Things to Know – Chem 1A

Chapter 1

1. What is matter? What is chemistry?
2. Macroscopic vs. submicroscopic ("molecular view")
3. Atom vs. molecule (what's the difference?)
4. States of matter (How do the observable properties relate to the arrangement and motion of the molecules in each? Be able to draw particles.)
5. Classification of matter: pure substances (elements or compounds), mixtures (homogeneous or heterogeneous). How do the observable properties differ? How do the particles differ? Understand and be able to explain the differences. Be able to draw a molecular picture of each. Give an example of each.
6. Mixtures can be purified – how?
7. Compounds can be separated into elements by a chemical reaction (not physical methods.)
8. Physical vs. chemical properties, examples
9. Extensive vs. intensive properties, examples
10. Physical change vs. chemical change
11. Metric system, meaning of prefixes: kilo-, centi-, milli-, micro-, nano- (Be able to write any of these as conversion factors and use them correctly in a calculation.)
12. Temperature conversions (°C, K, °F) Memorize the °C↔K conversion. You will be given one of the °C ↔°F conversions. Be able to do the algebra to convert it to the form you need.
13. Accuracy vs. precision. Be able to explain both. Can you have one without the other? Give examples of accurate and precise measurements.
14. Be able to **interpolate** –estimate between the lines – when measuring
15. Significant figures: counting, rounding off, determining the uncertainty in a measurement.
16. Dimensional Analysis (conversion factors) – practice lots of these! This is one of the most important topics in this chapter, and almost all of the problems we will do in this class will involve conversion factors.
17. Conversions between squared or cubed units (square or cube the entire conversion factor)
18. Density: how to calculate it (d = m/v), how to use it as a conversion factor (2.70 g/cm^3 means 2.70 g/ 1 cm^3)
19. Percent: how to calculate it, how to use it as a conversion factor (12.3% X by mass means 12.3 g X/ 100 g total)

Chapter 2

1. Postulates of Dalton's atomic theory

2. How atomic theory explained the law of conservation of mass and the law of constant composition
3. Law of multiple proportions
4. Know, in general terms, how early experiments led to conclusions about the structure of the atom. Know who discovered what, and the order of discoveries.
5. What did Rutherford's experiment show? How? Be able to explain this one in detail, including the plum pudding model.
6. Structure of atom: protons, electrons, neutrons. (Mass, charge, and location)
7. Atomic number, mass number, isotope symbols (know how to interpret and how to write isotope symbols)
8. Isotopes – definition and examples
9. Calculating weighted-average atomic masses

$$\textbf{Atomic mass} = (\textbf{abundance A})(\textbf{mass A}) + (\textbf{abundance B})(\textbf{mass B}) + \ldots$$

   In the above equation, use abundances as decimals. The decimal abundances add up to 1 (exactly).
10. General stuff about the periodic table: period, group, metals, nonmetals, semimetals, main-group, transition elements, inner-transition elements, alkali, alkaline earth, halogens, noble gases.
11. Why is the periodic table arranged the way it is?
12. Diatomic elements (memorize which ones are diatomic)
13. Compounds – molecular vs. ionic – what do they consist of?
14. What is an ion? Cation? Anion?
15. Know the normal charges of main-group ions.
16. Transition metals – charges can vary (except Ag^+ and Zn^{2+})
17. Know the formulas, charges, and names of polyatomic ions.
18. There are no molecules in ionic compounds!
19. What holds ionic compounds together?
20. Naming and writing formulas for ionic compounds (metal + nonmetal): name cation, then anion. <u>No prefixes</u>! $Fe_2(SO_3)_3$ is iron (III) sulfite, K_2O is potassium oxide. Compounds must be uncharged overall.
21. Naming and writing formulas for acids
    Binary acids: HCl is hydrochloric acid. Oxoacids: $HClO_3$ is chloric acid.
22. Naming and writing formulas for binary molecular compounds (2 nonmetals): Use prefixes. N_2O is dinitrogen monoxide, NO_2 is nitrogen dioxide. Remember, there are no ions in binary molecular compounds.
23. Organic compounds are carbon-based, and they have a totally different naming system. They can be very long and complicated molecules.

<u>Chapter 3</u>

1. Writing and balancing chemical equations for reactions
2. Be able to identify combination reactions, decomposition reactions, and combustion reactions.

