CHEM-1300: GENERAL CHEMISTRY I

Cuyahoga Community College

Viewing: CHEM-1300 : General Chemistry I

Board of Trustees:
January 2022

Academic Term:
Fall 2022

Subject Code
CHEM - Chemistry

Course Number:
1300

Title:
General Chemistry I

Catalog Description:
Study of fundamental principles of chemistry emphasizing atomic theory and structure, chemical bonding, periodic trends, thermochemistry, nuclear chemistry, aqueous solutions, stoichiometry, and the gaseous state of matter. To fulfill the laboratory science requirement, students should enroll in the related laboratory course.

Credit Hour(s):
4

Lecture Hour(s):
4

Lab Hour(s):
0

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
CHEM-1010 Introduction to Inorganic Chemistry, or sufficient score on Chemistry assessment test; and MATH-0965 Intermediate Algebra* or qualified math placement; or departmental approval: equivalent knowledge or skills.

Note: MATH-1200 taken prior to Fall 2013, or MATH-1270 or MATH-1280 taken prior to Fall 2016 will also be accepted to fulfill prerequisite requirements.

Outcomes

Course Outcome(s):
Apply the principles of chemistry to advanced scientific studies and/or applications of chemistry in society.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Use the empirical gas laws.
2. Use the ideal gas law.
3. Write thermodynamic equations.
4. Use the quantum numbers to determine the electronic state.
5. Draw Lewis structures for polyatomic ions and molecules.
6. Describe isotopes.
7. Describe atomic orbitals including the shape of the orbital.
8. Describe the properties of light including energy, wavelength, and frequency.
9. Describe electronic transitions between energy levels.

10. Describe periodic trends including effective nuclear charge, atomic radius, ionic radius, ionization energy, electron affinity, metallic character, and electronegativity.
11. Demonstrate an understanding of chemical nomenclature.
12. Describe and differentiate between metallic, ionic, and covalent bonding.
13. Describe lattice energy and its relationship to the melting point.
14. Describe resonance.
15. Describe sigma and pi bonds and identify each type of bond in a structure.
16. Describe hybridization of orbitals.
17. Record data to the appropriate number of significant figures.
18. Describe accuracy and precision.
19. Describe density.
20. Describe the solubility of a substance.
21. Describe percent yield.
22. Describe an atom or ion in terms of subatomic particles, electron configuration, orbital diagram, and quantum numbers.
23. Describe the thermodynamics of breaking and forming bonds.
24. Define the enthalpy of formation.
25. Describe an endothermic and exothermic process.
26. Describe ideal gas behavior.
27. Write a balanced nuclear equation.
28. Describe nuclear transmutation and decay.
29. Describe types of radioactive decay.
30. Provide examples of the uses of radioisotopes.
31. Describe valence bond theory.
32. Describe hybrid orbitals.
33. Apply valence bond theory to molecules with single bonds and to molecules with multiple bonds.
34. Explain molecular orbital theory.
35. Describe bonding orbitals and antibonding orbitals.
36. Define and calculate bond order.
37. Describe molecular orbital configurations in diatomic molecules.

Course Outcome(s):

Develop interpretative skills to apply mathematical methods to solve problems in other scientific studies and/or real-world applications.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.
Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Demonstrate an understanding of the basic concepts of measurement utilizing both the English and metric units.
2. Convert between the number of particles, moles, and mass of a substance.
3. Determine the empirical and molecular formula from percent composition and mass spectroscopy data.
4. Calculate the limiting reagent in a chemical reaction.
5. Determine how to prepare a solution of specified Molarity and use it to make a more dilute solution.
6. Apply the ideal gas law to calculate gas density and molar mass.
7. Calculate enthalpies of reaction from calorimeter or standard enthalpies of formation data.
8. Apply Hess's Law to solve for the enthalpy of a reaction.
9. Demonstrate a working knowledge of stoichiometry formula and equation problems involving solids, liquids, and gases.
10. Calculate density given volume and mass.
11. Calculate mass percentage in a compound or mixture.
12. Calculate the percent yield using a limiting reagent and theoretical yield.
13. Use molarity to calculate the amount of a substance in a volume of solution.
14. Calculate the energy, wavelength, and frequency of electromagnetic radiation.
15. Calculate the energy, frequency, and wavelength of electronic transitions for H.
16. Determine atomic weight from isotopic masses and abundance.
17. Calculate the formal charge on an atom.
18. Calculate the oxidation number of an atom in a compound or ion.
19. Determine the molar mass of a compound.

