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 **MOHAWK VALLEY COMMUNITY COLLEGE**

 **UTICA, NEW YORK**

**COURSE OUTLINE**

**I. Course Description**

 CH112 Introduction to Chemistry 2 C-3, P-2, Cr-4

 Pre-requisite: CH 111 Introduction to Chemistry 1

 This is the second introductory level chemistry course. Topics include solutions, colligative properties, concentrations, acids and bases, salts, solution equilibrium, pH buffers, electrolytes, and an introduction to organic chemistry with attention to organic molecules of biological importance. This course does not meet graduation requirements for Chemistry, Biology or Engineering Majors.

**II. Student Learning Outcomes**

 Upon the completion of Introduction to Chemistry 2, the student will be able to:

1. Explain how solutions are formed and the unique properties of water.
2. Express the concentration of a solution and perform calculations in units of molarity and percent by weight or volume.
3. Distinguish among and describe properties of acids, bases and salts.
4. Demonstrate an understanding of chemical equilibrium and the equilibrium systems in the human body.
5. Distinguish an ordinary chemical reaction from a nuclear reaction and write equations for simple nuclear reactions.
6. Demonstrate a scientific approach to solving problems and an ability to analyze data collected.
7. Understand the importance of record keeping not only as a scientific discipline in the lab but beyond. (Nursing charts, tax records, etc.)
8. Generate and recognize names and structures for organic compounds by applying the IUPAC (and common) nomenclature rules, and describe the characteristic properties of different categories of organic compounds.
9. Appreciate the importance of safety in the lab and the home.
10. Understand that chemistry (all science) and its application in technology is an activity of humans interacting with, and as a part of society.

**III. Major Topics**

1. Gases

a. Kinetic Molecular Theory

b. Boyle's Law

c. Charles' Law

d. Molar Volume of a Gas (Avogadro's Law)

e. Combined Gas Law

1. Applications of the Ideal Gas Law
2. Dalton’s Law of Partial Pressures
3. The Ideal Gas Law
4. Density of Gases
5. Stoichiometry in the Gas Phase
6. Shape and Structure
7. Lewis Formulas
8. Valence Shell Electron Pair Repulsion Theory
9. Molecular Polarity
10. Properties of Liquids

 (a) Changes of state

 (i) Freezing point/boiling point

 (ii) Vapor pressure

 (c) Properties of water

 (i) Hydrogen bonding

 (d) Hydrates

 4. Solutions

 (a) The solution process

 (b) Solubility

 (i) Definitions

 (ii) Factors that affect solubility

 (c) Concentration units

 (i) Molarity

 (ii) Percent mass, volume, PPM, osmolarity

 (d) Colligative Properties

 (i) Freezing point depression

 (ii) Boiling point elevation

 (iii) Osmosis

 (e) Colloids

 5. Acids & Bases

 (a) Definitions

 (b) Properties

 (c) Strong and Weak, Concentrated and Dilute

 (d) Ionization and dissociation in solution

 (e) Electrical conductivity in solution

 (f) Strong and Weak electrolytes

 (g) Acid-Base Reactions

 (h) Neutralization – titrations

 6. Solution Equilibrium (Qualitative)

 (a) The dissociation of Water, pH

 (b) Hydrolysis of salts

 (c) Buffers

 7. Hydrocarbons

 (a) Alkanes – Structure

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (b) Alkenes

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (c) Halogenated Hydrocarbons

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (d) Cycloalkanes

 (i) Physical Properties

 (e) Polymerization

 (f) Alkynes

 (i) Physical Properties

 (g) Aromatic Hydrocarbons Structure

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 8. Alcohols, Ethers and Phenols

 (a) The Alcohol Functional Group

 (i) Classifications of Alcohols

 (b) Alcohols

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (iv) Preparation of Alcohols

 (c) Glycols

 (d) Phenols

 (e) Ethers

9. Aldehydes and Ketones

 (a) The Carbonyl Functional Group

 (b) Aldehydes

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (c) Ketones

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 10. Carboxylic Acids and Derivatives

 (a) Carboxylic Acid Functional Group

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (b) Esters

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (c) Amides

 11. Amines

 (a) The Amine Functional Group

 (i) Physical Properties

 (ii) Nomenclature IUPAC and Common

 (iii) Characteristic Reactions

 (b) Amino Acids - General Properties

Specific Measurable Learning Outcomes for CH 112 –Introduction to Chemistry 2

The Gaseous State of Matter

* Describe the Kinetic Molecular Theory.
* Understand the concept of pressure and how it is measured.
* Recognize various pressure units and be able to convert pressure units given the appropriate values.
* Define and apply Avogadro’s law.
* Define absolute zero.
* Understand the relationships between P, V and T.
* Understand Charle’s Law, Boyles law.
* Perform calculations utilizing the combined gas law.

Applications of the Ideal Gas Law

* Perform calculations involving Dalton’s law of partial pressures.
* Perform stoichiometric calculations for gas phase reactions, based on volumes.
* Understand and apply the ideal gas law.
* Understand the terms diffusion and effusuion.
* Perform calculations involving the density of gases.

Structure and Shape

* Draw the Lewis structure for any molecule made up of main group elements.
* Describe the electron-pair geometry when a central atom is surrounded by two, three, or four regions of electron density.
* Predict the molecular geometry around a central atom that is surrounded by two, three, or four regions of electron density.
* Predict the molecular polarity of a compound.

