CHEM-130H: HONORS GENERAL CHEMISTRY I

Cuyahoga Community College

Viewing: CHEM-130H : Honors General Chemistry I

Board of Trustees:
January 2022

Academic Term:
Fall 2022

Subject Code
CHEM - Chemistry

Course Number:
130H

Title:
Honors General Chemistry I

Catalog Description:
Study of fundamental principles of chemistry emphasizing atomic theory, periodic trends, structure and bonding, chemical reaction and stoichiometry, energy, and the states of matter. Honors General Chemistry I combines lecture and laboratory into one course with laboratory experiments designed to demonstrate chemical concepts and support theoretical phenomena.

Credit Hour(s):
5

Lecture Hour(s):
4

Lab Hour(s):
3

Requisites

Prerequisite and Corequisite
CHEM-1010 Introduction to Inorganic Chemistry, or CHEM-101H Honors Introduction to Inorganic Chemistry, or sufficient score on Chemistry assessment test; and MATH-1530 College Algebra and MATH-1540 Trigonometry; or MATH-1580 Precalculus, or qualified math placement; or department approval: equivalent knowledge or skills.

Outcomes

Course Outcome(s):
Apply the principles of general 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.
38. Examine the chemical principles and scientific method used in experiments.
39. Predict the outcomes of an experiment using chemical principles.
40. Observe chemical reactions, identify the products, and summarize the change by a chemical equation.
41. Describe the purpose of the laboratory as a means of supporting theoretical phenomena.
42. Collect, organize, and interpret data.

Course Outcome(s):

Develop strong interpretative skills to effectively 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.
20. Determine the accuracy and precision of a set of measurements.
21. Demonstrate graphing techniques.
22. Observe chemical reactions, identify the products, and summarize the change by a chemical equation.
23. Describe the purpose of the laboratory as a means of supporting theoretical phenomena.
24. Collect, organize, and interpret data.
25. Locate and review credible, scientific information relevant to a specific purpose.
26. Use credible, scientific information to advance the purpose of a research project or to solve a problem.
27. Use information ethically including citing sources using the appropriate format.
28. Differentiate between scholarly, scientific information and popular, non-scientific information.
10. Understand the importance of utilizing scholarly, scientific information in advanced scientific studies and the application of chemistry in society.

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 the 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):

Develop preparative skills to safely and effectively use various experimental techniques to collect laboratory data required to support chemical concepts and principles. To use these skills in advanced 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.
Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):

1. Demonstrate knowledge of rules of safety in the laboratory.
2. Measure and calculate using the metric system.
3. Demonstrate an understanding of chemical nomenclature.
4. Record data with the correct number of significant figures.
5. Acquire knowledge of basic statistics.
6. Perform basic laboratory techniques.
7. Use various types of laboratory equipment and computer software to acquire data.
8. Perform experiments relating to the topical outline.

Course Outcome(s):

Develop analytical skills required to interpret, evaluate, and report experimental results.

Essential Learning Outcome Mapping:

Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):

1. Calculate using rules of significant figures.
2. Calculate the average, average deviation, and standard deviation of a data pool.
3. Determine the accuracy and precision of a set of measurements.
4. Demonstrate graphing techniques.
5. Observe chemical reactions, identify the products, and summarize the change by a chemical equation.
6. Develop an appreciation for the laboratory as a means of supporting theoretical phenomena.
7. Collect, organize, and interpret data.

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.
Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):

1. Determine the accuracy and precision of a set of measurements.
2. Demonstrate graphing techniques.
3. Observe chemical reactions, identify the products, and summarize the change by a chemical equation.
4. Describe the purpose of the laboratory as a means of supporting theoretical phenomena.
5. Collect, organize, and interpret data.
6.Locate and review credible, scientific information relevant to a specific purpose.
7. Use credible, scientific information to advance the purpose of a research project or to solve a problem.
8. Use information ethically including citing sources using the appropriate format.
9. Differentiate between scholarly, scientific information and popular, non-scientific information.
10. Understand the importance of utilizing scholarly, scientific information in advanced scientific studies and the application of chemistry in society.

Course Outcome(s):

Apply preparative skills and experimental techniques safely and effectively to acquire laboratory data to support chemical concepts and principles.

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. Demonstrate knowledge of rules of safety in the laboratory.
2. Measure and calculate using the metric system.
3. Demonstrate an understanding of chemical nomenclature.
4. Record data with the correct number of significant figures.
5. Acquire knowledge of basic statistics.
6. Perform basic laboratory techniques.
7. Use various types of laboratory equipment and computer software to acquire data.
8. Perform experiments relating to the topical outline.

Course Outcome(s):

Apply laboratory skills and techniques in advanced 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.

Objective(s):

1. Demonstrate knowledge of rules of safety in the laboratory.
2. Measure and calculate using the metric system.
3. Demonstrate an understanding of chemical nomenclature.
4. Record data with the correct number of significant figures.
5. Acquire knowledge of basic statistics.
6. Perform basic laboratory techniques.
7. Use various types of laboratory equipment and computer software to acquire data.
8. Perform experiments relating to the topical outline.

Course Outcome(s):

Evaluate experimental results and communicate the analysis and conclusions effectively using appropriate scientific language.