Course Outcome(s):

Utilize the fundamental knowledge of chemistry to analyze chemical reactions and associated properties and develop critical thinking skills to predict and determine the causes of physical and/or chemical change.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Classify matter as an element, compound, or mixture and identify the change in matter as either physical or chemical.
2. Utilize the periodic table to predict classification, electron configuration, atomic structure, and physical and chemical properties of the elements.
3. Use Lewis structures to predict molecular arrangement and geometry and explain molecule polarity.
4. Identify strong, weak, and nonelectrolytes.
5. Determine if a solution will conduct electricity.
6. Determine if a precipitate forms when two compounds are mixed in an aqueous solution.
7. Determine bond type based on chemical formula.
8. Use the Periodic trends to qualitatively compare elements based on effective nuclear charge, atomic radius, ionic radius, ionization energy, electron affinity, electronegativity, and metallic character.
9. Use specific heat, mass, change in temperature, and/or heat when performing thermodynamic calculations.
10. Use kinetic molecular theory to determine similarities and differences in kinetic energy and rates of effusion of various gas particles.
11. Write molecular, ionic, and net ionic equations for a chemical reaction.
12. Balance both simple and Redox chemical equations.
13. Classify chemical reactions.

Course Outcome(s):

Apply the scientific method to solve a problem and explain the design of scientific studies.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Describe the scientific method including the basic steps of the process.
2. Define the terms law, hypothesis, and theory.
3. Differentiate between a theory and a law.
4. Apply the steps of the scientific method to solve a problem.

Course Outcome(s):

Evaluate and differentiate between credible and non-credible sources of scientific arguments, use the gathered scientific information effectively, and appropriately cite the source of the information.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.
Information Literacy: Acquire, evaluate, and use information from credible sources in order to meet information needs for a specific research purpose.

Objective(s):

1. Locate and review credible, scientific information relevant to a specific purpose.
2. Use credible, scientific information to advance the purpose of a research project or to solve a problem.
3. Use information ethically including citing sources using the appropriate format.
4. Differentiate between scholarly, scientific information and popular, non-scientific information.
5. Understand the importance of utilizing scholarly, scientific information in advanced scientific studies and the application of chemistry in society.

Methods of Evaluation:

1. Written examinations
2. Out-of-Class Assignments
3. In-Class Assignments
4. Quizzes

5. American Chemical Society -General Chemistry First Term Exam
6. Research Papers
7. Case Studies

Course Content Outline:

1. Chemistry and measurement
    a. Phases and classification of matter
    b. Physical and chemical properties
    c. Physical measurements
        i. Uncertainty
        ii. Precision
        iii. Accuracy
        iv. Error
        v. Percent Error
        vi. Theoretical Yield
    d. Significant figures
2. Scientific Method
    a. Observations
    b. Hypothesis
    c. Controlled Experiment
        i. Variables
            1. Independent Variable
            2. Dependent Variable
            3. Controlling Variables
        ii. Control Group
        iii. Experimental Group
    d. Model
    e. Laws
    f. Theories
3. Atomic theory
    a. Subatomic particles
        i. Protons
        ii. Neutrons
        iii. Electrons
        iv. Isotopes
    b. Atomic structure and symbolism
    c. The Periodic table
    d. Chemical nomenclature
        i. Molecular compounds
        ii. Ionic compounds
4. Electronic structure and periodic properties
    a. Electromagnetic radiation
        i. Energy
        ii. Frequency
        iii. Wavelength
    b. Bohr model
    c. Quantum theory
        i. Quantum numbers
        ii. Shells, subshells, atomic orbitals
    d. Electron configurations
        i. Atoms
        ii. Ions
    e. Periodic trends
        i. Effective nuclear charge
        ii. Atomic radii
        iii. Ionic radii
        iv. Ionization energy

