CHEMISTRY 3A
OBJECTIVES AND STUDY HINTS

For each chapter, you will be provided with a list of key objectives on which you should concentrate. Use this outline as a guide when studying for quizzes and exams. Of course, you are responsible for thoroughly reading each chapter, with the exception of sections or topics which are specifically deleted by your instructor.

You should read the chapters and attempt the homework problems ***before*** we cover the material in class. Note any questions or problems you had with the material and concentrate on those areas when we discuss them in class. After reading the chapter and working the homework problems, complete the worksheets which are provided for each chapter. The worksheets are excellent preparation for the chapter quizzes. The three exams will cover material from the chapters, assigned homework, worksheets, quizzes, lectures, and lab experiments. The topics which are emphasized in lecture are most likely to be emphasized on quizzes and exams, so take good notes and review them. The exams will consist in large part of problems like those on the quizzes and worksheets. However, don't be deceived into thinking that simply memorizing the worksheets and quizzes will be sufficient preparation for exams. Problems may be asked in different ways on exams than on the quizzes in order to measure your ***understanding*** of the material, not your ability to memorize. In this course critical thinking skills are considered more important than the ability to memorize facts. While some material must be memorized to function smoothly, it will be kept to a minimum.

A comprehensive final exam will be given on the last day of class. If you understand the material from the three exams and the quizzes, you should do well on the final. Always feel free to ask questions regarding the material if there are topics you don't understand. If you require more help than classtime permits, then you should see me in my office for some extra help.

CHAPTER 1 --- OBJECTIVES

After completing your study of this chapter, you should

1. Understand the ***scientific method*** and how to apply it in solving a problem or understanding a natural phenomenon. Recall how we used the scientific method in determining why Diet Coke floats in water while Classic Coke sinks. The steps in the scientific method are:

   Observation: (observation of a phenomenon)

   Hypothesis: (a tentative explanation based on initial observations)

   Experimentation: (designed to test the hypothesis)

   Theory: (a hypothesis which has been confirmed by experimentation and appears to explain the initial observations)

   Experimentation: (designed to test the theory more thoroughly)

   Law: (a theory which has been tested and found to hold true in all cases)

2. Know the following conversions:

   a. 1 in = 2.54 cm
   b. 1 lb = 454 g or 1 kg = 2.20 lb
   c. 1 qt = 946 mL or 1 L = 1.06 qt
   d. 1 lb = 16 oz
   e. 1 ga = 4 qt
   f. 1 qt = 2 pt
   g. 1 ft = 12 in
   h. 1 yd = 3 ft
   i. 1 mi = 5280 ft
   j. 1 ton = 2000 lb

3. Know the base units of measurement used in the metric system, i.e. the ***meter, gram, liter, and Kelvin***.

4. Know the meaning of the metric prefixes ***milli, centi, and kilo***. You should also be able to use other metric prefixes, given their definitions.

5. Know the difference between ***mass*** and ***weight***.

6. Know the difference between ***precision*** and ***accuracy***.

7. Understand how to write numbers in scientific notation, and be able to multiply and divide numbers which are written in scientific notation.

CHAPTER 8 --- OBJECTIVES

After completing your study of this chapter, you should

1. a. Understand the basic concept of ***significant figures*** and be able to round measured number to the appropriate number of significant figures. You will not be graded down on quizzes or exams for errors in significant figures.

2. Know how to use ***dimensional analysis*** to solve problems involving unit conversions. Examples will include:

    a. metric - metric conversions
    b. English - English conversions
    c. metric - English conversions
    d. dosage calculations

3. Understand the concept of ***density***, know that density equals mass divided by volume, and be able to determine density, mass, or volume, given the values of the other two variables.

4. Know the three systems used for temperature measurement, ***Fahrenheit***, ***Celsius***, and ***Kelvin***. Given the equation relating ^{o}C and ^{o}F, be able to convert temperatures from one system to the other. Know how to convert temperatures between the Celsius and Kelvin scales.

5. Understand the concept and definition of absolute zero and know that absolute zero equals -273 ^{o}C.

CHAPTER 2 --- OBJECTIVES

After completing your study of this chapter, you should

1. Understand the concept of a ***scientific model***.

2. Know that the universe consists of ***matter*** and ***energy***.

4. Know that chemistry is " ***the study of matter and the changes it undergoes".***

4. Know that matter is "***anything which has mass and occupies space***". For example, all solid, liquid, and gaseous substances are types of matter. Energy includes such things as heat, visible light, microwaves, ultraviolet radiation, and x-rays.

