SAGRADO
Universidad del Sagrado Corazón

**SCHOOL OF HEALTH AND SCIENCES**

**SYLLABUS**

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|---|---|
| **TITLE:** | General Chemistry I |
| **CODE:** | QUI 101 |
| **PREREQUISITE:** | N/A |
| **CORREQUISITES**: | QUI 101L |
| **CREDITS:** | 4 credits \| 45 contact hours \| 45 lab hours \| 1 term |

## DESCRIPTION

Introduction to the fundamental laws and principles of modern Chemistry. It aims to develop an understanding of chemical principles so that students can explain at the molecular level the relationship between the structure of a substance and how and why a reaction can occur, and how changes in energy resulting from the interactions of matter occur. In this first part, the properties and structure of atoms and molecules are studied, and their relationship with the periodic table of the elements. In addition, a link is established between the chemical reactions, mass ratios 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 research. This course is aimed at students majoring in Chemistry, Biology, Biomedical Sciences, and other health-allied sciences, trained to understand the biological and industrial processes of the world around us.

## JUSTIFICATION

Knowledge of the behavior and properties of the matter around us is a fundamental element in better understanding and explaining the world in which we live. The continuous development and material progress of our contemporary society presents us with a changing environment that requires an ever-increasing understanding of its components. Since Chemistry is the scientific discipline that studies the topics mentioned above, it is essential that all scientific training at the university level includes as part of the study program the introductory course of General Chemistry. In addition, the study of this

subject constitutes one of the pillars on which lay the most advanced and specialized knowledge required in various professional careers, such as Medicine, Engineering, and Biotechnology, among others.

## COMPETENCES

The course develops the following competences in students:

- **Critical questioning**
- **Research and exploration**

## OBJECTIVES

After completion of the course, students will be able to:

1. Solve problems involving conversions between units of measurement, apply the correct use of significant figures, and detect 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 be applied to determine the quantities of the substances involved and the energy associated with the reaction.
5. Develop procedures for preparing a mixture or separating its components.
6. Describe the behavior of the gaseous state.

## CONTENTS

I. Fundamentals of Chemistry
   A. Matter
      1. Classification of matter
      2. Physical and chemical properties of matter
   B. Measurements in Chemistry
      1. International System of Units (SI) or Metric System
      2. English or US Customary Unit System
      3. Temperature scales
      4. Use of prefixes
      5. Measurement conversions

6. Significant figures, rounding, and math
7. Absolute and relative uncertainty
8. Precision and accuracy
9. Types of errors (systematic, random, and crass)

C. Density

II. Atomic Elements and Structure

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

B. Subatomic particles
1. Discovery and properties of the electron
2. Discovery and properties of the proton
3. Discovery and properties of the neutron

C. Periodic table
1. Elements
2. Atomic symbols
3. Atomic number

D. Isotopes
1. Mass number
2. Representation of an isotope
3. Atomic mass

E. Periodic law
1. Groups (or families) and periods
2. Classification of elements (metals, metalloids, and non-metals)
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. Ion-forming elements with predictable charges

F. Periodic trends and properties
1. Metallic character
2. Atomic radius

3. Electronic affinity
4. Ionization energy
5. Electronegativity

G. Atom, mass, and mole number
1. Change from grams to moles, or vice versa
2. Change in 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's hypothesis
8. Schrödinger's equation
9. Quantum numbers
10. Atomic orbitals
11. Electron spin
12. Pauli's exclusion principle
13. Electronic configuration
14. Hund's Rule

III. Bonds and Structure of Composites

A. Types of bonds
1. Covalent bonding (polar and non-polar)
2. Ionic bonding
3. Dipole moment

B. Inorganic nomenclature
1. Binary Compounds
2. Ternary Compounds

C. Empirical, structural, and molecular formula

D. Molar mass
1. Determination of molecular mass or weight formula
2. Change from grams to moles or vice versa

E. Composition of compounds
    1. Number of molecules or formula units
    2. Percent of elemental composition
F. Lewis structures
G. G. Repulsion theory of electron pairs
    1. Hybridization sp, $sp^2$, $sp^3$, $sp^3d$, $sp^3d^2$
    2. Molecular geometry
H. Molecular orbital diagram for homonuclear molecules
    1. Link order and stability
    2. Paramagnetic and diamagnetic behavior
I. Polarity of molecules

