D Units Used in Science

In the American system of measurement (originally developed in England), the fundamental units of length, weight, and time are the foot, pound, and second, respectively. There are also larger and smaller units, which include the ton (2240 lb), the mile (5280 ft), the rod (16 1/2 ft), the yard (3 ft), the inch (1/12 ft), the ounce (1/16 lb), and so on. Such units, whose origins in decisions by British royalty have been forgotten by most people, are quite inconvenient for conversion or doing calculations.

In science, therefore, it is more usual to use the *metric system,* which has been adopted in virtually all countries except the United States. Its great advantage is that every unit increases by a factor of ten, instead of the strange factors in the American system. The fundamental units of the metric system are:

- length: 1 meter (m)
- mass: 1 kilogram (kg)
- time: 1 second (s)

A meter was originally intended to be 1 ten-millionth of the distance from the equator to the North Pole along the surface of Earth. It is about 1.1 yd. A kilogram is the mass that on Earth results in a weight of about 2.2 lb. The second is the same in metric and American units.

Length

The most commonly used quantities of length of the metric system are the following.

Conversions

1 kilometer (km) = 1000 meters = 0.6214 mile
1 meter (m) = 0.001 km = 1.094 yards = 39.37 inches
1 centimeter (cm) = 0.01 meter = 0.3937 inch
1 millimeter (mm) = 0.001 meter = 0.1 cm
1 micrometer (μm) = 0.000001 meter = 0.0001 cm
1 nanometer (nm) = 10^{-9} meter = 10^{-7} cm

Table D1 Length

To convert from the American system, here are a few helpful factors:

- 1 mile = 1.61 km
- 1 inch = 2.54 cm

Mass

Although we don't make the distinction very carefully in everyday life on Earth, strictly speaking the kilogram is a unit of mass (measuring the quantity of matter in a body, roughly how many atoms it has,) while the pound is a unit of weight (measuring how strongly Earth's gravity pulls on a body).

The most commonly used quantities of mass of the metric system are the following.

Conversions
1 metric ton = 10^6 grams = 1000 kg (and it produces a weight of 2.205×10^3 lb on Earth)
1 kg = 1000 grams (and it produces a weight of 2.2046 lb on Earth)
1 gram (g) = 0.0353 oz (and the equivalent weight is 0.002205 lb)
1 milligram (mg) = 0.001 g

Table D2 Mass

A weight of 1 lb is equivalent on Earth to a mass of 0.4536 kg, while a weight of 1 oz is produced by a mass of 28.35 g.

Temperature

Three temperature scales are in general use:

- Fahrenheit (F); water freezes at 32 °F and boils at 212 °F.
- Celsius or centigrade[1] (C); water freezes at 0 °C and boils at 100 °C.
- Kelvin or absolute (K); water freezes at 273 K and boils at 373 K.

All molecular motion ceases at about −459 °F = −273 °C = 0 K, a temperature called *absolute zero.* Kelvin temperature is measured from this lowest possible temperature, and it is the temperature scale most often used in astronomy. Kelvins have the same value as centigrade or Celsius degrees, since the difference between the freezing and boiling points of water is 100 degrees in each. (Note that we just say “kelvins,” not kelvin degrees.)

On the Fahrenheit scale, the difference between the freezing and boiling points of water is 180 degrees. Thus, to convert Celsius degrees or kelvins to Fahrenheit degrees, it is necessary to multiply by 180/100 = 9/5. To convert from Fahrenheit degrees to Celsius degrees or kelvins, it is necessary to multiply by 100/180 = 5/9.

The full conversion formulas are:

- K = °C + 273
- °C = 0.555 × (°F − 32)
- °F = (1.8 × °C) + 32

1 Celsius is now the name used for centigrade temperature; it has a more modern standardization but differs from the old centigrade scale by less than 0.1°.