5. Know the three states of matter, ***solid***, ***liquid***, and ***gas***, and the properties which distinguish the three.

6. Be able to explain why oxygen is a gas at room temperature, water is a liquid, and gold is a solid.

7. Know the definition of an ***element***.

8. Know the names and symbols for element numbers 1-20,26,29,30,33,35,47,50,53,79,80, and 82.

9. Know the differences between the **discrete theory** of matter proposed by Democritus and the **continuous theory** of Aristotle.

10. Know the principles of **Dalton's Atomic Theory**.

11. Understand the **Laws of Definite Proportions** and **Multiple Proportions**.

12. Know that matter is electrical in nature and that like charges repel and opposite charges attract.

13. Know the three subatomic particles which comprise all atoms, the ***electron***, ***proton***, and ***neutron***.

14. Know that the atom is mostly empty space, with a very small, dense ***nucleus*** containing protons and neutrons, surrounded by electrons.

15. Know the definition of an ***isotope*** and be able to write the ***nuclear symbol*** for any isotope.

16. Know the definition of ***atomic number***, ***mass number***, and ***atomic mass***.

17. Understand how the atomic mass of an element is calculated as the weighted average of the masses of the naturally occurring isotopes of an element.

18. Know how to use the periodic table to find the symbol, atomic number, or atomic mass of an element.

19. Be able to identify the metallic elements, nonmetallic elements, periods, rows, main group elements, and transition elements on the periodic table.

20. Know the definitions of ***ions***, ***cations***, and ***anions***.

CHAPTER 11 --- OBJECTIVES

After completing your study of this chapter, you should

1. Know that there are discrete ***energy levels*** around the nucleus in which electrons reside.

2. Know the maximum number of electrons each of the first four levels can hold.

3. Know what **electromagnetic radiation** is and the relative energies of microwave, infrared, visible, ultraviolet, x-ray, and gamma radiation.

4. Know the colors of visible light and be able to rank them in order of increasing or decreasing energies. Remember Roy G. Biv.

5. Be able to explain why an atom which has been excited emits only a few discrete wavelengths of radiation instead of a continuous spectrum.

6. Understand the meaning of ***ground state*** and ***excited state***. Understand that when an atom absorbs energy an electron jumps to a higher energy level (excited state) and when the electron returns to the lower energy level (ground state), a photon of electromagnetic energy is emitted.

7. Understand the basic concepts of the **Bohr Model** of the atom.

8. Understand the basic concepts of the **Quantum Mechanical** model of the atom.

9. Know that the energy levels in atoms are further divided into sublevels, or subshells, which have letter designations of s, p, d, and f.

10. Know the number of electrons which each subshell can accommodate.

11. Know that the subshells are further divided into ***orbitals***, each of which can hold a maximum of two electrons.

12. Be able to write the shorthand electronic configuration of any element.

CHAPTERS 3 and 12 --- OBJECTIVES

After completing your study of this chapter, you should

1. Be able to classify a sample of matter as an ***element***, a ***chemical compound***, a ***homogeneous mixture***, or a ***heterogeneous mixture***.

2. Know the definitions of ***ionic*** and ***covalent*** bonding.

3. Be able to identify a compound as ***ionic*** or ***covalent*** (***molecular***).

4. Know that covalent bonds are formed when two ***nonmetal*** atoms share a pair of electrons. A single bond consists of one pair of shared electrons, a double bond has two shared pairs, and a triple pair has three shared pairs. Quadruple bonds are rare and occur only in certain transition metal compounds.

5. Know that a metal and nonmetal will form an ionic bond, while two nonmetals will form a covalent bond.

6. Be able to determine the number of ***valence electrons*** in elments from the main group.

7. Know that the term ***isoelectronic*** means that two atoms have exactly the same electronic configuration. For example, an oxide ion is isoelectronic to a neon atom.

8. Be able to write the ***electron dot symbol*** for any main group element.

9. Know that each covalent bond adds one electron to an atom. Thus, elements form one covalent bond for each electron they need to complete their octet of electrons. For example, elements in group VII form one bond, elements in group VI form two bonds, and so on.

10. Know the difference between ***bonding*** and ***nonbonding electrons***.

11. Given the formula for a covalent compound, be able to draw a ***ball and stick*** and ***Lewis*** diagram for the compound.

