General Chemistry

Course Title: General Chemistry
Course Code: Chem 1012
Credit Hours/ECTS: 3/5
Contact Hours: 2 Lecture Plus 3 Laboratory Hours per Week
Year: I
Semester: II
Pre-Requisite: Does not Require Pre-Requisite

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Course description:

Nature and applications of chemistry in different fields of study will be demonstrated. Properties of matter including intensive and extensive, physical and chemical properties will be explored. Units and measurements, composition of matter, chemical reactions, reaction stoichiometry, atomic structure, periodic table, chemical bonding, structure of molecules, properties of solutions, concept of chemical equilibrium, introduction of functional groups and their typical reactions will be discussed.

Practical General Chemistry parts deals with introduction of laboratory conditions, safety in chemistry laboratory, laboratory report writing and data handling, and the various experiments that are related to chemistry courses at high school. Moreover, experiments related to the basic chemistry concepts will be comprehensively addressed. Experimental works on measuring mass and volumes, experimental errors, systematic and random errors, significant digits, Digital balance, mean, mean deviation, Bunsen burner, luminous and non-luminous flame, physical and chemical changes, properties

and reaction of substances, diffusion of gases, kinetic theory of gases, Graham's law of diffusion; colorimetric analysis, investigation of heat involved in a chemical reaction; basic laboratory operations such as recrystallization, simple distillation, and fractional distillations will be explored.

Course Objectives

Upon completion of the course the students will be able to:

- Express the role of chemistry in science fields
- Mention the different properties of matter
- Explain solution types and measurement units
- Describe the effect of different factors on solubility
- Discuss the mixture of liquids and their Laws
- Apply the different units and measurements
- Discuss atoms, ions, and their structures
- Describe the periodic table trends
- Discuss the stoichiometry of chemical reaction
- Apply the mole concept
- Describe the electronic structure of elements
- Explain the chemical bonding and molecular geometry
- Discuss the concept of acids and bases
- Examine the concept of hydrocarbons
- Explain the different types of functional groups
- Grasp the general guidelines of laboratory
- Develop the skill of mass and volume measurement
- Differentiate experimental errors
- Discuss the difference between physical and chemical changes
- Operate Bunsen burner and discuss on parts and description of each part
- Discus on the property of the flame of Bunsen burner

- Observe limiting reagents
- Verify the Graham's law of diffusion and observe the motion of the molecules
- Determine the percentage of water of hydration
- Perform solution preparations and define concentrations
- Discuss quantitative analysis using instruments
- Explain the difference between exothermic and endothermic reactions
- Carry out recrystallization, simple, and fractional

Course outline

1. Nature and Essence of Chemistry

1.1. Role of chemistry
1.2. Scientific methods of analysis
1.3. The domains of chemistry
1.4. State and classification of matter
    1.4.1. State of matter
    1.4.2. Classification of matter
1.5. Physical and chemical properties
1.6. Extensive and intensive property of matter

2. Properties of Solutions

2.1. Measures of concentration
2.2. Emphasizing the amounts of solute in solution
2.3. Emphasizing relative amounts of solute and solvent molecules
    2.3.1 Solubility
    2.3.2. Saturation and solubility
    2.3.3. The effect of pressure on gas solubility
    2.3.4. The effect of temperature on solubility
2.4. Colligative properties

2.4.1. Changes in vapor pressure, boiling points, and freezing points
2.4.2. Osmosis
2.5. Mixtures of liquids
2.5.1. Raoult's law for mixtures of liquids
2.5.2. The distillation of mixtures of liquid
3. Measurements and Units
3.1. Si base units
3.2. Derived units
3.3. Molarity and other concentration units
3.3.1. Molarity
3.3.2. Dilution of solutions
3.3.3. Percentage of (w/w, w/v and v/v)
3.3.4. Parts per million (ppm) and part per billion (ppb)
3.4. Measurement uncertainty
3.5. Significant figures in measurement
3.5.1. Significant figures in calculations
3.6. Accuracy and precision
3.7. Conversion factors and dimensional analysis
4. Atoms, Molecules and Ions
4.1. Atomic structure and symbolism
4.1.1. Chemical symbols and isotopes
4.1.2. Atomic mass unit and average atomic mass
4.2. Chemical formulas
4.3. The periodic table
4.3.1. Historical development of the periodic table
4.3.2. Classification of elements in the periodic table
4.4. Ionic and molecular compounds
4.4.1. Formation of ionic compounds
4.4.2. Formation of molecular compounds
4.5. Chemical nomenclature
4.5.1. Ionic compounds

