KEY TOPICS: CHAPTER 1

Chapter 1: Matter, Measurement, and Problem Solving

This chapter is deceptively easy. Yes, the topics are simple to understand, but there are details that you need to be careful with. Reading the chapter won't be enough. WORK ENOUGH PROBLEMS that you are SURE of what you are doing! Also, doing well with unit conversions will help you throughout the semester and beyond. Many of the problems we work in this class will be based on the unit conversions you will learn to work here.

- ❑ The scientific method is a way of learning about our world that emphasizes observation and experiment.
  - ✓ While most of us were taught that the scientific method must occur with steps in a particular order, it is now understood that scientists often perform the steps in whatever order fits the problem they are trying to solve and often includes revisions of Laws, hypotheses, or theories due to the result of an experiment.
- ✓ The scientific method always begins with an observation!
- ✓ Know the definition and differences between the steps of the scientific method!
- ✓ Be able to apply your knowledge of the definitions to label a statement as law, theory, hypothesis, or observation!

- ❑ Different types of matter have many properties, and can go through numerous changes. We classify these properties and changes as chemical or physical.
  - ❑ Physical: Properties and changes that are physical do not involve a change in the composition of the substance.
    - ✓ Phase changes are always physical changes.
    - ✓ Dividing a substance into many tiny pieces is also physical.
    - ✓ Look for verbs like vaporizes, evaporates, freezes, boils, or mixes without reaction to indicate a physical change.
    - ✓ Separating a mixture involves only physical processes.
      - ✓ You should be able to describe mixture separation through decanting, distillation, and filtration. Explain which physical property of the components is exploited in the separation to cause the separation.
  - ❑ Chemical: Properties and changes that are chemical ALWAYS involve a change in the composition of the substance.
    - ✓ You cannot observe a chemical property except through chemical change. For example flammability is a chemical property of wood. This is only known because someone tried to burn it. By checking for a chemical property, I change the composition of the wood.
    - ✓ Chemical changes are identified by words such as: burns, reacts, decomposes, corrodes, oxidizes.

- MATTER is anything that has mass and takes up space. Atoms are the fundamental building blocks of all matter, which are often bonded together to form molecules.
- One way to classify matter is according to its state. The common states of matter are solid, liquid, and gas.
  - ✓ The atoms or molecules in a solid are closely packed and cannot move past one another. Therefore, solids are incompressible, do not flow, and have definite shape and volume.
  - ✓ In a liquid, the atoms or molecules are still closely spaced, but they are able to flow past one another. So, liquids are incompressible, but have indefinite shape.
  - ✓ "A gas is like Kansas." Gas phase molecules or atoms have large distances between them. In fact, we consider a gas mostly empty space! Because the particles are free-moving and far apart, a gas is compressible and has indefinite shape.
- Another way to classify matter is according to its composition.
  - ✓ Matter may be classified as a pure substance if it is made up of only one type of atom or one type of compound. Pure substances cannot be separated through physical means like boiling or filtering.
  - ✓ Matter is classified as a heterogeneous or homogeneous mixture if it is made up of a combination of more than one kind of atom or compound. Both types of mixtures can be separated using physical processes.

Unit Conversions

This is a HUGE skill that you need to master! There are numerous methods that are equally successful. Your job is to practice enough of these problems to be able to worry about the problem and not about the mechanics.

- ❑ Gearing up for Dimensional Analysis
  Before you jump into working dimensional analysis problems, you need the following skills:
  - ❑ Temperature Unit Conversions
    - ✓ Temperature is a measure of how much thermal energy a substance has. When the temperature of a substance changes, it indicates a transfer of thermal energy called heat.
    - ✓ There are three common temperature scales in use. These are Fahrenheit, Celsius, and Kelvin. **These unit conversions occur using algebraic equations. You should be able to use these equations to convert from one scale to another, but I will provide you with the equations.**
  - ❑ Prefix Multipliers
    - ✓ These are an alternative to scientific notation. They are used to express units that are tens of times larger or smaller than the base unit.
    - ✓ **Memorize the prefixes and their multipliers from Table 1.2 on page 17 of the text.**
    - ✓ Multipliers can be used for many types of units. For example, kilograms, millimeters, gigabytes…the list goes on and on.
  - ❑ Derived Units
    - ✓ Some units are combinations of other units. For example volume, area, speed, density.
    - ✓ Density is an intensive property (independent of sample size). It is a measure of the amount of matter in a given volume.
    - ✓ Know how to calculate density from a mass and a volume, or how to manipulate the density equation to calculate a mass or a volume given the density and the other variable.
  - ❑ Significant Figures
    - ✓ Know how to determine how many sig figs a number has. (The rules are in your notes and in the book)
    - ✓ Know how to round any number to a given number of sig figs. (Be ready to use scientific notation to do this!)
    - ✓ Be able to use sig figs in your calculations. The most important thing to remember here for conversion problems is that most of the time, you will report your answer with the same number of sig figs as you have in the beginning value.

- Unit Conversions using Dimensional Analysis

  Most often, when we need to convert from one type of unit to another, we will use conversion factors and then employ a technique called dimensional analysis. This math tool will be used throughout this class to do many types of problems, so do your best to MASTER it now before we add much chemistry to it.

  - ✓ One of the most challenging parts of working a unit conversion problem is getting a plan for how to get from the units you have to the units you need. You will get better at this as you practice. The best strategy is to look at the conversion factors you have and find those units see where you can go from here. Then, keep taking baby steps until you get to the units you need.
  - ✓ While the resulting method is the same in all of the following cases, I have split up the problems to show that there are different ways of acquiring a conversion factor.

  - Simple
    - ✓ These are usually English to metric conversions, where the conversion factor is found on a table. Note that you SHOULD NOT waste time memorizing these as I will give you any of these conversion factors that you need. Use the back of the book as an example of conversion factors of this type.
  - Prefix Units
    - ✓ You will need to write your own conversion factor for this type of conversion factor. The table of prefix multipliers is critical for building these, and MUST BE MEMORIZED.
    - ✓ The conversion factors are all written like this:

      1 x Prefix Unit =Multiplier x Base Unit

    Example: 1ng =10^{-9} g

    1 Gbyte = 10^{9} bytes

    1mm = 10^{-3} m
  - Units raised to a Power (volume or area)
    - ✓ For these conversion factors, you will use a conversion factor from the simple or the prefix cases above, and then cube or square them to give you the new conversion factors you need.

    Example: For volume, take a length conversion factor, and cube each number and unit to make a volume conversion factor:

    Length: 1 in = 2.54 cm

    Volume: 1^3 in^3 = $(2.54)^3$ cm^3
  - Derived Units
    - ✓ When you convert derived units to new derived units (think m/s to miles per hour, or g/mL to kg/m^3) You need to treat the top and bottom units separately
    - ✓ You can also use derived units as conversion factors. For example, 10.54 g/mL means that you can write 10.54 g = 1 mL which is a great conversion factor for converting units of mass to units of volume.
  - You will also be responsible for doing conversion problems based on word problems. I have put several online for you to practice. These problems are more complex and should be attempted ONLY after you feel comfortable with the basic 4 types of conversions.