SAGRADO
Universidad del Sagrado Corazón

SYLLABUS

TITLE: General Chemistry I

CODE: QUI 101

PREREQUISITE: N/A

CREDITS: 4 credits | 45 contact hours | 45 hours of laboratory | 1 term

DESCRIPTION

The General Chemistry course is an introduction to the laws and fundamental principles of modern Chemistry. Its goal is to develop an understanding of chemical principles, so that students can explain at the molecular level the relationship between the structure of a substance with how and why a reaction can occur, and how changes in energy occur. result of the interactions of matter. In this first part, we study the properties and structure of atoms and molecules, and their relationship with the periodic table of elements. In addition, a link is established between chemical reactions, mass relationships, and energy transfers that occur in these processes. Also, the study of the laws that govern the behavior of gases is incorporated. The course incorporates laboratory experiences to illustrate theoretical concepts, develop technical skills and analysis, and stimulate the development of scientific investigations. This course is aimed at students of concentration in Chemistry, Biology, Biomedical Sciences, and other allied health sciences, who are trained to understand the biological and industrial processes of the world around us.

JUSTIFICATION

The knowledge of the behavior and the properties of the matter that surrounds us constitutes a fundamental element to better understand and explain the world in which we live. The continuous development and material progress of our contemporary society presents us with a changing environment that requires a growing understanding of its components. Being Chemistry the scientific discipline on the topics, it is essential that all scientific training at the university level include the introductory course of General Chemistry as part of the study program. In addition, the study of this subject constitutes one of the pillars on which the most advanced and specialized knowledge required in various professional careers, such as Medicine, Engineering and Biotechnology, among others, rest.

COMPETENCES

The course develops in the student the following competencies:

- **Communication**
- **Critical Thinking**
- **Innovation and entrepreneurship**
- **Research and exploration**

OBJECTIVES

At the end of the course, students will be trained to:

1. Solve problems involving conversions between units of measurements, the application of the correct use of significant figures, and the detection of errors in experimental measurements.
2. Describe how the internal structure of atoms dictates the physical and chemical properties of matter.
3. Explain how, through ionic and covalent bonds, molecules are formed with different compositions, properties and structures that influence their behavior.
4. Formulate representations for chemical changes to apply them in determining the quantities of the substances involved and the energy associated with the reaction.
5. Develop procedures to prepare a mixture or separate its components.
6. Describe the behavior of the gaseous state.

CONTENT

I. Fundamentals of chemistry

   A. Matter
      1. Classification of matter
      2. Physical and chemical properties of matter
   B. Chemistry measures
      1. International System (SI) or metric
      2. English System
      3. Temperature scales
      4. Prefix uses
      5. Measure’s conversion
      6. Significant figures, rounding, and math operations

7. Absolute and relative uncertainty
8. Precision and accuracy
9. Types of errors (systematic, aleatory, and crass)

C. Density

II. Elements and atomic structure

A. Dalton's atomic theory
   1. Law of mass's conservation
   2. Law of constant composition
   3. Law of multiple proportions

B. Subatomic particles
   1. Electron discovery and properties
   2. Proton discovery and properties
   3. Neutron discovery and properties

C. Periodic Table
   1. Elements
   2. Atomic Symbols
   3. Atomic number

D. Isotopes
   1. Mass number
   2. Isotope's representation
   3. Atomic Mass

E. Periodic law
   1. Groups (or families) and periods
   2. Element's classification (metals, metalloids, and nonmetals)
   3. Properties and external configuration of alkali and alkaline earth metals
   4. Properties and external configuration of halogens
   5. Properties and external configuration of noble gases
   6. Elements that form ions with predictable charges

F. Periodic trends and properties
   1. Metallic character
   2. Atomic radio
   3. Electronic affinity
   4. Ionization energy
   5. Electronegativity

G. Atom number, mass, and moles
   1. Change from grams to moles, or vice versa
   2. Changing the number of atoms from moles, or vice versa

H. Quantum-mechanical model of the atom
   1. Properties of electromagnetic radiation

2. Types of electromagnetic radiation
3. Diffraction
4. Photoelectric effect
5. Atomic emission spectroscopy for H
6. Bohr model
7. De Broglie hypothesis
8. Schrödinger equation
9. Quantum numbers
10. Atomic orbitals
11. Electron spin
12. Pauli Exclusion Principle
13. Electronic configuration
14. Hund's rule

III. Compounds bonds and structures

A. Types of bonds
   1. Covalent bond (polar and nonpolar)
   2. Ionic bond
   3. Dipolar moment
B. Inorganic nomenclature
   1. Binary compounds
   2. Ternary compounds
C. Empiric, structural, and molecular formula
D. Molar mass
   1. Determination of molecular mass or formula weight
   2. Change from grams to moles or vice versa
E. Composition of the compounds
   1. Number of molecules or formula units
   2. Elemental composition percent
F. Lewis structures
G. Repulsion theory of the electrons pair
   1. Hybridization sp, sp2, sp3, sp3d, sp3d2
   2. Molecular geometry
H. Molecular Orbital Diagram for Homonuclear Molecules
   1. Bond order and stability
   2. Paramagnetic and diamagnetic behavior
I. Molecule’s polarity

