# SECTION HEADING

## CHEM 1101: General Chemistry I

### Description

General Chemistry I provides an in-depth introduction to fundamental theories and applications of chemistry including measurements, matter, chemical quantities, thermochemistry, atomic theory, bonding theory, and gases. This course is for students considering a major in science, pre-engineering, or pre-health (medicine, pharmacy, veterinary medicine, four-year nursing). This course is the first semester in a two-semester general chemistry sequence. This course includes a lab.

### Credits

4

### Prerequisite

High school chemistry (or) CHEM 1100 (or) CHEM 1150, High school algebra (or) MATH 1107 (or) placement by multiple measures

### Corequisite

None

### Topics to be Covered

1. Chemistry and measurements

2. Atoms, molecules, and ions

3. Composition of substances and solutions

4. Stoichiometry of chemical reactions

5. Thermochemistry

6. Electronic structure and periodic properties of elements

7. Chemical bonding and molecular geometry

8. Advanced theories of covalent bonding

9. Gases

### Learning Outcomes

Quantitative skills/problem solving/scientific method

1. Determine the number of significant digits in a number, and round numbers and calculated results to an appropriate number of significant digits

2. Apply dimensional analysis with proper attention to units and significant figures

3. Describe and apply the scientific method used by scientists in solving problems

Nomenclature

4. Given the name of a polyatomic ion, give the correct formula and charge; and vice-versa

5. For ionic and simple inorganic molecular compounds, given a chemical formula, give the correct name; and vice-versa

Atomic structure

6. Describe electrons, protons, and neutrons, and the general structure of the atom

7. Define isotope and determine the atomic number, mass number, and number of neutrons for a specified isotope

8. Identify the atomic number and atomic mass for any element

9. Calculate the average atomic mass of an element from isotopic abundances and isotopic masses

10. Correlate wavelength, frequency, and energy of light with electron energy levels in the atom via the photoelectric effect and the Bohr model

11. Apply wave-particle duality and the uncertainty principle to describe properties of electrons

12. Apply the results of the Schrödinger quantum mechanical model of the atom to assign quantum numbers to electrons and write electron configurations of multi-electron atoms and ions

13. Identify valence vs. core electrons and predict trends in atomic size, ionization energy, electron affinity, and charges on main-group ions

Stoichiometry

14. Given a chemical formula, calculate molar mass; given the amount of a substance, use Avogadro's number to calculate number of particles

15. Balance chemical equations and use stoichiometric relationships to calculate product and reactant amounts, determine limiting reagents, and calculate percent yields

16. Determine the empirical formula of an unknown compound using composition by mass or combustion analysis data

17. Calculate molarity; give amount or mass of solute and volume of solution; determine how to prepare a solution of a given molarity from the solute and water or by dilution of a more concentrated solution

18. Apply titration principles to determine the concentration of an unknown aqueous solution

Reaction types

19. Identify insoluble ionic compounds, strong and weak acids and bases, and oxidizing and reducing agents in precipitation, acid-base neutralization, and oxidation-reduction (redox) reactions

20. Predict products, identify spectator ions, and write net ionic equations

Thermochemistry

21. Explain the First Law of Thermodynamics and express relationships among heat, work, energy, and enthalpy

22. Apply thermochemical equations to relate amount to heat energy to the quantity of substance reacted

23. Calculate heat transferred using temperature measurements, heat capacity or specific heats

24. Apply Hess's Law and enthalpies of formation to determine enthalpies of reaction

25. Calculate reaction enthalpies using calorimetry data

Molecular structure: bonding, geometry, and polarity

26. Describe bonding in pure covalent, polar covalent and ionic structures

27. Draw Lewis structures for compounds including resonance, formal charge, and exceptions to the octet rule

28. Interpret VSEPR theory, Valence Bond Theory and possibly Molecular Orbital Theory to predict molecular shape, polarity and bonding

States of matter: gas phase

29. Explain the major points of the kinetic molecular theory of gases.

30. Describe the relationship between pressure, volume, moles, and temperature using gas laws

31. Write the equation for the ideal gas law and use it in calculations

32. Apply Dalton's Law to determine the mole fraction, partial pressures, and total pressure of a gas mixture

Broad-based laboratory competencies

33. Conduct laboratory work in compliance with guidelines for personal lab safety and responsible management of chemical waste; this includes appropriate use of personal protective equipment and interpretation of Globally Harmonized System for Hazard Communication (GHS) labels

34. Measure quantities such as mass, volume, temperature, and absorbance with proper technique, and record the results of measurements with the appropriate number of significant figures and units

35. Record observations of chemical processes (such as precipitate formation, gas evolution, etc.) and write chemical reactions consistent with their observations

36. Use proper techniques for laboratory procedures, such as titration, filtration, solution preparation, spectrophotometric measurements, etc.