12. Know the meaning of the ***octet rule***.

13. Know that there are exceptions to the octet rule, though in this class we will deal mainly with those compounds which follow this rule.

14. Using VSEPR theory, be able to predict the shape of a molecule based on the number of atoms and nonbonding pairs of electrons attached to the central atom in the molecule.

15. Be able to name binary ionic compounds containing elements from the s and p blocks.

16. Be able to write formulas given the name of an ionic compound containing elements from the s and p blocks.

17. Be able to name binary ionic compounds containing metals from the d and f blocks.

18. Be able to write formulas given the name of an ionic compound containing Metals from the d and f blocks.

19. Be able to write formulas and names of ionic compounds containing polyatomic ions.

20. Be able to write names and formulas of binary covalent compounds.

CHAPTER 4 --- OBJECTIVES

After completing your study of this chapter, you should

1. Understand the difference between ***chemical*** and ***physical changes*** and be able to distinguish between examples of the two.

2. Identify evidence that a chemical reaction has occurred, such as a color change, the formation of a gas or solid, or a flame.

3. Be able to identify the **reactants** and **products** in a chemical reaction.

4. Know the symbols indicating the state of reactants and products, e.g., **solid, liquid, gas, or aqueous**.

5. Be able to balance chemical equations.

6. Know the meaning of the terms **precipitate** and **precipitation reaction**.

7. Be able to describe what happens when an ionic compound dissolves in water.

8. Be able to use the solubility rules to predict if a precipitation reaction will occur and what the identity of the precipitate will be.

9. Be able to write the **molecular**, **complete ionic**, and **net ionic** equations for precipitation reactions.

CHAPTER 5 --- OBJECTIVES

After completing your study of this chapter, you should

1. Understand the ***Arrhenius*** and ***Bronsted-Lowry*** definitions of ***acids*** and ***bases***.

2. Be able to write names and formulas of acids.

3. Know the definitions of strong and weak acids and bases and be able to identify a compound as a strong acid, strong base, weak acid, or weak base.

4. Know the common properties of acids and bases.

5. Be able to write acid-base neutralization reactions.

6. Understand that water can dissociate into hydrogen and hydroxide ions, and is thus both an acid and a base.

7. Understand the difference between a substance being an acid or a base and a solution being acidic or basic.

8. Understand the definition of ***pH*** and ***pOH*** and be able to relate these mathematically to the concentration of H^+ and OH^- ions.

9. Be able to identify the **acid**, **base**, **conjugate acid**, and **conjugate base** in a chemical equation.

CHAPTER 6 --- OBJECTIVES

After completing your study of this chapter, you should

1. Know that oxidation involves the loss of electrons and reduction the gain of electrons.

2. Know that an ***oxidizing agent*** gains electron while a ***reducing agent*** loses electrons.

3. Be able to identify ***combination reactions***, ***decomposition reactions***, ***combustion reactions***, and ***single-displacement*** reactions.

4. Understand how a voltaic cell uses redox reactions to produce electricity.

5. Understand the process of ***electrolysis***.

CHAPTER 7 --- OBJECTIVES

After completing your study of this chapter, you should

1. Know the difference between ***potential*** and ***kinetic energy*** and realize that in many cases both are present. Be able to determine whether examples contain primarily potential or kinetic energy.

2. Understand the ***Law of Conservation of Energy*** and that energy and mass are actually interconvertable.

3. Know the various types of potential energy; ***electrical, chemical, mechanical, gravitational, and nuclear.***

4. Understand that chemical reactions involve energy. When heat is released in a chemical reaction, the process is said to be ***exothermic***. A chemical reaction which absorbs heat is called ***endothermic***.

5. Understand what is meant by a ***spontaneous*** process.

6. Understand that (until Chapter 15) spontaneous processes always release energy, i.e., they are exothermic. On the energy hill, exothermic processes move down the hill from high to low energy, while endothermic processes must move up the hill.

7. Know the definitions of ***calorie (cal)*** and ***joule (J)***, and be able to convert between the two.

8. Understand that ***thermal energy*** (internal kinetic energy) is simply a measure of the motion of the atoms in a substance.

9. Know that the breaking of bonds is always endothermic and the formation of bonds is always exothermic.

10. Know the definition of ***specific heat***.

11. Be able to use the equation, $q = m \times \Delta T \times s$, to solve for any of the four variables, given the values of the other three.