IV. Chemical reactions

A. Physical and chemical changes

B. Chemical equations
    1. Balancing chemical equations
C. Stoichiometry
    1. Theoretical and experimental yield
    2. Limiting reagent and excess reagent
    3. Yield percent
D. Classification of reactions
    1. Decomposition
    2. Synthesis or combination
    3. Simple replacement or displacement
    4. Substitution or double displacement
E. Precipitation reactions
    1. Solubility of ionic compounds in water
    2. Molecular equation, total ionic and net ionic
F. Neutralization reactions
    1. Arrhenius acids and bases
    2. Salts
    3. pH
G. Oxidation-reduction reactions
    1. Oxidation numbers
    2. Reduction and oxidation
    3. Reducing agent and oxidating agent
H. Combustion reactions
I. Termochemistry
    1. Energy
    2. Heat
    3. Work
    4. Enthalpy of reaction
    5. Hess Law
    6. Calorimetry
    7. Specific heat and calorific capacity
J. Introduction to solutions
    1. Solute and solvent
    2. Ways to express concentration
        a. Molarity
        b. Weight percent
        c. Volume percent
    3. Solutions preparation
        a. From a solid reactive
        b. Dilutions

4. Physical's media to separate mixtures
    a. Evaporation
    b. Sublimation
    c. Condensation
    d. Distillation
    e. Decantation
    f. Extraction
    g. Chromatography

K. Properties of gases
    1. Pressure
    2. Laws that define the behavior of the gases
        a. Boyle's Law
        b. Charles Law
        c. Avogadro's Law
        d. Ideal gas equation
    3. Molecular kinetic theory

LABORATORY EXPERIENCES

A. Criteria discussion, laboratory rules and safety
B. General laboratory equipment and procedures / Graphical representation of data in Excel
C. Laboratory Basics: Accuracy and Precision
D. Components of a Mix
E. Hydrates
F. Nomenclature
G. VSEPR and molecular models
H. Conservation of mass and types of reactions
I. Calorimetry
J. Chemiluminescence
K. Determination of acetic acid in vinegar
L. Paper chromatography
M. Gas laws

METHODOLOGY

The following strategies of the active learning methodology are recommended:

- Conference
- Project Based Learning (PBL)
- Problem-based learning (ABPro)
- Service Based Learning (ABS)

- Discussion, forums, debates, colloquia and panels
- Simulations
- Laboratories
- Flipped classroom
- Discussion and analysis of problems
- Collaborative learning
- Teamwork
- Use of Web resources and tools
- Procedure-oriented coaching and problem solving
- Demonstration and practical exercises
- Self-assessment and peer assessment
- Application of theorems and laws
- Graphs and functions

EVALUATION

Partial works	40%
Midterm exams (30%)	
Assigned exercises (10%)	
Oral presentation	10%
Audiovisual demonstration	
Report / debate	
Immersive experience	25%
Laboratory	
Final exam	25%
Total	100%

LEARNING ASSESSMENT

The institutional assessment rubric is applied to the core activity of the course.

BIBLIOGRAPHY

TEXT

Tro, N. J. (2020). *Chemistry: A molecular approach* (5th ed.). Pearson.

LABORATORY MANUAL

Tro, N. (2020). *Chemistry: A Molecular Approach.* (5th ed.) Pearson.

REFERENCES

Brown, T. L., Lemay, H. E., Jr., Bursten, B. E., Murphy, C. J., Woodward, P. M., & Stoltzfus, M. W. (2017). *Chemistry: The Central Science* (14th ed.). Pearson.

Chang, R., & Overby J. (2019). *Chemistry* (13th ed.). McGraw-Hill.

Ebbing, D. D., & Gammon, S. D. (2017). *General Chemistry* (11th ed.). Cengage Learning.

Hein, M., Arena, S., & Willard, C. (2016). *Foundations of College Chemistry* (15th ed.). Wiley.

Kotz, J. C., Treichel, P. M., Townsend, J. R., & Treichel, D. (2015). *Chemistry & Chemical Reactivity* (9th ed.). Cengage Learning.

Petrucci, R. H., Petrucci, R. H., Herring, F. G., Madura, J. D., & Bissonnette, C. (2011). *General Chemistry: Principles and Modern Applications* (10th ed.). Pearson.

Reid, S. A. (2020). Restructuring a general college Chemistry sequence using the ACS anchoring concepts content map. *Journal of Chemical Education, 97*(3), 651-658. https://doi.org/10.1021/ed500712k

Silberberg, M. (2018). *Chemistry: The molecular nature of matter and change with advanced topics* (8th ed.). McGraw-Hill.

Zumdahl, S. S., Zumdahl, S. A., & DeCoste, D. J. (2017). *Chemistry* (10th ed.). Cengage Learning.

ELECTRONIC RESOURCES

American Chemical Society. (n.d.). *ACS Publications: Chemistry journals, books, and references published by the American Chemical Society.* https://pubs.acs.org/

American Chemical Society. (n.d.). *Chemical health and safety resources.*

https://www.acs.org/content/acs/en/education/policies/safety/chemical-health-and-safety.html

ChemCollective. (n.d.). *Online resources for teaching and learning Chemistry*.

http://www.chemcollective.org/

Flowers, P., Theopold, K., Langley, R., Robinson, W. R. (2019). *Free Chemistry textbook available to download.* OpenStax.

https://openstax.org/details/books/chemistry-2e

Senese, F. (2010). *General Chemistry Online!.*

http://antoine.frostburg.edu/chem/senese/101/index.shtml

Find more information resources related to the course topics on the library page http://biblioteca.sagrado.edu/

REASONABLE ACCOMMODATION

To obtain detailed information on the process and the required documentation, you must visit the corresponding office. To guarantee equal conditions, in compliance with the ADA (1990) and the Rehabilitation Act (1973), as amended, all students who need reasonable accommodation services or special assistance must complete the process established by the Vice Presidency for Academic Affairs.

ACADEMIC HONESTY, FRAUD AND PLAGIARISM

Any student who misses the policy of honesty, fraud and plagiarism is exposed to the following sanctions: received a grade of zero in the evaluation and / or repetition of the work in the course, grade of F (*) in the seminar: suspension or expulsion as established in the Academic Honesty Policy document (DAEE 205-001) effective August 2005.