暨南大學
JINAN UNIVERSITY

Summer 2020

0703C101
General Chemistry I (With Lab)

Instructor: Ozeas Costa
Time: Monday through Friday (June 15, 2020-July 17, 2020)
Office Hours: 2 hours (according to the teaching schedule)
Contact Hours: 60 (50 minutes each)
Credits: 4
Location: Huiquan Building
Office: Huiquan Building 518

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. Daily lectures will be supplemented by practical exercises. At the end of each week, students will use the interactive simulations from the PhET program (http://phet.colorado.edu) to practice the concepts learned in class through hands-on experimentation, observation, and data analysis.

Required Textbook(s)

Chemistry, The Molecular Nature of Matter and Change, 7th edition (2014), by Martin S. Silberberg. Publisher: McGraw-Hill, ISBN 978-0021442546.

Prerequisites

No prerequisites

Course Hours

The course has 20 lecture sessions and 5 lab sessions in total. Each session is 120 minutes in length. Lecture session meets from Monday to Thursday. Lab session meets on Fridays.

Course Structure

The course content is divided into 10 modules:

Module I (***Keys to the Study of Chemistry***) discusses central ideas in chemistry, including: matter and energy; the process of science and the origins of chemistry; units of measurement for mass, length, volume, density, and temperature; applications of chemical problem-solving to unit conversions; uncertainty in measurements and the distinction between accuracy and precision.

Module II (***The Components of Matter***) 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; the atomic arrangement in the periodic table; introduction to chemical bonding, and the formation of ionic compounds and covalent substances; naming compounds and formulas, and calculating their masses on the atomic scale.

Module III (***Stoichiometry of Formulas and Equations***) 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 amounts of reactants and products in a reaction, and determine limiting reactants and reaction yields.

Module IV (***Major Classes of Chemical Reactions***) 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, and explore the nature of equilibrium.

Module V (***Gases and the Kinetic-Molecular Theory***) 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.

Module VI (***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 VII (***Quantum Theory and Atomic Structure***) discusses quantum mechanics, the theory that explains the fundamental nature of energy and matter and accounts for atomic structure. We begin by considering the classical distinction between the wave properties of energy and the particle properties of matter, then examine some observations that led to a quantized, or particulate, model of light. We see that light emitted by excited atoms suggests an atom with distinct energy levels, and we apply spectra to chemical analysis. We investigate how wave-particle duality and the uncertainty principle led to the current model of the H atom.

Module VIII (***Electron Configuration and Chemical Periodicity***) 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. We then examine the reasons for periodic trends in three atomic properties, and see how these trends account for chemical reactivity with regard to metallic and redox behavior, oxide acidity, ion formation, and magnetic behavior.

Module IX (***Models of Chemical Bonding***) examines how atomic properties give rise to three models of chemical bonding (ionic, covalent, and metallic) and how each model explains the behavior of substances. We see how metals and nonmetals combine via three 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, with a focus on fuels and foods. We examine periodic trends in electronegativity and learn its role in the range of bonding, and we consider a simple bonding model that explains the properties of metals.

Module X (***The Shapes of Molecules***) explores the three-dimensional shapes of molecules and examines some effects of these molecular shapes on physical and biochemical behavior. We learn how to apply the octet rule to convert a molecular formula into a flat structural formula that shows atom attachments and electron-pair locations. We see how electron delocalization limits our ability to depict a molecule with a single structural formula and requires us to apply the concept of resonance. We introduce bond angle and apply a theory that converts two-dimensional formulas into three-dimensional shapes. We describe five basic classes of shapes that many molecules adopt and consider how multiple bonds and lone pairs affect them and how to combine smaller molecular portions into the shapes of more complex molecules. We discuss the relation among bond polarity, shape, and molecular polarity and the effect of polarity on behavior.

Course Schedule

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

Week 1
Lecture 1: Keys to the Study of Chemistry (Chapter 1)
Lecture 2: Components of Matter: Atoms, Molecules, Ions, Compounds (Chapter 2)
Lecture 3: Molar Mass and Chemical Formulas (Chapter 3)
Lecture 4: Stoichiometry of Formulas and Equations (Chapter 3)
Lab 1: Atoms, Isotopes, and Chemical Equations

Week 2
Lecture 5: Ionic, Precipitation, and Acid-Base Reactions (Chapter 4)
Lecture 6: Redox Reactions and the Equilibrium State (Chapter 4)
Lecture 7: Gas Pressure and Gas Laws (Chapter 5)
Lecture 8: The Kinetic-Molecular Theory (Chapter 5)
Lab 2: Chemical Reactions and Gas Properties

Week 3
Lecture 9: Thermochemistry, Energy Conversion, and Enthalpy Changes (Chapter 6)
Lecture 10: Calorimetry, Thermochemical Equations and Hess's Law (Chapter 6)
Lecture 11: Review session for the Mid-Term Exam (Chapters 1-6)
Mid-Term Exam (Chapters 1 to 6)
Lab 3: Energy Forms and Changes