4.5.2. Molecular compounds

5. Stoichiometry of Chemical Reactions and the Mole Concept

5.1. Writing and balancing chemical equations

5.1.1. Writing chemical equations

5.1.2. Balancing chemical equations

5.1.3. Equations for ionic reactions

5.2. Classification of chemical reactions

5.2.1. Acid-base reactions

5.2.2. Precipitation reactions and solubility rules

5.2.3. Oxidation-reduction reactions

5.3. Reaction stoichiometry

5.4. Mole concept and calculations

5.4.1 Mole and molar mass

5.4.2. Determining empirical and molecular formulas

5.4.3. Percent composition

5.4.4. Determination of empirical formulas

5.4.5. Determination of molecular formulas

5.4.6. Reaction yield/percent yield

5.4.7. Limiting reactant

6. Electronic Structure and Periodic Properties of Elements

6.1. Electromagnetic energy

6.1.1. Characteristics of light

6.1.2. Quantization and photons

6.2. The Bohr model

6.3. Development of quantum theory

6.3.1. The quantum–mechanical model of an atom

6.3.2. Quantum theory of electrons in atoms

6.3.3. The Pauli Exclusion Principle

6.4. Electronic structure of atoms

6.4.1. Orbital energies and atomic structure

6.4.2. The Aufbau principle

6.4.3. Electron configurations and the periodic table
6.4.4. Electron configurations of ions
6.5. Periodic variation in element properties
6.5.1. Variation in covalent radius
6.5.2. Variation in ionic radii
6.5.3. Variation in ionization energies
6.5.4. Variation in electron affinities
7. Chemical Bonding and Molecular Geometry
7.1. Ionic bonding
7.1.1. The formation of ionic compounds
7.1.2. Electronic structures of cations and anions
7.2. Covalent bonding
7.2.1. Formation of covalent bonds
7.2.2. Polarity of covalent bonds
7.3. Lewis structures
7.3.1. Writing Lewis structures with the octet rule
7.3.2. Exceptions to the octet rule
7.4. Formal charges and resonances
7.4.1. Calculating formal charge
7.4.2. Predicting molecular structure using formal charge
7.4.3. Resonance
7.5. Strengths of ionic and covalent bonds
7.5.1. Ionic bond strength and lattice energy
7.5.2. Bond strength of covalent bond
7.6. Molecular structure and polarity
7.6.1. VSEPR theory
7.6.2. Molecular structure and dipole moment
8. The Concepts of Acids and Bases
8.1. Arrhenius concept
8.2. Br∅nsted-Lowery concept
8.3. Lewis concept

8.4. p-function in chemistry: pH and pOH
8.5. Relative strength of acids and base

9. Organic Chemistry

9.1. Functional groups
  9.1.1. Hydrocarbons
  9.1.2. Alkanes
  9.1.3. Alkenes
  9.1.4. Alkynes
9.2. Aromatic hydrocarbons
9.3. Alcohols and ether
  9.3.1. Alcohols
  9.3.2. Ethers
9.4. Aldehydes, ketones, carboxylic acids and esters
  9.4.1. Aldehydes and ketones
  9.4.2. Carboxylic acids and esters
9.5. Amines and amides
  9.5.1. Amines
  9.5.2. Amides

Instructional Methods and Strategies: Instructional methods and strategies including gapped lecture, inquiry, homework, assignment, group discussion etc., in general, student-centered approach will be implemented in the course.

Students' Activities: Active participation in discussion and team works; active listening during lecturing; taking notes on the lessons; asking questions and answering to questions; submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time. PowerPoints, white boards, demonstration videos etc.

Assessment Strategies and Techniques: The theoretical section take 70% share of the course evaluation. Formative and summative assessments should be employed in

students' assessments. At least 40% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 30% final examination.

Instructional Materials: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

Text book:

A course module for General Chemistry (Chem1012). (2019). Ministry of Science and Higher Education (as prepared by: Yiheyis Bogale (PhD), Habdolo Esatu (MSc), and Tamene Beshaw (MSc).

References

1. Peter Atkins and Julio de Paula. Physical Chemistry for the Life Sciences, co-published with Oxford University Press, 2006.
2. P.W. Atkins and J.A. Beran, General Chemistry, 2nd Ed., 1992.
3. R. Chang, General Chemistry: The Essential Concepts, 5th Ed., 2008
4. J.W. Hill and R.H. Petrucci, General Chemistry: An Integrated Approach, 2nd Ed., 1999.
5. J. E. Brady, J. W. Russel and J.R. Holum, General Chemistry: Principles and Structure, 5th Ed., 2006.
6. S. S. Zumdahal and S.A. Zumdahal, Chemistry, 7th Ed., 2007
7. A course module for General Chemistry (Chem.1012). (2019). Ministry of Science and higher education (as prepared by: Yiheyis Bogale (PhD), Habdolo Esatu (MSc), and Tamene Beshaw (MSc).
8. David Harvey-1st ed. Modern analytical Chemistry, publisher: *James M. Smith, year 2000.*