IV. Chemical Reactions
A. Physical and chemical changes
B. Chemical equations
    1. Balancing chemical equations
C. Stoichiometry
    1. Theoretical and experimental performance
    2. Limiting reagent and excess reagent
    3. 3. Percent yield
D. Classification of reactions
    1. Decomposition
    2. Synthesis or combination
    3. Single replacement or displacement
    4. Double replacement or displacement
E. Precipitation reactions
    1. Solubility of ionic compounds in water
    2. Molecular, total ionic, and net ionic equation
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 oxidizing agent

H. Combustion reactions

I. Thermochemistry

1. Energy
2. Heat
3. Work
4. Enthalpy of reaction
5. Hess's law
6. Calorimetry
7. Specific heat and heat capacity

V. Introduction to solutions

A. Solute and solvent

B. Ways to express concentration

1. Molarity
2. Percentage by weight
3. Percentage in volume

C. Preparation of solutions

1. From solid reagent
2. Dilutions

D. Physical means for the separation of a mixture

1. Evaporation
2. Sublimation
3. Condensation
4. Distillation
5. Decanting
6. Extraction
7. Chromatography

VI. Properties of gases

A. Pressure

B. Laws defining the behavior of gases

1. Boyle's law
2. Charles' law

3. Avogadro's law
4. Ideal gas equation

C. Molecular kinetic theory

LAB EXPERIENCES

The following lab experiences are recommended:

A. General lab and safety rules
B. General lab equipment and procedures/Graphic presentation of data in Excel
C. Laboratory basics: accuracy and precision (experiment 1)
D. Components of a mixture (experiment 2)
E. Nomenclature/VSEPR and molecular models (experiment 13)
F. Conservation of mass and types of reactions (experiment 4)
G. Determination of acetic acid in vinegar
H. Hydrates (experiment 6)
I. Calorimetry (experiment 8)
J. Paper chromatography (experiment 15A)
K. Gas laws

**METHODOLOGY**

The following strategies from the active learning methodology are recommended:

- Lecture
- Project-Based Learning (PBL)
- Problem-Based Learning (PBL)
- Service-Based Learning (ABS)
- Discussions, forums, debates, colloquiums, 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 hands-on exercises
- Self-assessment and peer assessment
- Application of theorems and laws
- Charts & functions

## EVALUATION

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|---|---|
| Partial assignments | |
| Exams (30%) | 40% |
| Assigned exercises (10%) | |
| Oral presentation | 10% |
| Audiovisual demonstration/report/debate | |
| Immersion experience | 25% |
| Laboratory | |
| Final exam | 25% |
| **Total** | **100%** |

## LEARNING ASSESSMENT

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

## BIBLIOGRAPHY


TEXTBOOK

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

LAB MANUAL

Tro, N. J., Vincent, J. J., & Livingston, E. J. (2020). *Laboratory Manual for 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.

Henrie, S.A. (2015). *Green Chemistry Laboratory Manual for General Chemistry* (1st ed.). CRC Press.

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.

Torres, V., Rodríguez, J. (2001). *Química: Manual de laboratorio curso básico, primera parte* (5th ed.). Librería Universal.

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

For more information resources related to the course's topics, access the library's webpage http://biblioteca.sagrado.edu/

## REASONABLE ACCOMMODATION

For detailed information on the process and required documentation you should visit the corresponding office. To ensure equal conditions, in compliance with the ADA Act (1990) and the Rehabilitation Act (1973), as amended, any student in need of reasonable accommodation or special assistance must complete the process established by the Vice Presidency for Academic Affairs.

## ACADEMIC INTEGRITY

This policy applies to all students enrolled at Universidad del Sagrado Corazón to take courses with or without academic credit. A lack of academic integrity is any act or omission that does not demonstrate the honesty, transparency, and responsibility that should characterize all academic activity. Any student who fails to comply with the Honesty, Fraud, and Plagiarism Policy is exposed to the following sanctions: receive a grade of zero in the evaluation and / or repetition of the assignment in the seminar, a grade of F (*) in the seminar, suspension, or expulsion as established in the Academic Integrity Policy effective in November 2022.