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.
Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):

1. Calculate using rules of significant figures.
2. Calculate the average, average deviation, and standard deviation of a data pool.
3. Determine the accuracy and precision of a set of measurements.

4. Demonstrate graphing techniques.
5. Observe chemical reactions, identify the products, and summarize the change by a chemical equation.
6. Describe the purpose of the laboratory as a means of supporting theoretical phenomena.
7. Collect, organize, and interpret data.

Course Outcome(s):

Apply the scientific method to solve a problem, develop experimental procedures, 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.
Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):

1. Calculate using rules of significant figures.
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4. Demonstrate graphing techniques.
5. Observe chemical reactions, identify the products, and summarize the change by a chemical equation.
6. Describe the purpose of the laboratory as a means of supporting theoretical phenomena.
7. Collect, organize, and interpret data.
8. Describe the scientific method including the basic steps of the process.
9. Apply the steps of the scientific method to solve a problem.

Methods of Evaluation:

1. Problem sets
2. Quizzes
3. Case studies
4. Laboratory experiments
5. Written exams
6. In class assignments
7. Oral presentations
8. Final exam - American Chemical Society 1st semester General Chemistry Exam
9. Laboratory
    a. Assignments
    b. Reports
    c. Notebooks
10. Research Paper

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
    d. Significant figures
    e. Scientific Method
        i. Observations
        ii. Hypothesis
        iii. Controlled Experiment
            1. Variables
                a. Independent Variable
                b. Dependent Variable
                c. Controlling Variables

2. Control Group
3. Experimental Group

f. Model
g. Laws
h. Theories

2. 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

3. 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

4. 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

5. 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

6. Composition of substances

a. Formula mass and the mole concept
b. Percent composition
c. Empirical and molecular formula

7. Composition of solutions
   a. Molarity
   b. Mass percent
   c. Volume percent
   d. Dilution
8. 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 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
9. 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
10. 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
11. 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
12. Critical Evaluation of Information

a. Sources of information
    i. Scholarly
    ii. Popular
    iii. Fact
    iv. Opinion
b. Determining bias in information
c. Citing information
d. Formats used in scientific research
e. Critical citation components
f. Evaluating information for credibility and scientific accuracy
    i. Peer-reviewed sources
    ii. Non-peer reviewed sources
    iii. Websites
    iv. Organizations, including non-profit
    v. Educational
    vi. Commercial
    vii. Government
g. Bias
h. Social media

13. Laboratory skills

a. Laboratory safety
    i. a. Safety procedures
    ii. b. Safety equipment
    iii. c. Correct handling of chemicals
    iv. d. Waste disposal
b. Metric system
    i. Measurements
    ii. Conversions
c. Significant figures
    i. Raw data
    ii. Calculations
d. Physical Measurements
    i. Accuracy
    ii. Precision
    iii. Uncertainty
e. Statistics
    i. Average
    ii. Average deviation
    iii. Standard deviation
    iv. Error analysis
    v. Percent Error
    vi. Percent Yield
f. Graphical analysis
    i. Preparation of a graph
    ii. Data abstraction
g. Chemical nomenclature
    i. Inorganic
    ii. Organic
h. Basic Equipment Use
    i. Analytical balance
    ii. Bunsen burner
    iii. Volumetric glassware
    iv. Class A pipettes
    v. Buret
    vi. Variable micropipettes
    vii. Centrifuge
    viii. Barometer
i. Experiments (~12 per semester)

i. Density-Unit conversion
ii. Separation of a Mixture
iii. Statistics: popcorn popping
iv. Atomic spectroscopy
v. Determination of water in a compound
vi. Lewis structures/geometry
vii. NMR Spectroscopy/electronegativity
viii. Metathesis reactions
ix. Mole ratios
x. Synthesis and reactions of copper
xi. Determination of the purity of recovered copper
xii. Acid-Base titration: determination of acetylsalicylic acid in aspirin tablets
xiii. Spectrophotometric determination of Fe in vitamin tablets
xiv. Determining the enthalpy of a reaction
xv. Gravimetric analysis: nickel
xvi. Behavior of gases: determination of the molar mass of a volatile liquid
xvii. Design a model airbag

Resources

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

Billo, Joseph. *Excel for Chemists.* 3rd ed. New York: John Wiley Sons, Inc., 2011.

Haynes, William ed. *CRC Handbook of Chemistry and Physics*. 102nd ed. New York: CRC Press, 2021.

Hansen-Polcar, Lois. *Laboratory Experiments for General Chemistry I*. Parma: CCC-West, 2017.

Murov, Steven. *Experiments in General Chemistry*. 6th ed. Boston: Cengage Learning, 2015.

Speight, James. *Lange's Handbook of Chemistry*. 17th ed. New York: McGraw-Hill Companies Inc., 2017.

Silberberg, Martin; Amateis, Patricia. *Principles of General Chemistry*. 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.

Randall, Jack. *Advanced Chemistry with Vernier*. Beaverton: Vernier Software and Technology, 2016.

Ebbing, Darrell. *Experiments in General Chemistry*. 10th ed. Belmont: Brooks/Cole Publishing, 2013.

Allotta, Paula; Difrancesco, Dale; Distler, Anne; Emmer, Elizabeth. . *Laboratory Experiments for General Chemistry*. Open Source, 2021.

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 and OSC023 (1 of 2 courses, both must be taken)

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