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**MOHAWK VALLEY COMMUNITY COLLEGE**

**UTICA, NEW YORK**

### COURSE OUTLINE

**I. Catalog Description**

 CH 111 Introduction to Chemistry 1 C-3, P-2, Cr-4

Prerequisite: An appropriate Mathematics Placement Test result or MA089 Arithmetic or MA090 Essential Math Skills.

 This course introduces chemistry for those who have had no prior chemistry study or who need chemistry review. Topics include matter, measurement, atomic structure and the periodic table, chemical bonding and reaction, and the three phases of matter. This course does not meet graduation requirements for Chemistry, Biology, or Engineering majors.

**II. Student Learning Outcomes**

Upon the completion of Introduction to Chemistry 1, the students will be able to:

1. Relate the observable properties and characteristics of elements, compounds, and mixtures to the concept of atoms and molecules.

2. Recognize the states of matter and conditions associated with them.

3. Describe the sub-atomic structures of atoms, ions and isotopes, and relate this information to chemical activity.

4. Utilize the strategy of dimensional analysis to solve problems.

5. Perform stoichiometric calculations involving chemical reactions.

6. Apply the law of conservation of mass to balance formula equations.

7. Write the names and formulae for inorganic compounds.

8. Predict the physical and chemical properties of compounds.

9. Appreciate the usefulness of chemistry in other areas of study.

10. Demonstrate appropriate safety techniques and proper use of protective equipment.

11. Demonstrate skills in measuring and recording data.

**III. Main Topics**

 1. Matter and Measurement

 a. Elements - Compounds – Mixtures

 (i) Symbols of Elements in Chemical Formulas

 b. Measurements in Chemistry

 c. Metric system

 d. Density

 e. Dimensional Analysis

 f. Unit Conversions

 g. Properties of Matter

 h. Changes in Matter

 i. Energy

 j. Heat

 2. Atomic Structure and the Periodic Tables

 a. Dalton's Atomic Theory

 b. Nuclear Atom

 c. Bohr Model

 d. Electron Configuration

 e. Periodic Table

 f. Elements

 (i) Isotopes

 (ii) Atomic Number

 (iii) Mass Number

3. Nuclear Chemistry

 a. Nuclear reactions (alpha, beta & gamma decay)

 b. Half-life

 c. Use of radio isotopes in research and nuclear medicine

 3. Nomenclature

 a. Ionic Compounds

 b. Molecular Compounds

 4. Chemical Equations

 a. Balancing Chemical Equation (The Law of Conservation of Mass)

 b. Types of Chemical Reactions

 c. Oxidation number

 d. Oxidation-Reduction

 e. Activity Series

 f. The Mole and Avogadro's Law

 g. Molecular and Formula Masses

 h. Molecular formula

 i. Stoichiometry

 (i) Mole Ratios

 (ii) Mass-Mass Calculations

5. Chemical Bonds

 a. Lewis Structure (Electron Dot)

 b. Ionic Bonding

 c. Covalent Bonding

 (i) electronegativity

 (ii) bond polarity

 d. Lewis Formulas - Octet Rule

 e. Polyatomic Ions

**Specific Measurable Learning Outcomes for CH 111 Introduction to Chemistry 1**

Matter and Energy

* Recognize examples of and explain the differences between pure substances, homogeneous mixtures and heterogeneous mixtures.
* Describe the differences between solids, liquids and gases.
* State the law of conservation of mass.
* Explain the difference between an element and a compound and recognize examples of each.
* Define the term atom.
* Define the term molecule.
* Understand the scientific method.
* Explain the difference between physical and chemical properties and recognize examples of each.
* Explain the difference between physical and chemical changes and recognize examples of each.
* Using the periodic table, identify an element as a metal, nonmetal or metalloid.
* Classify elements as being alkali metals, alkaline earth metals, halogens or noble gases.
* Explain whether the rows or the columns in the periodic table are more important for predicting chemical properties, and briefly explain why.
* Know the difference between main group elements and transition elements.
* Know which elements are diatomic.
* Know the names and symbols of the first 20 elements and common metals and nonmetals.
* Understand why elements are not all abbreviations of the names used today.
* Know the difference between compounds, molecules and ions.
* Interpret a chemical formula in terms of number of atoms of each element in a compound.
* Explain the law of conservation of mass and the law of conservation of energy.
* Given a chemical reaction, determine which components are the reactants and which are the products.

Measurement and Chemical Calculations

* Perform density calculations and interpret density information.
* Calculate and interpret specific gravity.
* Given the relevant equations, convert among temperature scales.
* Describe the relationship between temperature and kinetic energy.
* Apply the rules for determining the number of significant figures in a particular measurement.
* Apply the rules for determining the number of significant figures in calculations.
* Know how to express numbers in scientific notation and round-off non-significant numbers.
* Define the terms volume and mass.
* Convert between basic metric units.
* Apply the technique of dimensional analysis/conversion factors to solve problems, especially unit conversion problems.
* Be able to take a formula and solve for any variable given the others.
* Convert units with other powers (cubic centimeters, square feet etc.)
* Convert measurements with compound units (feet per second, km per hour etc.)
* Understand the term energy and recognize that there are different types of energy.
* Understand the terms potential and kinetic energy and be able to give examples of each.
* Understand the difference between heat and temperature
* Understand the concept of thermal equilibrium
* Perform heat calculations involving heat, specific heat, temperature change and mass.