Gases, Liquids, and Solids

* Recognize the terms for the various changes of state.
* Define *boiling point*.
* Define and describe the term *vapor pressure*.
* Given heat of fusion/vaporization and specific heat, perform calculations involving changes of state and/or temperature.
* Interpret a heating curve.
* Describe the effects of hydrogen bonding.
* Recognize the formula of a hydrate, and be able to name it.
* Understand the structure and physical properties of water.
* Predict the products for reactions of metal oxides and nonmetal oxides with water.

 Solutions

* Describe the general properties of solutions.
* Describe the factors that affect the rate of dissolving.
* Define solution terminology: solute, solvent, unsaturated, saturated, supersaturated, concentrated, dilute.
* Be able to use the “like dissolves like” rule to predict solubility.
* Understand how temperature and pressure affect solubility.
* Interpret information from solubility curve charts and solubility tables.
* Calculate a molarity.
* Calculate a percent concentration (m/m, m/v, v/v) and other parts per (ex. ppm).
* Given a concentration, calculate required amount of solute and solvent.
* Perform dilution calculations.
* Describe the effect of solutes on colligative properties.
* Describe the process of osmosis.

 Acids, Bases, and Salts

* Classify a substance as an electrolyte or non-electrolyte.
* Understand dissociation and ionization in terms of conducting electricity.
* Given the concentration of an ionic compound in solution, determine the concentration of each of the ions.
* Describe the colors of litmus and phenolphthalein in the presence of acids and bases.
* Describe the reactions of acids and bases.
* Define *Arrhenius acid* and *base*.
* Define *Bronsted acid* and *base*, and recognize conjugated acid-base pairs.
* Interpret pH in terms of [H+] and [OH-], and determine whether a substance is an acid or a base based upon its pH.
* Understand that pH is a log scale and each unit represents a 10 fold change in concentration.
* Perform titration calculations. (not using MA\*VA = MB\* VB)
* Describe the products and reactants of an acid-base neutralization reaction, and write the net ionic equation for a neutralization reaction.
* Know that nonmetal oxides are acidic in water, and metal oxides are basic in water.

Chemical Equilibrium

* Define *equilibrium*.
* Understand activation energy.
* Apply LeChatelier’s Principle to determine the direction in which a reaction at equilibrium will shift as a result of stresses such as changes in concentration, temperature or pressure, and to determine the effect of the shift on other substances in the reaction.
* Understand how a catalyst affects equilibrium.
* Describe what *buffers* do and predict how pH will change when acid or base is added to a solution in the presence of a buffer.

Introduction to Organic Chemistry

* Define *hydrocarbon*.
* Identify a hydrocarbon as being an *alkane*, *alkene* or *alkyne* based upon its formula.
* Describe the difference between *saturated* and *unsaturated* hydrocarbons and/or fatty acids.
* Describe bonding for carbon atoms in terms of how many and the types of bonds carbon atoms can form.
* Define and recognize examples of a *homologous series*.
* Define the term *isomer* and recognize examples of isomers.
* Use IUPAC rules to name alkanes, including substituted alkanes.
* Use IUPAC rules to name alkenes and alkynes.
* Recognize geometric isomers (cis and trans).
* Recognize cyclic compounds (cycloalkanes and cycloalkenes).
* Recognize examples of *alkyl, phenyl, & carbonyl* groups.
* Determine IUPAC & common names for *aromatic* (substituted benzene) molecules.
* Be able to distinguish one organic functional group from another.
* Determine IUPAC & common names for alcohols, aldehydes, ethers, ketones, esters and carboxylic acids.
* Recognize the following common name prefixes: isopropyl-, terbutyl-, form-, and acet-.
* Recognize the products of addition (hydrogenation), substitution and combustion reactions.
* Classify an alcohol as primary, secondary or tertiary.
* Determine the products of the oxidation of alkenes, alcohols and aldehydes.
* Given a list of organic molecules, predict which would have the highest boiling point.
* Define *polymerization* and the terms *polymer* and *monomer*.

Introduction to Biochemistry

* Identify the building blocks of starches, fats, proteins and nucleic acids.
* Classify the following as monosaccharides or disaccharides: *glucose*, *fructose*, *galactose*, *sucrose*, *maltose*, *lactose,* and recognize *starch*, *glycogen* and *cellulose* as examples of polysaccharides.
* Define *peptide bond*.
* Recognize that *enzymes* are proteins and explain how they act in terms of conformation and activation energy.
* Describe the structure of DNA and explain what happens during DNA replication.
* Identify the type of bonding holding together the strands of DNA.

**Introduction to Chemistry 2 LABORATORY SCHEDULE**

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| **Week**  | **Experiment title** |   | **Week**  | **Experiment title** |
| 1 | Check in/Safety/ Fizzies Beverage | 8 | Properties of Acids |
| 2 | Molar Volume | 9 | Titration to an End Point |
| 3 | VSEPR Modeling | 10 | Chemical Equilibrium |
| 4 | Heat of Fusion | 11 | Hydrocarbons |
| 5 | Properties of Solutions | 12 | Alcohols, Aldehydes, Ketones & Esters |
| 6 | Colligative Properties | 13  | Synthesis of Aspirin |
| 7 | Electrolytes & Properties of Bases | 14 | Synthesis of Aspirin & Checkout |