CHAPTER 9 --- OBJECTIVES

After completing your study of this chapter, you should

1. Know that the atomic masses of the elements are based on the mass of the carbon - 12 isotope, which is assigned a mass of exactly 12 amu.

2. Know the definition of the ***atomic mass unit*** (amu).

3. Determine the number of atoms of each element in a compound.

4. Know the difference between the ***actual*** and ***empirical*** (simplest) formula of a compound.

5. Understand the definition of a ***mole*** and know that it is equal to 6.02×10^{23}.

6. Know that the atomic mass of an element can refer to the mass of 1 atom in units of amu, or to the mass of 1 mole of atoms in units of grams.

7. Be able to calculate the formula mass of an ionic compound, the molecular mass of a covalent compound, and the molar mass of any compound.

8. Be able to convert the mass of a substance into moles, molecules, atoms etc., and the reverse.

9. Be able to determine the percent composition of a compound from either masses of each element in a sample of the compound, or from the formula of the compound.

10. Be able to determine the empirical formula of a compound from mass data or the percent composition.

11. Be able to determine the actual formula of a compound from the empirical formula and molar mass.

CHAPTER 10 --- OBJECTIVES

After completing your study of this chapter, you should

1. Be able to write mole-mole conversion factors using the coefficients from a balanced chemical equation.

2. Be able to use a combination of gram-mole and mole-mole conversions to determine the mass of a reagent in a chemical reaction, given the mass of any other reagent in the reaction.

3. Know the definition of ***actual yield***, ***theoretical yield***, and ***percent yield***, and be able to calculate any one of these, given the other two.

4. Understand the meaning of ***limiting reagent*** and ***excess reagent*** in a chemical reaction.

5. Be able to use stoichiometric calculations to identify the limiting reagent in a reaction.

CHAPTER 13 --- OBJECTIVES

After completing your study of this chapter, you should

1. Know the basic properties of gases and how they differ from the properties of solids and liquids.

2. Know and understand the main points made in the **Kinetic Theory of Gases.**

3. Understand that pressure is a measure of the force exerted on a specific area.

4. Know the value of standard pressure in units of atmospheres, psi, torr, and mmHg, and be able to convert between any two units of pressure.

5. Be able to reason or calculate the direction of change in any one of the four gas parameters (P, V, n, T) given the changes in the other three.

6. Be able to use the combined and ideal gas laws to solve gas law problems.

7. Be able to determine whether a balloon can float, given the identity of the gas in the balloon and the composition of the atmosphere in which it is placed.

8. Understand and be able to use Dalton's Law of Partial Pressures.

CHAPTER 14 --- OBJECTIVES

After completing your study of this chapter, you should

1. Know the basic properties of liquids and solids.

2. Know and understand the three types of intermolecular forces; ***London***, ***Dipole***, and ***Hydrogen Bonding***.

3. Know how intermolecular forces affect ***viscosity***, ***surface tension***, ***boiling point***, ***vapor pressure***, and ***heat of vaporization*** of a liquid.

4. Know the properties of water which make it unique and how they are due to hydrogen bonding between water molecules.

5. Understand the meanings of ***vaporization*** and ***vapor pressure***.

6. Understand the processes of ***evaporation*** and ***boiling*** and how they are affected by pressure.

7. Know the meaning of a ***change of state*** and of the terms ***fusion***, ***freezing***, sublimation, and ***condensation***.

8. Know the definition of ***heat of fusion*** and ***heat of vaporization***.

9. Know the equations for calculating energy changes during changes of state.

10. Be able to draw and label a heating-cooling curve.

11. Understand the concept of ***dynamic equilibrium***.

12. Understand the concept of electronegativity and be able to predict whether a molecule will be polar or nonpolar.

CHAPTER 15 --- OBJECTIVES

After completing your study of this chapter, you should

1. Know the definition of ***solution***, ***solvent***, and ***solute***.
2. Be able to identify the solvent and solute in a solution.
3. Know the seven types of solutions which can be formed.
4. Know the three steps in the formation of a solution and which steps are endothermic and which are exothermic.
5. Understand the concept of ***entropy***.
6. Be able to determine the changes in entropy and energy in a given process.
7. Understand how pressure and temperature affect solubility.
8. Be able to determine whether a given solute would be expected to be more soluble in a polar or nonpolar solvent.
9. Understand the meaning of ***percent concentration*** and ***molarity*** and be able to solve problems using these measurements.