Week 4
Lecture 12: Quantum Theory: The Nature of Light and Atomic Spectra (Chapter 7)
Lecture 13: The Quantum-Mechanical Model of the Atom (Chapter 7)
Lecture 14: Electron Configuration and Chemical Periodicity (Chapter 8)
Lecture 15: Atomic Properties and Chemical Reactivity (Chapter 8)
Lab 4: Quantum Theory and Atomic Models

Week 5
Lecture 16: Models of Chemical Bonding (Chapter 9)
Lecture 17: Bond Energy, Electronegativity, and Bond Polarity (Chapter 9)
Lecture 18: The Shapes of Molecules: Lewis Structures & VSEPR Theory (Chapter 10)
Final Exam (Chapters 1 to 10)
Lab 5: Molecule Shapes and Polarity

Course Requirements

Quizzes/Homework
Multiple self-assessment quizzes and homework assignments will be offered for students to practice their concept understanding and prepare for lectures. These assignments will be provided to students before each class, so that students can use them to practice. Many of these assignments will be discussed during class and/or recitation. Late homework will NOT be accepted, except in the case of a documented medical reason (documentation is required).

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 class. They will work in small groups on practical exercises using the interactive simulations developed by the PhET program (http://phet.colorado.edu). Students can access these interactive simulations free of charge, but will need to register at the PhET website. A tutorial for each lab activity will guide students through the use of 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; 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", "Molarity", "pH Scale", "Acid-Base Solutions", "States of Matter", and "Gas Properties"** – 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; use molarity to calculate the dilution of solutions; compare solubility limits between solutes; determine if a solution is acidic, basic, or neutral; describe on a molecular scale how the water equilibrium varies with pH; predict (qualitatively and quantitatively) how dilution and volume will affect the pH and concentration of hydroxide, hydronium and water; relate the strength of an acid or base to the extent to which it dissociates in water; identify all the molecules and ions that are present in a given acid or base solution; compare the relative concentrations of molecules and ions in weak versus strong acid (or base) solutions; describe the similarities and differences between strong acids and weak acids or strong bases and weak bases; investigate different combinations of strength/concentrations that result in same pH values; describe a molecular model for solids, liquids, and gases, and extend this model to phase changes; describe how heating (or cooling) changes the behavior of the molecules, and how changing the volume can affect temperature, pressure, and state.

Week 3 Simulations: **"Energy Forms and Changes", "Energy Skate Park", "Molecules and Light", and "Greenhouse Effect"** – 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; explain conservation of energy in real-life systems; design a system with energy sources, changers, and users and describe how energy flows and changes from one form into another; explain the Conservation of Mechanical Energy concept using kinetic energy (KE) and gravitational potential energy (PE); explain how changing the mass affects energy; understand the role of friction in mechanical systems; explore how light interacts with molecules in the atmosphere; explain that absorption of light depends on the molecule and the type of light; predict the motion of a molecule based on the type of light it absorbs; identify energy increases from microwave to ultraviolet radiation; explore how the structure of a molecule affects how it interacts with light; describe the effect of greenhouse gases and clouds on photons and temperature.

Week 4 Simulations: **"Rutherford Scattering", "Blackbody Spectrum", "Quantum Wave Interference", and "Models of the Hydrogen Atom"** – In this practice exercise, students will: describe the qualitative difference between scattering off positively charged nucleus and electrically neutral atoms; describe qualitatively which factors affect the angle of deflection on charged nucleus; describe what happens to the blackbody spectrum as you change temperature; understand why light bulbs get hot; associate multiple temperatures to multiple light spectra; identify when photons, electrons, and atoms behave like particles or like waves; understand how the double slit experiment explains that matter and light behave as waves; describe the behavior of a wave function under different interference patterns; determine how the interference pattern will change if you change the mass, speed, or wavelength; recognize large range of size scales involved in quantum interference experiments; recognize the conditions in which two coherent light sources interfere with each other; 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", and "Molecule Polarity"** – 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.

Attendance Participation

Attendance at lectures, labs, and recitations is required. Continued absences will detract from your final grade. If you have missed/will be missing a class or recitation session for an acceptable reason, such as illness or religious observance, please let me know in person with a written document. Ideally, you should let me know of your absence prior to missing the class. In addition, **missing a class for an acceptable reason will not excuse you from completing the class exercises and the out-of-class assignments** so, if you miss a class, it is your responsibility to obtain notes from a classmate and contact the instructor in order to complete all the assignments by their original or extended deadlines.

Grading Policy

Your final grade is based on the following components:

Type	Percentage
Chapter Quizzes/Homework	20% of grade
Lab Exercises	25% of grade
Midterm Exam	25% of grade
Final Exam	30% of grade
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

Attendance

Attendance is mandatory in the class. It would be recorded each class and forms part of students` participation record. Students should inform the instructor at the earliest opportunity if they need to ask for a leave. All absences may have negative effect on students` final grades. Any students with more than three unexcused absences will automatically fail the course.

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 receiving a failing grade (E) in the course.