Atomic Theory: The Nuclear Model of the Atom

* Describe Dalton’s atomic model.
* Briefly explain Rutherford’s gold foil experiment and describe the two important conclusions that can be drawn from the results, and the observations that led to those conclusions.
* List the two types of particles that are contained in the nucleus of an atom.
* Describe how the mass of an electron compares with that of a proton or neutron.
* Define and recognize isotopes; interpret the standard notation for isotopes; and understand that the difference in isotopes is due to the number of neutrons..
* Recognize that the number of protons is equal to the atomic number and determines the identity of an element.
* Determine the number of electrons in an ion.
* Define mass number and explain how it relates to number of protons and neutrons.
* Understand that the mass of the elements on periodic table represent the average of the most stable isotopes.
* Understand the difference between mass number and atomic mass.

Nuclear Chemistry

* Define the term *radioactive*.
* Describe the uses of radioisotopes.
* Define and compare *alpha*, *beta*, *gamma* and *positron* radiation.
* Complete nuclear equations including those for alpha and beta decay and other transmutation reactions.
* Define *half-life*, perform half-life calculations, and explain how half-life is impacted by changes in temperature or pressure.
* Define nuclear *fission* and nuclear *fusion*, and recognize examples of each.

Atomic Theory: The Quantum Model of the Atom

* Understand what the electromagnetic spectrum represents with respect to frequency and wave length
* Given an electron configuration, identify the element.
* Given an element in the ground state, identify the electron configuration.
* Define valence electron and explain why they are important.
* Using the periodic table, determine the number of valence electrons an atom has.
* Given an electron configuration, determine the number of valence electrons an atom has.
* Understand what ground state means
* Understand what principal energy levels, sublevels and orbitals are, and the number of electrons that each holds.
* Understand how sublevels correspond to the organization of the periodic table.

Chemical Bonding

* Compare ionic and covalent bonding.
* Recognize that a metal plus a nonmetal will form an ionic bond.
* Understand the concept of polarity of covalent bonds.
* Describe ion formation in terms of electron loss/gain and resulting charge.
* Explain what happens in terms of electrons in single, double and triple bonds.
* Draw a Lewis dot structure and use it to predict types of bonds formed.
* Understand why the periodic table is called periodic.
* Describe the trend in atomic radius, electronegativity, and ionization energy as you move across a row or down a column in the periodic table.
* Identify the most reactive metal and the most reactive nonmetal on the periodic table.

Chemical Nomenclature

* Understand that charges on ions are a result of moving electrons to and from the valence shell.
* Know what a polyatomic ion is.
* Given the name, write the formula for, and, given the formula, write the name for the following: binary ionic compounds
	+ ionic compounds involving polyatomic ions
	+ ionic compounds involving transition metals (utilizing the stock system for naming)
	+ binary molecular compounds
	+ binary acids
	+ oxyacids

Chemical Equations

* Balance chemical equations.
* Recognize the following types of reactions: combination, decomposition, single displacement, double displacement, and combustion.
* Explain how you can tell whether or not a double replacement reaction may have taken place when you mix two solutions together.
* Predict the products for a double displacement reaction.
* Determine whether a single displacement reaction will go forward based on an activity series.
* Define *oxidation* and *reduction*, and describe what happens in an oxidation-reduction reaction.
* Determine an oxidation number.
* Define *oxidizing agent* and *reducing agent*.
* Determine whether or not a reaction is a redox reaction.
* Define endothermic and exothermic, and recognize examples of endothermic and exothermic reactions.
* Understand the term hydrocarbon.
* Know the products of combustion reactions, and write the equations for combustion reactions involving fuels containing C, H and O.

Chemical Formula Relationships

* Define and interpret the term mole.
* Interpret chemical equations in terms of atoms/molecules or in terms of moles.
* Calculate a molar mass.
* Define and recognize empirical formulas and, given a molecular formula, determine the empirical formula.
* Convert grams to moles or molecules or atoms, and vice versa.
* Calculate a percent by mass based upon the formula of a compound or upon results of a lab experiment.

Quantity Relationships in Equations

* Perform moles-to-moles calculations.
* Perform gram-to-gram calculations.
* Define the term limiting reagent/reactant.

**Introduction to Chemistry 1 LABORATORY SCHEDULE**

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| --- | --- | --- | --- | --- |
| **week** | **Experiment title** |   | **week** | **Experiment title** |
| 1 | Check in/Safety Lecture/ Graphing | 8 | Periodicity |
| 2 | Separation of a mixture | 9 | Percent composition of potassium chlorate |
| 3 | Physical vs. Chemical Changes | 10 | Types of Reactions 1 |
| 4 | Properties of Oxygen | 11 | Types of Reactions 2 |
| 5 | Conservation of Mass | 12 | Gases & Reactivity |
| 6 | Specific Heat of a Metal | 13 | Mass Relationships in Chemical Reactions |
| 7 | The Nuclear Atom | 14 | Searching for a Regularity (optional make up) |