暨南大學
JINAN UNIVERSITY

Summer 2021

0703C101
General Chemistry I (With Lab)

Instructor: TBA
Time: June 14, 2021-July 16, 2021
E-mail: TBA
Office Hours: 2 hours (according to the teaching schedule)
Contact Hours: 60
Credits: 4

Course Description

General Chemistry I is designed as an introduction to the most fundamental laws, theories, and principles of general chemistry. It is appropriate for students that have not had an advanced chemistry course in high school, and for those majoring in the environmental, earth, and social sciences, as well as disciplines such as architecture, business, and the humanities. The goal of this course is to provide students with a firm foundation on the basic concepts and principles of chemistry, by working through example cases and practice problems.

Required Textbook(s)

Chemistry, The Central Science, 14th edition (2018), by Theodore E. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine Murphy, Patrick Woodward, and Matthew E. Stoltzfus. Publisher: Pearson, ISBN-13: 978-0134414232.

Course Structure

The course content is divided into 10 modules:

- Module I (***Matter, Energy, and Measurement)*** discusses central ideas about matter and energy; about the process of science, as it relates to the origins of chemistry; about units of measurement for mass, length, volume, density, and temperature; about applications of chemical problem-solving to unit conversions;

and about uncertainty in measurements and the distinction between accuracy and precision.

- Module II (***Atoms, molecules, and Ions***) examines the properties and composition of matter on the microscopic and atomic scales, including: the differences between elements, compounds, and mixtures, and between atoms, ions, isotopes, and molecules; the evolution of the atomic theory and the nuclear atom model; we explore the atomic arrangement in the periodic table; we introduce chemical bonding in the formation of ionic compounds and covalent substances; we derive names and formulas of inorganic compounds and some simple organic compounds.

- Module III (***Chemical Reactions and Reaction Stoichiometry***) relate the mass of a substance to the number of chemical entities comprising it (atoms, ions, molecules, or formula units) and apply this relationship to formulas and equations. We start by defining the mole, and using it to convert between mass and number of entities, and to derive a chemical formula from mass analysis. We explore how formulas relate to molecular structures, and learn how to write and balance chemical equations. We calculate the empirical formula from analyses, amounts of reactants and products in a reaction, and determine limiting reactants and reaction yields.

- Module IV (***Reactions in Aqueous Solutions***) examines the underlying nature of three classes of reactions, and the complex part that water plays in aqueous chemistry. We start by exploring the molecular structure of water and its role as a solvent, then discuss molarity as a way to express the concentration of an ionic or covalent compound in a solution. We write equations for aqueous ionic reactions, describe precipitation reactions and their stoichiometry, explore acid-base reactions as proton-transfer processes, examine oxidation-reduction reactions in the formation of ionic and covalent substances. We calculate the concentration of solutions using molarity as the unit.

- Module V (***Thermochemistry***) investigates how heat, or thermal energy, flows when matter changes, how to measure the quantity of heat for a given change, and how to determine the direction and magnitude of heat flow for any reaction. We begin by exploring energy transformation and flow between systems, then we discuss the units of energy and identify the heat of a reaction as a change in enthalpy. We describe how a calorimeter measures heat and how the quantity of heat in a reaction is proportional to the amounts of substances. We define standard conditions in order to compare enthalpies of reactions and see how to obtain the change in enthalpy for any reaction, and discuss some current and future energy sources.

- Module VI (***Electronic Structure of Atoms***) explores recurring patterns of electron distributions in atoms to see how they account for the recurring behavior of the elements. We begin by describing a new quantum number and a restriction on the number of electrons in an orbital. We then explore electrostatic effects that lead to splitting of atomic energy levels into sublevels, and recognize how this filling order correlates with the order of elements in the periodic table.

- Module VII (***Periodic Properties of the Elements***) examines the development of the periodic table in order to understand the reasons for periodic trends with regard of atomic size, ionization energy, electronegativity. We then explore some common patters of reactivity across the periodic table. We utilize the periodic table and our knowledge of electron configurations to better understand the chemistry of alkali metals and alkaline earth metals.

- Module VIII (***Basic Concepts of Chemical Bonding***) examines how atomic properties give rise to two models of chemical bonding (ionic and covalent) and how each model explains the behavior of substances. We see how metals and nonmetals combine via these types of bonding and learn how to depict atoms and ions with Lewis symbols. We look at how a bond forms and discuss the relations among bond order, energy, and length. We explore the relationship between bond energy and the enthalpy change of a reaction. We examine periodic trends in electronegativity and learn its role in the range of bonding.

- Module IX (***Molecular Geometry and Bonding Theories***) examines the three-dimensional shapes of molecules as described by the valence-shell electron-pair repulsion (VSEPR) model. We then examine how multiple bonds and lone pairs affect the molecular geometry. We discuss the common types of hybridization and explore the connection between the type of hybridization and molecular geometries predicted by the VSEPR model.

- Module X (***Gases***) explores the physical behavior of gases and the theory that explains this behavior. We begin by comparing the behavior of solids, liquids, and gases, the discuss methods for measuring gas pressure. We consider laws that describe the behavior of a gas and its volume changes, and rearrange the ideal gas law to determine the density and molar mass of an unknown gas, the partial pressure of a gas in a mixture, and the amounts of reactants and products in a chemical change. We relate gas laws to the kinetic-molecular theory, and apply key ideas about gas behavior to Earth's atmosphere.

Course Schedule

Please note that the schedule is meant to give an overview of the major concepts in this course. Changes may occur in this calendar as needed to aid in the student`s development.

