metric system
3. Learn the prefixes used in the metric system and what each represents

The metric system is an international decimalized system of measurement that was originally based on the mètre des archives and the kilogramme des archives introduced by France in 1799. Over the years, the definitions of the meter and kilogram have been refined and the metric system extended to incorporate many more units. Although a number of variants of the metric system emerged in the late nineteenth and early twentieth centuries the term is now often used as a synonym for "SI" or the "International System of Units" (French: "Système international d'unités") - the official system of measurement in almost every country in the world.

Only a handful of countries in the world have not adopted the metric system, with sources generally including Liberia, Burma, and the United States in this very rare category. The United States is the only industrialized country that does not use the metric system as its official system of measurement, although the metric system has been officially sanctioned for use there since 1866. Although the metric system has changed and developed since its inception, its basic concepts have hardly changed - it was designed for transnational use; it consisted of a basic set of units of measurement, now known as base units; derived units were built up from the base units using logical rather than empirical relationships while multiples and submultiples of both base and derived units were decimal based and identified by a standard set of prefixes.

At the outbreak of the French Revolution each country, and in many cases each city, had its own system of measurement. Although different countries might have used the same names for their units of measure such as the foot, the sizes of those units varied as did their relationship with their multiples and submultiples, much like the modern-day variation between the US and the UK pint and gallon. The metric system was, in the words of the French philosopher Condorcet to be "for all people for all time". It was designed for ordinary people, for engineers who worked in human-related measurements and for astronomers and physicists who worked with numbers both small and large, hence the huge range of prefixes that have now been defined in SI.

The metric system was designed to be universal, that is, available to all. When the French Government first investigated the idea of overhauling their system of measurement, Talleyrand, in the late 1780s, acting on Condorcet's advice, invited Riggs, a British Parliamentarian and Thomas Jefferson, the American Secretary of State to George Washington, to work with the French in producing an international standard by promoting legislation in their respective legislative bodies. However, these overtures failed and the custody of the metric system remained in the hands of the French Government until 1875.

In the United States, where the use of metric units was authorized by Congress in 1866, such units are widely used in science, military, and partially in industry, but customary units predominate in household use. At retail stores the liter is a commonly used unit for volume, especially on bottles of beverages, and milligrams are used to denominate the amounts of medications, rather than grains. Also,
other standardized measuring systems other than metric are still in universal international use, such as nautical miles and knots in international aviation.

The dual usage of metric and non-metric units has resulted in serious errors. These include:
The degree of overloading of an American International Airways aircraft flying from Miami to Maiquetia, Venezuela on 26 May 1994 was consistent with a cargo weighed in kilograms, not pounds. [The Institute for Safe Medication Practices has reported that confusion between grains and grams led to a patient receiving phenobarbital 0.5 grams instead of 0.5 grains (0.03 grams) after the practitioner misread the prescription.

The Canadian "Gimli Glider" accident in 1983, when a Boeing 767 jet ran out of fuel in mid-flight because of two mistakes related to in calculating the fuel supply of Air Canada's first aircraft to use metric measurements: mechanics miscalculated the amount of fuel required by the aircraft as a result of their unfamiliarity with metric units.

The root cause of NASA's 1999 loss of the US$125 million Mars Climate Orbiter which crashed into Mars was a mismatch of units - the spacecraft engineers calculated the thrust forces required for velocity changes using US customary units (lbf·s) whereas the team who built the thrusters were expecting a value in metric units (N·s) as per the agreed specification.

From Wikipedia
1. When was the metric system first proposed?
2. What were the 2 units that were part of the first proposal?
3. What countries do not use the metric system?
4. What were some of the reasons for the development of a universal measurement system?
5. List fields in the United States that use metrics.

The unit of length is the meter. The meter is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second. The abbreviation for meter is m.

The origins of the meter go back to at least the 18th century. At that time, there were two competing approaches to the definition of a standard unit of length. Some suggested defining the meter as the length of a pendulum having a half-period of one second; others suggested defining the meter as one ten-millionth of the length of the earth's meridian along a quadrant (one fourth the circumference of the earth). In 1791, soon after the French Revolution, the French Academy of Sciences chose the meridian definition over the pendulum definition because the force of gravity varies slightly over the surface of the earth, affecting the period of the pendulum.

Thus, the meter was intended to equal 10⁻⁷ or one ten-millionth of the length of the meridian through Paris from pole to the equator. However, the first prototype was short by 0.2 millimeters because researchers miscalculated the flattening of the earth due to its rotation. Still this length became the standard. (The engraving at the right shows the casting of the platinum-iridium alloy called the "1874 Alloy.") In 1889, a new international prototype was made of an alloy of platinum with 10 percent
iridium, to within 0.0001, that was to be measured at the melting point of ice. In 1927, the meter was more precisely defined as the distance, at 0°, between the axes of the two central lines marked on the bar of platinum-iridium kept at the BIPM, and declared Prototype of the meter by the 1st CGPM, this bar being subject to standard atmospheric pressure and supported on two cylinders of at least one centimeter diameter, symmetrically placed in the same horizontal plane at a distance of 571 mm from each other.

The 1889 definition of the meter, based upon the artifact international prototype of platinum-iridium, was replaced by the CGPM in 1960 using a definition based upon a wavelength of krypton-86 radiation. This definition was adopted in order to reduce the uncertainty with which the meter may be realized. In turn, to further reduce the uncertainty, in 1983 the CGPM replaced this latter definition by the following definition:

The meter is the length of the path travelled by light in vacuum during a time interval of 1/299,792,458 of a second.

Note that the effect of this definition is to fix the speed of light in vacuum at exactly 299,792,458 m·s⁻¹. The original international prototype of the meter, which was sanctioned by the 1st CGPM in 1889, is still kept at the BIPM under the conditions specified in 1889.

Ok, that is a bit much. But that gives you an idea of exacting science is and how important measurements are.

Unit of mass is kilogram. However, some sources will say the base unit for mass is the gram. Kilogram contains a prefix, kilo (kilo = 1000). The rest of the base units don’t contain a prefix. A gram is a very small measurement; it is about the mass of 1 large paperclip. Since it is so small, it is often not practical to use to measure objects. Additionally, most of the derived units such as force and momentum use the kilogram. For these reasons, kilograms is used as the base unit of mass.

The unit of time is the second. The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom.

The metric unit for liquid volume that we will be using is the liter. It is abbreviated with a L. The liter is not considered to be a base unit though. The base unit for volume is actually is m³ or cubic meter.

Many metric units are called derived. This means that they cannot be measured, but are determined through calculations. There are many of these. Some of the ones we will use in class include: for volume, the cubic meter m³ (L x w x h), for speed or velocity m/s (distance/time).

6. What is the base unit for length?

7. What is the base unit for mass?

8. What unit will we be using for volume?
The prefixes are used when measuring larger or smaller things than the base unit. Adding a prefix from the top row is the same as multiplying by a power of ten, and one from the bottom section is the same as dividing by a power of ten.

9. How much is the base unit multiplied by if the prefix k is added?

10. What does the prefix da mean?

11. What is the numerical value for deci?

12. What does the prefix mm stand for? How big is it?

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<th>Kilo-</th>
<th>Mega-</th>
<th>Giga-</th>
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