Chapter 1: The Nature of Science

Section 2: Standards of Measurement

Description: a spoken or written summary of observations

- 2 types of descriptions
  - *Qualitative descriptions*: use your senses to describe observations
    - Color of a shirt
  - *Quantitative description*: use numbers and measurements to describe an observation
    - 70^{o}C outside

International System of Units (SI): the internationally accepted system for measurement

Quantity Measured	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric Current	ampere	A
Temperature	kelvin	K
Amount of Substance	mole	mol
Intensity of light	candela	cd

Metric system: uses factors of 10 and 100 to convert one unit to another

kilo – hecto – deka - Base Unit – deci – centi – milli

(K) (h) (da) (g) (d) (c) (m)

(L)

(m)

gram (g), Liter (L), and meter (m)

*Practice on board

Dimensional analysis: using conversion factors to move, or convert, one unit to another

- Conversion factor – a ratio of equivalent values having different units
    - 1 tablespoon = 3 teaspoons
    - 1 week = 7 days
    - 1 day = 24 hours
    - 1 dollar = 4 quarters

Practice using conversion factors

- Start with money!
    - How many nickels are in $2.50?

      ($2.50 ~~dollars~~) (4 ~~quarters~~) (5 nickels) = 50 nickels
      1 ~~dollar~~ 1 ~~quarter~~

    - How many pennies are in $11.92?

      ($11.92 ~~dollars~~) (100 pennies) = 1192 pennies
      1 ~~dollar~~

- Practice with the Metric system
    - Conversion factor: 100 cm = 1 m

    - Convert 2.5 meters into centimeters

      (2.5 ~~m~~) (100 cm) = 250 cm
      1 ~~m~~

Volume: the amount of space that matter occupies

- Solid = length x width x height
    - Label is usually measured in centimeters (cm) so the label would be centimeters cubed (cm^3)
    - All solid volume is cubed in its label
        - in^3, cm^3, ft^3
- Liquid = the measurement on the graduated cylinder
    - Label is usually measured in liters (L)
        - We know fluid ounces (fl oz) or pints (pt.)
    - The label is never cubed

- 1 mL = 1 cm^3

Matter: anything that takes up space and has mass

- Give me some examples
  - Solid, liquid, and gas examples

Mass: the amount of matter in an object

- How much "stuff" it is made up of
- Never changes depending on gravity

Density: a measure of the mass of a material in a given volume

- Density (D) = $\frac{\text{mass (g)}}{\text{volume } (cm^3)}$

There are three types of labels to describe temperature:

1. **Celsius**
   a. Labeled as ^oC
   b. Label we use in science labs
2. **Fahrenheit**
   a. Labeled as ^oF
   b. Label used in weather forecasts
3. **Kelvin**
   a. Labeled as K
   b. Popular in scientific applications because it has no negative numbers

Conversions:

- ^oF into ^oC
  - $^oC = (^oF - 32)/1.8$
- ^oC into ^oF
  - $^oF = (1.8 * ^oC) + 32$
- K into ^oC

- $K = 273.15 + {}^{o}C$

	^{o}C	^{o}F	K
Freezing Point	0 ^{o}C		
Boiling Point	100 ^{o}C		
Room Temperature		70 ^{o}F	
Body Temperature		98.6 ^{o}F	

Measurement and Uncertainty:

- Measure how precise your instrument can measure
- Estimate the last number

Significant figures (digits): The number of digits that are meaningful

- They have an accuracy matching our measurements

Rules to determining significant figures:

1. All digits that are non-zeros are considered significant
    a. Ex. 3.95g has 3 significant digits
2. Zeros appearing between non-zero digits are significant
    a. Ex. 40.7 L has 3 significant digits
3. Zeros appearing in front of all nonzero digits are not significant
    a. Ex. 0.095897 m has 5 significant digits
4. Zeros at the end of a number and to the right of a decimal point are significant
    a. Ex. 85.00 g has 4 significant digits
5. Zeros at the end of a number but to the left of a decimal point may or may not be significant. If a zero has not been measured or estimated but is just a placeholder, it is not significant. A decimal point placed after zeros indicates that they are significant.
    a. Ex. 2000 m has 1 significant digit
    b. Ex. 2000. m has 4 significant digits

Addition or Subtraction with Significant Figures:

- The answer must have the same number of digits to the right of the decimal point as there are in the measurement having the fewest digits to the right of the decimal point.
    - Ex. 25.1 g + 2.03 g = 27.1 g

Multiplication and Division with Significant Figures:

- The answer can have no more significant figures than are in the measurement with the fewest number of significant figures
    - Ex. D = m/V = 3.05 g / 8.47 mL = 0.360 g/mL