37. Properly use glassware and equipment including beakers, Erlenmeyer flasks, volumetric pipets, burets, volumetric flasks, watch glasses, graduated cylinders, filtration apparatus, single-beam spectrophotometer, pH meter, balances

38. Effectively communicate lab procedures, observations, and results in the form of laboratory notebook, written reports, and verbal presentation

39. Interpret and analyze qualitative observations and quantitative results, incorporating graphs and tables as appropriate

## Credit Details

Lecture: 3

Lab: 1

OJT: 0

MnTC Goal Area(s): Goal Area 03 - Natural Sciences

**Minnesota Transfer Curriculum Goal Area(s) and Competencies**

Goal Area 03: Natural Sciences

1. Demonstrate understanding of scientific theories.

2. Formulate and test hypotheses by performing laboratory, simulation, or field experiments in at least two of the natural science disciplines. One of these experimental components should develop, in greater depth, students' laboratory experience in the collection of data, its statistical and graphical analysis, and an appreciation of its sources of error and uncertainty.

3. Communicate their experimental findings, analyses, and interpretations both orally and in writing.

4. Evaluate societal issues from a natural science perspective, ask questions about the evidence presented, and make informed judgments about science-related topics and policies.

**Transfer Pathway Competencies**

Chemistry Transfer Pathway AS

General Chemistry I

Required Course Competencies

QUANTITATIVE SKILLS/PROBLEM SOLVING/SCIENTIFIC METHOD

1. Determine the number of significant digits in a number, and round numbers and calculated results to an appropriate number of significant digits

2. Apply dimensional analysis with proper attention to units and significant figures

3. Describe and apply the scientific method used by scientists in solving problems

NOMENCLATURE

1. Given the name of a polyatomic ion, give the correct formula and charge; and vice-versa

2. For ionic and simple inorganic molecular compounds, given a chemical formula, give the correct name; and vice-versa

ATOMIC STRUCTURE

1. Describe electrons, protons, and neutrons, and the general structure of the atom

2. Define isotope and determine the atomic number, mass number, and number of neutrons for a specified isotope

3. Identify the atomic number and atomic mass for any element

4. Calculate the average atomic mass of an element from isotopic abundances and isotopic masses

5. Correlate wavelength, frequency, and energy of light with electron energy levels in the atom via the photoelectric effect and the Bohr model

6. Apply wave-particle duality and the uncertainty principle to describe properties of electrons

7. Apply the results of the Schrödinger quantum mechanical model of the atom to assign quantum numbers to electrons and write electron configurations of multi-electron atoms and ions

8. Identify valence vs. core electrons and predict trends in atomic size, ionization energy, electron affinity, and charges on main-group ions

STOICHIOMETRY

1. Given a chemical formula, calculate molar mass; given the amount of a substance, use Avogadro's number to calculate number of particles

2. Balance chemical equations and use stoichiometric relationships to calculate product and reactant amounts, determine limiting reagents, and calculate percent yields

3. Determine the empirical formula of an unknown compound using composition by mass or combustion analysis data

4. Calculate molarity; give amount or mass of solute and volume of solution; determine how to prepare a solution of a given molarity from the solute and water or by dilution of a more concentrated solution

5. Apply titration principles to determine the concentration of an unknown aqueous solution

REACTION TYPES

1. Identify insoluble ionic compounds, strong and weak acids and bases, and oxidizing and reducing agents in precipitation, acid-base neutralization, and oxidation-reduction (redox) reactions

2. Predict products, identify spectator ions, and write net ionic equations

THERMOCHEMISTRY

1. Explain the First Law of Thermodynamics and express relationships among heat, work, energy, and enthalpy

2. Apply thermochemical equations to relate amount to heat energy to the quantity of substance reacted

3. Calculate heat transferred using temperature measurements, heat capacity or specific heats

4. Apply Hess's Law and enthalpies of formation to determine enthalpies of reaction

5. Calculate reaction enthalpies using calorimetry data

MOLECULAR STRUCTURE: Bonding, Geometry, and Polarity

1. Describe bonding in pure covalent, polar covalent and ionic structures

2. Draw Lewis structures for compounds including resonance, formal charge, and exceptions to the octet rule

3. Interpret VSEPR theory, Valence Bond Theory and possibly Molecular Orbital Theory to predict molecular shape, polarity and bonding

STATES OF MATTER: Gas Phase

1. Explain the major points of the kinetic molecular theory of gases.

2. Describe the relationship between pressure, volume, moles, and temperature using gas laws

3. Write the equation for the ideal gas law and use it in calculations

4. Apply Dalton's Law to determine the mole fraction, partial pressures, and total pressure of a gas mixture

General Chemistry 1 & 2 Lab Competencies

1. Conduct laboratory work in compliance with guidelines for personal lab safety and responsible management of chemical waste; this includes appropriate use of personal protective equipment and interpretation of Globally Harmonized System for Hazard Communication (GHS) labels

2. Measure quantities such as mass, volume, temperature, and absorbance with proper technique, and record the results of measurements with the appropriate number of significant figures and units

3. Record observations of chemical processes (such as precipitate formation, gas evolution, etc.) and write chemical reactions consistent with their observations

4. Use proper techniques for laboratory procedures, such as titration, filtration, solution preparation, spectrophotometric measurements, etc.

5. Properly use glassware and equipment including beakers, Erlenmeyer flasks, volumetric pipets, burets, volumetric flasks, watch glasses, graduated cylinders, filtration apparatus, single-beam spectrophotometer, pH meter, balances

6. Effectively communicate lab procedures, observations, and results in the form of laboratory notebook, written reports, and verbal presentation

7. Interpret and analyze qualitative observations and quantitative results, incorporating graphs and tables as appropriate