ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences and Business

COURSE: CHM 1006 General Chemistry I

Date: Spring 2023

Credit Hours: 5

Complete all that apply or mark "None" where appropriate:

Prerequisite(s): CHM 1004 (or one year of high school chemistry)

Enrollment by assessment or other measure? ☒ Yes ☐ No
If yes, please describe: by appropriate assessment for MTH 1003 or higher

Corequisite(s): None

Pre- or Corequisite(s): None

Consent of Instructor: ☐ Yes ☒ No

Delivery Method:		
☒ **Lecture**	**3 Contact Hours**	**(1 contact = 1 credit hour)**
☒ **Seminar**	**1 Contact Hours**	**(1 contact = 1 credit hour)**
☒ **Lab**	**3 Contact Hours**	**(2-3 contact = 1 credit hour)**
☐ **Clinical**	**0 Contact Hours**	**(3 contact = 1 credit hour)**

Offered: ☒ **Fall** ☒ **Spring** ☐ **Summer**

CATALOG DESCRIPTION and IAI NUMBER (if applicable):
This course covers the general principles of chemistry including atomic theory, bonding and molecular geometry, stoichiometry, the states of matter, thermodynamics, atomic structure, and solution chemistry. Laboratory emphasizes quantitative work. **IAI Equivalent: P1 902L; CHM 911**

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:

1. Matter and Measurement
- a. Classifications of Matter, Properties of Matter types of Changes, Scientific Method, Units of Measurement, Dimensional Analysis
- b. Uncertainty in Measurement, Significant figures

2. Atoms, Molecules, Ions, Compounds, Law of Conservation of Mass, Law of Constant Composition, The Atomic Theory of Matter
- a. The Discovery of Atomic Structure, The Modern View of Atomic Structure, Atomic Weights, The Periodic Table
- b. Nomenclature, Molecules and Molecular Compounds, Naming Inorganic Compounds
- c. Formulas: Ions and Ionic Compounds, Molecular Compounds

3. Stoichiometry, Chemical Equations, Formula Weights
- a. Avogadro's Number and the Mole, Empirical Formulas
- b. Stoichiometry, Limiting Reactants

4. Reaction Types and Solution Stoichiometry
- a. Aqueous Solutions, Precipitation Reactions, Acids, Bases, and Neutralization Reactions, Concentrations of Solutions
- b. Solution Stoichiometry, Acid-base titration, Gravimetric Analysis

5. Thermochemistry
- a. Nature of Energy, The First Law of Thermodynamics, Enthalpy, Enthalpies of Reaction
- b. Heat Capacity, Specific Heat, Calorimetry
- c. Hess's Law, Enthalpies of Formation

6. Electronic Structure of the Atom
- a. The Wave Nature of Light, Quantized Energy and Photons, Line Spectra and the Bohr Mode, The Wave Behavior of Matter
- b. Quantum Mechanics and Atomic Orbitals, Representations of Orbitals, Many-Electron Atoms, Electron Configurations

7. Periodic Properties of the Elements
- a. Development of the Periodic Table, Effective Nuclear Charge, Sizes of Atoms and Ions, Ionization Energy, Electron Affinities, Electronegativity

8.Chemical Bonding
- a. Lewis Symbols and the Octet Rule, Ionic Bonding and Covalent Bonding, Bond Polarity,
- b. Drawing Lewis Structures, Resonance Structures, Exceptions to the Octet Rule

9. Molecular Geometry and Bond Theories
- a. Molecular Shapes, The VSEPR Model
- b. Molecular Shape and Molecular Polarity, Hybrid Orbitals, Multiple Bonds
- c. Molecular Orbitals

INSTRUCTIONAL METHODS:
A. Lecture
B. Lecture demonstrations
C. YouTube videos (animations of chemical processes, chemical demonstrations)
D. Laboratory experiments

E. Laboratory reports
F. Online Homework and Quizzing system
G. Examinations
H. Peer tutoring

EVALUATION OF STUDENT ACHIEVEMENT:

A. Regular attendance in lecture, seminar and laboratory
B. Reading assignments
C. Quizzes
D. Online homework assignments
E. Examinations
F. Participation in classroom discussions
G. Performance of laboratory experiments

A = 90 -100
B = 80 – 89
C = 70 – 79
D = 60 – 69
F = 59 and below

Laboratory Requirements

Students are expected to complete all laboratory assignments. Missing one experiment will result in the final course grade being lowered by one full grade letter. Missing two experiments will result in an “F” for the final course grade. Students are expected to attend seminars during which the laboratory procedure will be discussed. Students will then complete the laboratory assignment following the prelab discussion.

