1.4 Units of Measurement

- Many properties of matter are quantitative, i.e., associated with numbers.
- A measured quantity must have BOTH a number and a unit.
- The units most often used for scientific measurement are those of the **metric system**. See metric prefixes AND their exponential values

SI Units

- 1960: All scientific units use **S**ystème **I**nternational d'Unités (**SI** Units).
- There are seven base units. See the *handout* on SI Units
- Smaller and larger units are obtained by decimal fractions or multiples of the base units.

Length and Mass

- SI base unit of length = meter (1 m = 1.0936 yards).
- SI base unit of mass (not weight) = kilogram (1 kg = 2.2 pounds).
  - **Mass** is a measure of the **amount of material** in an object.

Temperature

- *Temperature* is the measure of the hotness or coldness of an object.
- Scientific studies use Celsius and Kelvin scales.
- **Celsius scale**: water freezes at 0°C and boils at 100°C (sea level).

Kelvin scale (SI Unit):
  - Water freezes at 273.15 K and boils at 373.15 K (sea level).
  - is based on properties of gases.
  - Zero is the lowest possible temperature (absolute zero).
  - 0 K = –273.15°C.
- Fahrenheit (**not** used in science):
  - Water freezes at 32°F and boils at 212°F (sea level).
  - Conversions:

$$°F = \frac{9}{5}°C + 32$$

$$°C = \frac{5}{9}(°F - 32)$$

$$°C = K - 273.15$$

$$K = °C + 273.15$$

Derived SI Units

- These are formed from the **seven** base units.
- Example: Velocity is distance traveled per unit time, so units of velocity are units of distance (m) divided by units of time (s): m/s.

Volume

- Units of volume = (units of length)^3 = m^3.
- This unit is unrealistically large, so we use more reasonable units:
  - cm^3 [also known as mL (milliliter) or cc (cubic centimeters)]
  - dm^3 (also known as liters, L).
- Important: the liter is not an SI unit.

Density

- Is used to characterize substances.
- **Density** is defined as mass divided by volume.
- Units: g/cm^3 or g/mL (for solids and liquids); g/L (often used for gases).
- Was originally based on mass (the density was defined as the mass of 1.00 g of pure water at 25°C).