3. For a combination reaction involving a metal and a nonmetal, be able to predict the formula of the product. (The product will be ionic. Think of the charges on the ions.)
4. Be able to write (and balance) the equation for any combustion reaction.
5. Be able to calculate the molecular weight, formula weight, or molar mass of any substance. (These terms all mean basically the same thing.)
6. Be able to find the mass percent of each element in a compound.

$$\textbf{mass \% A} = \frac{\textbf{mass of A}}{\textbf{total mass}} \times \textbf{100}$$

7. What is a mole? What is Avogadro's number?
8. Be able to convert grams to moles to molecules and vice versa.
9. Also be able to calculate how many atoms of a particular element are in a particular compound. (Look at the formula of the compound to get a conversion factor. For example, in 1 mole of $C_4H_{10}O$, there are 4 moles C, 10 moles H, and 1 mole of O.)
10. Find the empirical formula of a compound from masses or mass percents. (Convert all masses to moles of each element, then divide all of them by the smallest number of moles to get the mole ratio. Make sure you have the lowest whole number ratio. If not, multiply everything by some number so as to get the lowest whole number ratio.)
11. What is the relationship between the empirical formula and the molecular formula?
12. Be able to determine molecular formula from the empirical formula and the approximate molar mass.
13. Determining empirical formula from combustion data – understand the concepts – why does this work?
    Compound containing C, H, and O:
    a. From mass of CO_2 produced, calculate the mass of C.
    b. From mass of H_2O produced, calculate the mass of H.
    c. Total mass compound – mass C – mass H = mass O in compound.
    d. Convert the masses of all elements to moles.
    e. Take mole ratio to get the formula.
14. Hydrocarbons (same type of problem as above) shortcut:
    a. From mass of CO_2 produced, calculate the moles of C.
    b. From mass of H_2O produced, calculate the moles of H.
    c. Take the mole ratio to get the formula.
15. Information you can get from a balanced equation: mole ratio of molecules that react.
16. Conversions: g of X ⇔ mol of X ⇔ mol of Y ⇔ g of Y
    Be able to do any variation. You need a balanced equation. If an equation is given, balance it first (don't assume that it's already balanced).
17. Limiting reactant problems: if you are given specific amounts of two or more different reactants, you must first determine which is limiting.
    a. Find moles of each.
    b. Compare the stoichiometric ratio from the balanced equation to the mole ratio that you have.

c. Which is limiting? Which is in excess?
d. Finish the problem using the number of moles of the LR that you have.
e. Be able to determine how much of the excess reactant is left over (first, calculate how much was used up in reacting with the LR, then subtract from the initial amount).

18. Percent yield, actual yield, theoretical yield – what are they? What does it mean if the percent yield is less than 100%? More than 100%?
19. Be able to calculate the percent yield or use it as a conversion factor.

Chapter 4

1. Solution, solute, solvent definitions
2. Strong vs. weak vs. nonelectrolytes – behavior in solution
3. Why is water a good solvent?
4. Solubility rules (will be provided) – know how to use them.
5. Writing equations: predicting products for precipitation, acid-base, and gas forming reactions
6. Be able to write total and net ionic equations. Also be able to write the net ionic equation without first writing the regular and the total ionic equations.
7. Remember: weak acids are not written as separate ions. Only soluble strong electrolytes exist as ions.
8. Memorize the 7 strong acids: HCl, HBr, HI, HNO_3, $HClO_3$, $HClO_4$, and H_2SO_4 for its first ionization.
9. Properties of acids and bases, meaning of monoprotic, diprotic, triprotic.
10. Acid-base reactions: what are the products? Be able to write equations.
11. For a polyprotic acid in excess base: remove all H^+ ions.
    Ex: $H_2SO_4 + 2NaOH \rightarrow 2\,H_2O + Na_2SO_4$
12. Reaction between ammonia and an acid: be able to predict the products
13. Gas forming reactions to know:
    a carbonate + acid $\rightarrow$ $CO_{2\,(g)}$ + $H_2O_{(l)}$ + ionic compound
    a bicarbonate + acid $\rightarrow$ $CO_{2\,(g)}$ + $H_2O_{(l)}$ + ionic compound
    a sulfide + acid $\rightarrow$ $H_2S_{(g)}$ + ionic compound
    ammonium salt + strong base $\rightarrow$ $NH_{3\,(g)}$ + $H_2O_{(l)}$ + ionic compound
    Be able to write the equations for any of the above reactions.
14. Definitions of oxidation, reduction.
15. Be able to find the oxidation number of any atom (in an element or compound)
16. Given a reaction, determine what is oxidized and what is reduced (first find oxidation numbers).
17. If an element appears in a reaction, the reaction must be a redox reaction.
18. Understanding the activity series and how to determine relative activities:
    A + BC $\rightarrow$ B + AC If this happens, A is more active than B.
19. Molarity = # moles solute/ L solution. Be able to calculate molarity or use it as a conversion factor.
20. Concentration of ions: 0.1 M $Na_2SO_{4\,(aq)}$ is 0.2 M Na^+ and 0.1 M SO_4^{2-}.

21. Describe how to make a solution of a given molarity. (Use a volumetric flask. Describe the process in words.)
22. Dilutions – you can use $M_cV_c = M_dV_d$, where V_d is the total final volume of solution ($V_d = V_c$ + water added). Why? Because # moles of solute doesn't change.
23. Titrations – no limiting reactant. Need a balanced equation. Start with the substance you can find moles of. Convert to moles of the other substance. Finish the problem: could find molarity, volume, mass %, molar mass, etc. **DO NOT** use $M_1V_1 = M_2V_2$. Why not?
24. Be able to do limiting reactant problems involving solutions. Write the net ionic equation, find concentrations of all ions present after the reaction.