INSTRUCTIONAL MATERIALS:

Textbooks:

Chemistry**:** The Central Science, Brown, Lemay, Burste
A. Laboratory manual: In house
B. Online eBook, homework and quizzing.
C. Worksheets

Resources

A. Chemistry and Chemical Reactivity, Kotz
B. Handbook of Laboratory Safety, Steere
C. Handbook of Chemistry and Physics
D. Chemistry, Chang
E. www.acs.org
F. Journal of Chemical Education
G. Chemical and Engineering News

LEARNING OUTCOMES AND GOALS:

Institutional Learning Outcomes

☐ 1) Communication – to communicate effectively;
☒ 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;

☐ 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;

☐ 4) Responsibility – to recognize how personal choices affect self and society.

Course Outcomes and Competencies

Outcome 1 - Students will be able to perform mathematical calculations to utilize, interpret and present chemical data appropriate to college chemistry.

Competency 1.1 - Students will be able to use the metric system, convert English to metric and vice versa.

Competency 1.2 - Students will be able to use scientific notation in expressing numbers and in calculations

Competency 1.3 – Students will be able to report measurements and result of calculations to the proper number of significant digits.

Competency 1.4 - Students will be able to distinguish between precision and accuracy, express precision of results and determine % error.

Competency 1.5 - Students will be able to graph data and interpret graphs.

Competency 1.6 - Students will be able to use the factor-label method of problem solving.

Outcome 2 - Students will be able to demonstrate an understanding of the general concepts and vocabulary of chemistry.

Competency 2.1 - Students will be able to distinguish between a scientific hypothesis, a scientific theory, and a scientific law.

Competency 2.2 - Students will be able to use the general outline of the classification of matter and the terminology involved to characterize a sample of matter that is described to you.

Competency 2.3 - Students will be able to correctly use the terminology: atom, molecule, symbol, isotope, allotrope, formula, equation, compound, element, and physical, chemical, and nuclear change.

Competency 2.4 - Students will be able to balance chemical equations.

Competency 2.5 - Students will be able to perform calculations involving density and specific gravity.

Competency 2.6 - Students will be able to define molar mass, atomic mass, mass number, Avogadro's number, and mole.

Competency 2.7 - Students will be able to convert between mass, moles and number of atoms or molecules.

Competency 2.8 - Students will be able to calculate the empirical formula and molecular formula given the per cent composition and the molar mass.

Competency 2.9 - Students will be able to perform calculations involving chemical equations.

Competency 2.10 -Students will be able to describe the historical development of the model of the nuclear atom.

Competency 2.11 -Students will be able to name binary compounds and compounds with common polyatomic ions (the list given must be memorized) and write their formulas given the names.

Outcome 3 - Students will be able to demonstrate an understanding of the concepts of thermochemistry.

Competency 3.1 - Students will be able to define work, energy, heat, temperature, units of energy, types of energy, enthalpy, endothermic, exothermic, state function and know the sign conventions.

Competency 3.2 -Students will be able to calculate the enthalpy of a reaction given either heats of formation or bond energies.

Competency 3.3 -Students will be able to calculate heat capacity and specific heat as well as use those values in calorimetry calculations.

Competency 3.4 -Students will be able to calculate the heat of a reaction using Hess's law.

Outcome 4 - Students will be able to demonstrate an understanding of atomic theory and periodicity.

Competency 4.1 - Students will be able to describe the difference between the Bohr model and the modern model (quantum mechanical model) of the atom.

