Intended Learning Outcomes for Chemistry 121

Students in Chemistry 121 will demonstrate the ability to:

A. BASICS

1. use metric and nonmetric conversions properly
2. use and indicate appropriate units
3. properly indicate significant figures
4. properly use a calculator, including solver functions

B. COMMUNICATION

1. write proper math expressions for chemical calculations
2. express a logical progression of ideas using meaningful conversion factors
3. name selected elements, provide their symbols, and determine the number of protons, neutrons, and electrons in their atoms using the periodic table
4. name selected salts, acids, bases and covalent compounds given a molecular formula, and, in reverse, provide a chemical formula given a name
5. identify at least six common strong acids and two common strong bases
6. properly graph data using Excel and utilize trend lines to determine slopes and intercepts
7. properly use functions and cell references in Excel
8. write clear observations, descriptions of methods, analyses, and conclusions in a laboratory notebook
9. find chemical information and critically evaluate its validity
10. understand the interconnectedness of science as a global enterprise

C. LABORATORY AND GREEN CHEMISTRY

1. understand and implement safety-related rules in the chemical laboratory
2. understand the need for proper personal protection from chemical hazards in the laboratory
3. understand the need for and methods of proper disposal of chemical waste
4. understand the proper function of fume hoods in a chemical laboratory
5. describe the general concepts of green chemistry
6. identify aspects of laboratory protocols that could be improved in relation to green chemistry
7. carry out common laboratory tasks using appropriate equipment efficiently and safely
8. design experiments to answer chemistry-related questions

D. ATOMS, ELEMENTS, COMPOUNDS, MIXTURES

1. understand the terms "isotope" and "allotrope"
2. use the concept of mole and molar mass appropriately in calculations
3. calculate percent composition given a molecular or empirical formula
4. determine an empirical formula given a percent composition
5. determine a molecular formula given a percent composition and a molar mass
6. understand the difference between homogeneous and inhomogeneous mixtures
7. understand the difference between chemical and physical change
8. use the Ideal Gas law appropriately
9. understand the relationships between pressure, volume, temperature and number of moles for an ideal gas, both in an overall mathematical sense and in a molecular sense

E. SOLUTIONS

1. identify substances as strong acids, weak acids, strong bases, or salts
2. identify substances as strong or weak electrolytes
3. describe the different definitions of acids and bases - Arrhenius and Bronsted/Lowry
4. understand the terms mono-, di-, tri-, and poly-protic

5. determine whether an ionic compound is soluble or not with the aid of a table of solubility rules for ions
6. identify principal species in solutions prior to reaction
7. calculate and use concentration (molarity) properly
8. calculate values relating to dilution, and understand how to do a dilution in the laboratory using proper glassware
9. understand the relationships among [H3O+], [OH-], pH, and pOH for a solution
10. understand the general connection between pH and solution acidity, neutrality, and basicity
11. identify a buffer and calculate the expected pH of its solution using the Henderson-Hasselbalch approximation

F. SPECTROSCOPY

1. describe the basic idea involved in mass spectrometry
2. describe at least two practical uses of mass spectrometry
3. understand the Beer-Lambert law and use it appropriately in relation to spectrophotmetry
4. understand the terms "lambda-max," "A-max," and "absorptivity"

G. CHEMICAL REACTIONS

1. identify principal species in solutions after a stoichiometric reaction
2. write chemical equations for combustion reactions
3. balance simple chemical equations
4. determine limiting reactants, theoretical yields, and percent yields
5. carry out calculations of the form (g) -> (mol) -> (mol) -> (g) based on balanced chemical equations
6. write proper net ionic equations given an overall equation
7. write net ionic equations for aqueous acid/base reactions given two reactant species
8. understand the essentials of titration in terms of stoichiometry

H. EQUILIBRIUM

1. write the equilibrium expression given a balanced chemical or net ionic equation involving concentrations of solutes and partial pressures of gases
2. understand the difference between Kc and Kp for reactions involving gases
3. calculate reaction quotients given concentrations and a balanced chemical equation in order to determine the direction a chemical system will shift to reach equilibrium
4. calculate equilibrium concentrations given initial concentrations and a balanced chemical equation and its associated equilibrium constant
5. understand Le Chatelier's principle in terms of "stress" and "response"
6. use Le Chatelier’s principle to predict the effect changes in concentration, partial pressure, volume will have on a system at equilibrium
7. use Le Chatelier’s principle to predict the effect of temperature on equilibrium for exothermic and endothermic reactions
8. predict the effect on equilibrium of the addition or removal of a reactant or product, either by physical addition or removal or by chemical reaction with other species
9. use Kw, Ka, pKa, Kb, and pKb appropriately
10. understand the meaning of Ksp and its use in determining the concentration of ions in saturated solutions
11. calculate missing information when given specific information involving Ka or Kb, pKa or pKb, pH, concentration, and percent ionization
12. calculate pH for titrations at any point in the titration, including at the equivalence point and beyond
13. fully explain all regions of a standard acid/base titration curve involving pH vs. volume of added base