v. Electron Affinity
vi. Metallic character
vii. Electronegativity

5. Chemical bonding and molecular structure
   a. Types of bonding
      i. ionic
      ii. covalent
      iii. metallic
   b. Lewis structures
      i. Resonance
      ii. Formal charge
   c. Molecular arrangement/electron pair geometry
   d. Molecular shape/structure
   e. Molecular polarity
6. Advanced theories of covalent bonding
   a. Valence bond theory
      i. Hybrid orbitals
      ii. Sigma and pi bonds
   b. Molecular orbital theory
      i. Bonding molecular orbitals
      ii. Antibonding molecular orbitals
      iii. MO energy diagrams
7. Composition of substances
   a. Formula mass and the mole concept
   b. Percent composition
   c. Empirical and molecular formula
8. Composition of solutions
   a. Molarity
   b. Mass percent
   c. Volume percent
   d. Dilution
9. Chemical reactions and stoichiometry
   a. Balancing chemical equations
      i. Simple
      ii. Redox
   b. Writing chemical reactions
      i. Classification of strong, weak, and nonelectrolytes
      ii. Molecular equations
      iii. Ionic equations
      iv. Net ionic equations
   c. Classifying chemical reactions in an aqueous solution
      i. Acid-base neutralization
         1. Strong and weak acids
         2. Strong and weak bases
      ii. Precipitation reactions
         1. Solubility table
         2. Soluble and nonsoluble
      iii. Oxidation-reduction reactions
         1. Oxidation number
         2. Oxidation, oxidized, and reducing agent
         3. Reduction, reduced, and oxidizing agent
   d. Reaction stoichiometry
      i. Limiting reagent
      ii. Theoretical yield
      iii. Percent yield
10. Thermochemistry
    a. Energy basics
       i. Heat
       ii. Work
       iii. Endothermic and exothermic

   b. Calorimetry
      i. Constant pressure calorimeter
      ii. Constant volume calorimeter
   c. Enthalpy and enthalpy change
      i. Bond energies
      ii. Law of heat summation
      iii. Standard enthalpies
11. Gases
   a. Pressure measurement
   b. Empirical gas laws
   c. Ideal gas law
   d. Kinetic molecular theory
   e. Effusion and diffusion
   f. Stoichiometry of gaseous reactions
   g. Non-ideal gas behavior
12. Nuclear chemistry
   a. Nuclide structure and stability
   b. Balancing nuclear reactions
   c. Nuclear transmutation reactions
   d. Uses of radioisotopes
   e. Biological effects of radiation
   f. Nuclear energy
13. Critical Evaluation of Information
   a. Sources of information
      i. Scholarly
      ii. Popular
      iii. Fact
      iv. Opinion
   b. Determining bias in information
   c. Citing information
      i. Formats used in scientific research
      ii. Critical citation components
   d. Evaluating information for credibility and scientific accuracy
      i. Peer-reviewed sources
      ii. Non-peer reviewed sources
      iii. Websites
         1. Government
         2. Commercial
         3. Educational
         4. Organizations, including non-profit
      iv. Bias
      v. Social media

Resources

Chang, Raymond and Kenneth Goldby. *Chemistry*. 13th ed. New York: McGraw-Hill Companies Inc., 2019.

Silberberg, Martin; Amateis, Patricia. *Chemistry: The Molecular Nature of Matter*. 9th ed. New York: McGraw-Hill Companies Inc., 2021.

Burdge, Julia. *Chemistry*. 5th. ed. New York: McGraw-Hill Companies, Inc, 2019.

Burdge, Julia and Overby, Jason. *Chemistry: Atoms First*. 4th ed. New York: McGraw-Hill Companies, Inc, 2020.

OpenStax. *Chemistry*. 2nd ed. Houston:OpenStax, 2019.

Sapling Learning. *General Chemistry II Access.* New York: Macmillian Higher Ed., 2009.

Resources Other

Eubanks, Lucy and Dwaine Eubanks. *Preparing for your ACS Examination in General Chemistry*. Milwaukee: American Chemical Society, Division of Chemical Education Examinations Institute, 2008.

Instructional Services

OAN Number:

Ohio Transfer 36 TMNS and Transfer Assurance Guide OSC008 (Course 1 of 2, both must be taken), and OSC023 (Course 1 of 4, all must be taken)

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