Competency 4.2 - Students will be able to write the ground-state electron configuration for any element or ion.

Competency 4.3 - Students will be able to calculate wavelength, frequency, and energy given one of these parameters and relate these terms to atomic spectra.

Competency 4.4 - Students will be able to sketch s, p, and d orbitals.

Competency 4.5 - Students will be able to name and explain the relationship of each of the four quantum numbers to the properties of electrons in orbitals.

Competency 4.6 - Students will be able to utilize Hund's rule and draw orbital diagrams.

Competency 4.7 - Students will be able to use the periodic table to predict and explain trends in atomic radius, ionic radius, ionization energy, electron affinity, metallic character, and electronegativity.

Competency 4.8 - Students will be able to use the terms isoelectronic, Heisenberg's uncertainty principle, and Pauli's exclusion principle.

Outcome 5 - Students will be able to demonstrate an understanding of chemical bonding.

Competency 5.1 - Students will be able to predict the type of bonding that takes place between two elements based on electronegativity difference and/or on the relative positions of the elements in the periodic table.

Competency 5.2 - Students will be able to explain what is meant by ionic bonds, polar covalent bonds, and nonpolar covalent bonds.

Competency 5.3 - Students will be able to predict the geometry, the bond angles, and the polarity of molecules or polyatomic ions using VSEPR.

Competency 5.4- Students will be able to predict the hybridization of atomic orbitals to account for the molecules geometry.

Competency 5.5 -Students will be able to account for the structure of a molecule in terms of hybrid orbitals and bonds.

Competency 5.5 –Students will be introduced to molecular orbital theory and be expected to draw the molecular orbital energy level diagram for simple diatomic systems to predict if the molecule is stable.

Outcome 6 - Students will be able to demonstrate an understanding of the states of matter.

Competency 6.1 - Students will be able to state the postulates of the Kinetic Molecular
Theory of gases and use it to explain the behavior of ideal gases and the relationship of kinetic energy to temperature.

Competency 6.2 - Students will be able to explain how real gases differ from ideal gases.

Competency 6.3 - Students will be able to state Dalton's law, Graham's law, Charles' law, Boyle's law, Avogadro's law, and Gay-Luussac's law.

Competency 6.4 - Students will be able to use the ideal gas law to calculate molar volume, density, mass, pressure, temperature and volume.

Competency 6.5 - Students will be able to calculate the mass, moles or volume of gases in a chemical reaction at nonstandard conditions.

Competency 6.6 - Students will be able to use Graham's law to account for relative rates of effusion.

Competency 6.7 - Students will be able to explain how the enthalpy of vaporization and the boiling point of a compound are related to the strength of its intermolecular forces.

Competency 6.8 - Students will be able to explain how dispersion forces arise and how they vary with the polarizability of an atom and the size and shape of a molecule.

Competency 6.9 - Students will be able to describe hydrogen bonds and explain why they are stronger than other kinds of intermolecular forces.

Competency 6.10 -Students will be able to distinguish between intermolecular forces and intramolecular forces as related to molecules, atoms, or ions.

Competency 6.11 -Students will be able to distinguish metals, ionic solids, network solids, and molecular solids by their structures and by their properties.

Competency 6.12 -Students will be able to sketch, label and interpret a phase diagram.

Competency 6.13 -Students will be able to distinguish between: face-centered and bodycentered cubic structures, crystalline and amorphous solids.

Competency 6.14 -Students will be able to interpret the cooling curve for a substance.

Outcome 7 - Students will be able to safely and correctly perform laboratory techniques and procedures.

Competency 7.1 - Students will be able to use proper techniques when measuring volumes and masses, absorption with a spectrophotometer or the atomic absorption etc.

Competency 7.2 - Students will be able to use proper recording and reporting techniques for data such as always recording information directly into the laboratory notebook.

Competency 7.3 - Students will be able to draw and interpret graphs from lab data.

Competency 7.4 - Students will be able to draw conclusions from experimental evidence.

Competency 7.5 - Students will be able to develop safe work habits in the laboratory.