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 and 2 — OBJECTIVES

After completing your study of this chapter, you should

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

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

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

4. Know the three systems used for temperature measurement, Fahrenheit, Celsius, and Kelvin. Given the equation relating °C and °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 °C.

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

7. 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.

8. Know the difference between mass and weight.
9. 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)

10. 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

11. 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
CHAPTER 3 — OBJECTIVES

After completing your study of this chapter, you should

1. Know that the universe consists of matter and energy.

2. Know that chemistry is “the study of matter and the changes it undergoes”.

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

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

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

6. 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.

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

8. Understand the Law of Conservation of Mass, i.e., matter is neither created nor destroyed in a non-nuclear process, such as a chemical reaction. Or more simply, “what goes in, must come out”.

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

10. Know the difference between temperature and heat.

11. Know the definition of specific heat.

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

13. Be able to use the equation, \( q = m \times \Delta T \times c \), to solve for any of the four variables, given the values of the other three.

14. Be able to classify a sample of matter as an element, a chemical compound, a homogeneous mixture, or a heterogeneous mixture.
15. Understand the difference between chemical and physical changes and be able to distinguish between examples of the two.

16. 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.

17. Understand what is meant by a spontaneous process.

18. Understand that (until Chapter 14) 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.

19. Know the difference between chemical and physical properties.
CHAPTER 4 — OBJECTIVES

After completing your study of this chapter, you should

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

2. Know the principles of Dalton’s Atomic Theory.

3. Understand the Laws of Definite Proportions and Multiple Proportions.

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

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

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

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

8. Know the definition of atomic number and mass number.

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

10. Know the properties of metals, nonmetals, and metalloids, and be able to locate them on the periodic table.

11. Be able to identify periods and groups on the periodic table.

12. Know which elements are gases and which of these are diatomic.

13. Know the definition of allotropes and be able to cite an example.

14. Be able to predict the charges of ions of the main group elements.
CHAPTER 10 — 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.

13. Know the definition of valence electrons.

14. Be able to write the Lewis electron dot diagram for any main group element.

15. Be able to locate the following on a periodic table: groups, periods, the main group elements, the transition elements, the rare earth elements, the s, p, d, and f block elements, and the noble gases.
CHAPTER 5 — OBJECTIVES

After completing your study of this chapter, you should

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

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

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

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

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

6. Be able to write names and formulas of covalent compounds.

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

8. Know that positive ions are called \textit{cations} and negative ions are called \textit{anions}.

9. Know that the term \textit{isoelectronic} means that two atoms have exactly the same electronic configuration. For example, an oxide ion is isoelectronic to a neon atom.
CHAPTER 11 — OBJECTIVES

After completing your study of this chapter, you should

1. Know that chemical bonds can be either ionic or covalent.

2. Know that ionic bonds consist of attractions between cations and anions.

3. 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.

4. 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.

5. Understand the meaning of electronegativity and be able to determine which of a pair of main group elements is more electronegative based on their positions on the periodic table.

6. Be able to determine whether a covalent bond is polar or nonpolar and indicate which atom is negative and which is positive.

7. Know the difference between bonding and nonbonding electrons.

8. 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.

9. Be able to determine whether a compound or molecule is ionic, nonpolar covalent, or polar covalent.

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

11. Know the meaning of the octet rule.

12. Know that there are exceptions to the octet rule, though in this class we will study only those compounds which follow this rule.
CHAPTER 6 and 7 — OBJECTIVES

After completing your study of this chapter, you should

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

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

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

4. Be able to balance chemical equations.

5. Know the meaning of the terms precipitate and precipitation reaction.

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

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

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

9. Know the Arrhenius definitions for acids and bases.

10. 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.

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

12. Know that oxidation is a loss of and reduction is a gain of electrons.

13. Be able to classify chemical reactions as acid-base, precipitation, oxidation-reduction, combination, decomposition, or combustion.
CHAPTER 8 — 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 why an atom of Mg - 24 does not have exactly twice the mass of an atom of carbon - 12.

6. Understand the definition of a **mole** and know that it is equal to $6.02 \times 10^{23}$.

7. 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.

8. 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.

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

10. 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.

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

12. Be able to determine the actual formula of a compound from the empirical formula and molar mass.
CHAPTER 9 — 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 12 -- OBJECTIVES

The following sections will not be covered in chapter 12: section 12.10

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, 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 13 — OBJECTIVES

The following sections will not be covered in Chapter 13: 13.5 and 13.6

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, 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.
CHAPTER 14 -- OBJECTIVES

The following sections will not be covered in Chapter 14: 14.6, 14.7, and 14.8

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.
10. Know the meaning of dilution and be able to calculate the concentration of a diluted solution using the ratio of initial and final volumes.
CHAPTER 15 -- OBJECTIVES

The following section will not be covered in Chapter 15:  15.6

After completing your study of this chapter, you should

1. Understand the *Arrhenius* and *Bronsted-Lowry* definitions of *acids* and *bases*.
2. Know the common properties of acids and bases.
3. Know the difference between strong and weak acids and bases and be able to classify compounds as one of these four.
4. Understand that water can dissociate into hydrogen and hydroxide ions, and is thus both an acid and a base.
5. Understand the difference between a substance being an acid or a base and a solution being acidic or basic.
6. Understand the definition of *pH* and *pOH* and be able to relate these mathematically to the concentration of H⁺ and OH⁻ ions.
7. Understand the theory behind acid-base titrations.
8. Be able to identify the *acid*, *base*, *conjugate acid*, and *conjugate base* in a chemical equation.