Week 1:
Chapter 1: Matter, Energy, and Measurement
Chapter 2: Atoms, molecules, and Ions
Chapter 3: Chemical Reactions and Reaction Stoichiometry

Week 2:
Chapter 4: Reactions in Aqueous Solutions
Chapter 5: Thermochemistry

Week 3:
Chapter 6: Electronic Structure of Atoms
Chapter 7: Periodic Properties of the Elements
Midterm Exam

Week 3:
Chapter 8: Basic Concepts of Chemical Bonding
Chapter 9: Molecular Geometry and Bonding Theories

Week 4:
Chapter 10: Gases
Final Exam

Practical Exercises (Lab Activities)

At the end of each week (on Fridays) students will have the chance to practice their understanding of the concepts discussed in the video lectures. They will work on practical exercises using the interactive simulations developed by the PhET program (http://phet.colorado.edu). A tutorial for each lab activity will guide students through the use of the simulations and help them engage in real experimentation, collect their own data, and develop their own analysis. The following concepts will be explored:

Week 1 Simulations: **"Build an Atom"**, **"Isotopes and Atomic Mass"**, **"Balancing Chemical Equations"**, and **"Reactants, Products, and Leftovers"** – In this practice exercise, students will: use the number of protons, neutrons, and electrons to draw a model of the atom, identify the element, and determine the mass and charge; predict how addition or subtraction of a proton, neutron, or electron will change the element, the charge, and the mass; use the element name, mass, and charge to determine the number of protons, neutrons, and electrons in an atom; use mass number, atomic number, number of protons, neutrons and electrons to identify and define isotopes; find the average atomic mass of an element given the abundance and mass of its isotopes; predict how the average atomic mass of an element changes given a change in the abundance of its isotopes; determine required conditions for a reaction to be considered "balanced" and relate these conditions to laws of matter; develop and apply different strategies to balance chemical equations; describe the difference between coefficients and subscripts in a chemical equation; translate from symbolic to molecular representations of matter; recognize that atoms are conserved during a chemical reaction; identify the limiting reactant in a chemical reaction; predict the products and leftovers after reaction, based on the quantities of reactants and ratios of molecules in the balanced chemical equation; predict the initial amounts of reactants given the amount of products and leftovers using the concept of limiting reactant.

Week 2 Simulations: **"Concentration"** and **"Molarity"** – In this practice exercise, students will: describe the relationships between volume and amount of solute to solution concentration; predict how solution concentration will change for any action (or combination of actions) that adds or removes water, solute, or solution; design a procedure for creating a solution of a given concentration and for changing a solution from one concentration to another; identify when a solution is saturated and predict its saturation concentration; calculate the concentration of solutions in units of molarity and use molarity to calculate the dilution of solutions.

Week 3 Simulations: **"Energy Forms and Changes"** – In this practice exercise, students will: predict how energy will flow when objects are heated or cooled, or for objects in contact that have different temperatures; describe the different types of energy and give examples from everyday life.

Week 4 Simulations: **"Models of the Hydrogen Atom"** – In this practice exercise, students will visualize different models of the hydrogen atom; explain the similarities for each model and what experimental predictions each model makes; explain the difference between the physical picture of the orbits and the energy level diagram of an electron; engage in model building.

Week 5 Simulations: **"Atomic Interactions"**, **"Build a Molecule"**, **"Molecule Shapes"**, **"Molecule Polarity",** and **"Gas Properties"** – In this practice exercise, students will: explain how attractive and repulsive forces govern the interaction between atoms; describe the effect of potential well depth on atomic interactions; contrast the potential well and behavior of a bonded pair of atoms with unbonded pairs; construct simple molecules from atoms; associate common molecule names with multiple representations; recognize that molecule geometry is due to repulsions between electron groups; understand the difference between electron and molecular geometry and identify molecule and electron geometries for a variety of molecules; compare bond angle predictions from the VSEPR-based model; describe how lone pairs affect bond angles; describe how heating (or cooling) changes the behavior of the molecules, and how changing the volume can affect temperature, pressure, and state; describe how forces on atoms relate to the interaction potential; predict how changing pressure/volume/temperature will affect the speed of molecules and influence gas properties and behavior.

Quizzes/Lab Assignment

Multiple quizzes and assignments will be offered for students to practice their concept understanding and to prepare for the lectures. These quizzes will be distributed in class a weekly basis. Late assignments will NOT be accepted, except in the case of a documented medical reason (documentation is required).

Grading Policy

Your final grade is based on the following components:

Quizzes	20%
Homework	10%
Midterm Exam	20%
Lab Activities	25%
Final Exam	25%
Total	100%

Grading Scale

The instructor will use the grading system as applied by JNU:

Definition	Letter Grade	Score
Excellent	A	90~100
Good	B	80~89
Satisfactory	C	70~79
Poor	D	60~69
Failed	E	Below 60

Academic Integrity

As members of the Jinan University academic community, students are expected to be honest in all of their academic coursework and activities. Academic dishonesty, includes (but is not limited to) cheating on assignments or examinations; plagiarizing, i.e., misrepresenting as one's own work any work done by another; submitting the same paper, or a substantially similar paper, to meet the requirements of more than one course without the approval and consent of the instructors concerned; or sabotaging other students' work within these general definitions. Instructors, however, determine what constitutes academic misconduct in the courses they teach. Students found guilty of academic misconduct in any portion of the academic work face penalties that range from the lowering of their course grade to awarding a grade of E for the entire course.