Chemical Foundations

Chapter 1

The Metric System

- mass → grams or kilograms
  - milligram = 1/1000g
- length --. centimeters (1/100m)
- volume → liters or milliliters
  - 1ml = $1cm^3$

Unit Analysis

- shows if problem is set up correctly
- all units should cancel to yield the correct unit on the final answer
- the answer to a problem must **Always** have a unit!

ex. 1.0 moles of dollar bills was created at the time Earth was formed, 4.5 billion years ago. This money was then given away at the rate of exactly 1.0 million dollars per second since that time. When did the money run out or how much of it remains today?

Significant Figures – rules for counting sig figs

1. Non zero integers are always significant
2. Zeroes
   a. Leading zeros are never significant
      i. ex. 0.0012 (2 sig figs)
   b. Zeros between nonzero integers are always significant
      i. ex. 504 (3 sig figs)
      ii. 0.01501 (4sig figs)
   c. Trailing zeros are significant only if the number contains a decimal point
      i. 100 (1 sig fig
      ii. 100. (3 sig figs)
      iii. 1.00×10^2 (3 sig figs)
      iv. .002010 (4 sig figs)
3. If a number is determined by counting, all digits in the number are significant.
   a. an exact number, not determined by measurement
      i. ex. 24 students in the class (2 sig figs)
      ii. 340 cars in the parking lot (3 sig figs)

Never use temperature to determine the number of significant figures!

(Don't worry about carrying the correct number of sif figs through the problem. Be sure your
<u>final answer</u> has the <u>correct number of sig figs that match the lowest number of sig figs in the question</u>!

<u>Significant Figures in Calculations</u>

1. Addition and Subtraction
    a. the number of decimal places in the final answer should be the same as in the number with the least number of decimal places
        i. ex
        15.13 + 2.5 + 107.93 = 124.723 = 124.7
        65.367 - 42.54 = 22.827 = 22.83

2. Multiplication and Division
    a. the number of sig figs in the final answer should be the same as in the number with the least number of sig figs.
        i. ex. $(521)(64.032) = 33{,}360{,}672 = 33{,}400{,}000 = 3.34X10^{7}$
        ii. ex. $56/4321 = 0.0129599 = 0.013 = 1.3X10^{-2}$

Ex. 1.4

a. $1.05 \text{ X } 10^{-3} / 6.135$
b. $21 - 13.8$
c. As part of a lab assignment to determine the value of the gas constant ®, a student measured the pressure (P), volume (V), and temperature (T) for a sample of gas, where R = PV/T. The following values were obtained: P = 2.560, T = 275.15, and V = 8.8. Calculate R to the correct number of significant figures.

<u>Precision and Accuracy</u>

- Precision
    - the degree of agreement between several measurements of the same quantity
    - if the values are <u>close to each other</u> they have <u>good precision</u>
- Accuracy

- the agreement of a measurement with the true value
- if the values are close to the correct answer they have good accuracy

Ex: comment on the precision & accuracy of the following data (true value = 2.84)

Experiment	Result	Experiment	Result	Experiment	Result
1	2.00	1	2.86	1	3.65
2	3.20	2	2.85	2	3.64
3	3.70	3	2.83	3	3.66
4	1.60	4	2.84	4	3.65

Temperature

- a measure of the average kinetic energy of a substances particles.
- measured using a thermometer
- the fixed points on a thermometer are:
  - boiling point of H_2O - 100°C = 373k
  - freezing point of H_2O = 0°C = 273k
    - K = °C + 273
  - 0k = absolute zero (Theoretically, this is the coldest possible temperature)

Classification of Matter

- Matter
  - anything that has mass and volume
  - anything with mass and volume has density
- Density
  - the amount of substance in a given volume
  - Density = Mass/volume
    - density is easily measured and can be useful in solving many problems

Ex. 1.13 V = 25.00cm^3, m = 19.625g, D = ?

- Phases of Matter could be:
  - solid → has definite shape & definite volume
  - liquid → has definite volume but does not gave definite shape
  - gas → does not have definite shape or definite volume
  - could be a <u>substance</u> or a <u>mixture</u>
    - Substance
      - matter, any sample of which has the <u>same composition</u> and <u>properties</u>
      - is "<u>homogeneous</u>"
      - is either an element or a compound
        - Elements
          - made up of atoms that all have the <u>same atomic number</u> (same # of protons)
          - <u>cannot</u> be decomposed by a chemical change
        - Compounds
          - made up of <u>2 or more elements chemically combined</u> (bonded together)
          - can be <u>decomposed</u> into simpler substances
            - ex. $C_6H_{12}O_6$ → $6C + 6H_2O$
          - has properties that are different from the elements that make it up

- ex. $2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$

- Mixture
  - 2 or more substances "<u>mixed</u>" together (<u>not</u> chemically combined)
  - retains the properties of the components of the mixture
    - ex. $NaCl_{(aq)}$
  - could be <u>heterogeneous</u> (solids)
    - ex. salt & pepper, soil
  - could be <u>homogeneous</u>
    - <u>Solution</u> = a homogeneous mixture
      - ex. KoolAid, $NaCl_{(aq)}$, Air (at sea level)
  - mixtures can be separated by <u>physical</u> changes (Δ in form, not composition)
    - ex. Distillation → 2 liquids with different boiling points
    - Filtration → removing solid particles by allowing liquid to pass through a filter
    - Chromatography → components move through a column of another substance and separate.