SAGRADO
Universidad del Sagrado Corazón

SCHOOL OF HEALTH AND SCIENCES

SYLLABUS

TITLE:	General Chemistry II
CODE:	QUI 102
PREREQUISITE:	QUI 101
CORREQUISITES:	QUI 102L
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 second part, the physical properties of the solutions are discussed. In addition, the chemical equilibria involved in acid-base, precipitation and oxidation-reduction reactions are studied, and the factors that affect how quickly reactions occur. The laws of thermodynamics, electrochemical cells, and their relationship to chemical equilibrium are discussed. 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. Describe the different intermolecular forces in matter and how they affect the properties of liquids and solids.
2. Explain the different ways of expressing concentration in a solution, how a solution is formed, the factors that affect its composition, and the colligative properties.
3. Determine the speed of a chemical reaction, its activation energy, its rate constant, and the factors that affect the rate.
4. Apply calculations to predict where a reaction will move and determine the equilibrium concentration of species involved in the ionization of an acid, base, ionic compound, water, and other reversible reactions.
5. Calculate different thermodynamic properties of a chemical process.
6. Describe the components of an electrochemical cell (galvanic or electrolytic) and how they affect the electrical potential they can develop.

CONTENTS

I. Intermolecular Forces and States of Matter
   A. Intermolecular forces
      1. Van der Waals and London dispersion forces
      2. Dipole-dipole, polar molecules
      3. H Bonds
      4. Ion-dipole, induced ion-dipole, induced dipole-dipole
   B. Properties of the liquid state resulting from intermolecular forces
      1. Viscosity
      2. Capillarity
      3. Surface tension

C. Solid state
    1. Crystalline and amorphous solids
    2. Unit cell
    3. Coordination number
    4. Density of solids
    5. X-ray diffraction
D. Heat transfers associated with state changes
    1. Boiling Point
    2. Point of fusion
    3. Molar heat of fusion
    4. Molar heat of vaporization
    5. Clausius-Clapeyron equation
    6. Phase diagrams

II. Solutions

A. Concentration of a solution
    1. Molarity
    2. Molality
    3. Mole fraction
    4. Percent by weight
    5. Density
B. Forming a solution
    1. Entropy
    2. Intermolecular forces in solution formation
    3. Enthalpy of the solution
    4. Heat of hydration
C. Saturated, unsaturated, and supersaturated solutions
D. Solubility of solids and gases
    1. Effect of temperature on the solubility of solids in liquids
    2. Effect of temperature on the solubility of gases in liquids
    3. Effect of pressure on the solubility of gases in liquids: Henry's Law
E. Colligative properties
    1. Raoult's Law: drop in vapor pressure
    2. Boiling point elevation

3. Freezing point depression
4. Osmotic pressure

F. Colloidal suspension

III. Chemical Kinetics and Nuclear Chemistry

A. Rate of reaction

1. Factors affecting rate
2. Average rate
3. Instantaneous rate
4. Rate law: rate order and constant

B. Rate as a function of reagent concentration

1. Initial velocity method
2. Integrated rate laws: zero order
3. Half-life time

C. Collision theory and transition state theory

1. Collision theory
2. Arrhenius equation: activation energy and frequency factor
3. Energy profile diagram of a reaction
4. Mechanism of a reaction
5. Catalysts

D. Nuclear chemistry

1. Radioactive emissions: alpha and beta particles, and gamma rays
2. Balancing nuclear reactions
3. Radioactive decay
4. Half-life time
5. Exponential decay
6. Nuclear fission
7. Nuclear fusion

IV. Chemical Equilibrium

A. Equilibrium state

1. Dynamic equilibrium
2. Law of mass action
3. Equilibrium constant

B. Homogeneous and heterogeneous equilibria

C. Reaction quotient (Qc)
    1. Criterion for deciding whether or not a system is in equilibrium
D. The constant Kp as a function of Kc
E. Le Chatelier's principle
    1. Effect of change in the concentration of reagents or products
    2. Effect of change in temperature
    3. Effect of change in volume or pressure
    4. Addition Effect of a Catalyst
F. Computation of equilibrium concentrations for various systems
G. Acid-base equilibrium
    1. Arrhenius acids and bases
    2. Brønsted-Lowry acids and bases
    3. Ionization of strong and weak acids/bases in water
    4. Water autoionization, Kw
    5. Ionization constant of acids and bases in water
    6. pH and pOH of a solution
    7. Titration curves
    8. Buffer solutions and the Henderson- Hasselbalch equation
H. Solubility equilibria
    1. Dissociation of ionic compounds in water
    2. Solubility product constant
    3. Molar solubility
    4. Common ion effect

V. Thermodynamics
A. First law of thermodynamics
    1. Internal energy
    2. Status variable
B. Entropy
    1. Definition of entropy
    2. Spontaneous process and entropy
    3. Second law of thermodynamics
    4. Molar entropy of a substance
    5. Third law of thermodynamics

6. Change in the entropy of a reaction

C. Gibbs free energy
    1. Definition of Gibbs free energy
    2. Change in Gibbs free energy
    3. Criterion for determining the spontaneity of a reaction
    4. Gibbs' equilibrium constant and free energy
    5. Equilibrium constant as a function of temperature

VI. Electrochemistry
    A. Redox reaction balancing
        1. Oxidation number
        2. Half reaction
        3. Balance in acidic medium
        4. Balance in basic medium
    B. Electrochemical cell
        1. Cell potential
        2. Salt bridge
        3. Electrodes, cathode, and anode
        4. Reaction of a cell
        5. Galvanic cell
    C. Standard reduction potential
        1. Definition and determining the standard potential
        2. Normal Hydrogen electrode
        3. Series of activity
        4. Nernst's equation
    D. Electrolytic cell
        1. Polarity of the electrodes
        2. Faraday's constant

LAB EXPERIENCES

The following lab experiences are recommended:

A. General lab and safety rules
B. Literature review, scientific writing, and ethics in the sciences
C. Packed structures (experiment 17)

D. Colligative properties (experiment 18)
E. Kinetics (experiment 19)
F. Equilibrium constant and Le Chatelier's principle (experiment 20)
G. Acid-base titration (experiment 22)
H. Determination of the buffering capacity of antacid (experiment 23)
I. Entropy: the chelate effect (experiment 24)
J. Redox reactions (experiment 25)
K. Qualitative analysis (experiment 27)

METHODOLOGY

The following strategies from the active learning methodology are recommended:

- Simulations
- Problem-based learning
- Web-supported learning
- Literature research
- Concept maps
- Use of Web resources and tools: Blog
- Lecture
- Flipped classroom
- Observation, discussion and analysis of processes, problems, or phenomena
- Collaborative learning and teamwork
- Independent use of Media Lab
- Procedure-oriented coaching and problem-solving
- Demonstration and hands-on exercises
- Self-assessment and peer assessment
- Application of theories
- Graphs & functions

EVALUATION

Partial assignments	30%
Compositions	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.

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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.

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