SAGRADO
Universidad del Sagrado Corazón

SYLLABUS

TITLE: General Chemistry II

CODE: QUI 102

PREREQUISITE: QUI 101

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 second part, the physical properties of solutions are discussed. In addition, the chemical equilibria involved in acid-base reactions, precipitation and oxidation-reduction, and the factors that affect the speed with which the reactions occur are studied. The laws of thermodynamics, electrochemical cells, and their relationship with chemical equilibrium are discussed. 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

Knowledge of the behavior and 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 above mentioned, it is essential that all scientific training at the university level include the introductory course in 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.

COMPETENCES

The course develops in the student the following competencies:

- **Critical thinking**

OBJECTIVES

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

1. Describe the different intermolecular forces in matter and how they affect the properties of liquids and solids.
2. Explain the different ways to express concentration in a solution, how a solution is formed, the factors that affect its composition, and colligative properties.
3. Determine the rate of a chemical reaction, its activation energy, its rate constant, and factors affecting the rate.
4. Apply calculations to predict where a reaction is going and determine the equilibrium concentration of the species involved in the ionization of an acid, a base, an 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.

CONTENT

I. Intermolecular forces and states of matter

   A. Intermolecular forces
      1. Forces of dispersion, van der Walls and London
      2. Dipole-dipole, polar molecules
      3. Bridges of H
      4. Ion-dipole, ion-induced dipole, dipole-induced 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 changes of state
1. Boiling point
2. Melting point
3. Molar heat of fusion
4. Molar heat of evaporation
5. Clausius-Clapeyron equation
6. Phase diagrams

II. Solutions

A. Concentration of a solution
1. Molarity
2. Molality
3. Molar fraction
4. Percent by weight
5. Density

B. Formación de una solución
1. Entropía
2. Fuerzas intermoleculares en la formación de la solución
3. Entalpía de la solución
4. Calor de hidratación

C. Saturated, unsaturated, and supersaturated solutions

D. Solubility of solids and gases
1. Effect of temperature on 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. Drop in vapor pressure: Raoult's law
2. Increase in boiling point
3. Drop in freezing point
4. Osmotic pressure

F. Colloidal suspensions

III. Chemical kinetics and nuclear chemistry

A. Rate of a reaction
1. Factors affecting rate
2. Average rate
3. Instant rate
4. Law of rate: order and rate constant

B. Rate as a function of reagent concentration
    1. Initial velocity method
    2. Integrated rate laws: zero order, 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 particles, 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. State of equilibrium
    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. The Le Chatelier principle
    1. Effect of change in the concentration of reactants or products
    2. Effect of change in temperature
    3. Effect of change in volume or pressure
    4. Effect of adding a catalyst
F. Computation of equilibrium concentrations for various systems
G. Acid-base equilibrium
    1. Arrhenius acids and bases
    2. Bronsted-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-Hasselbach 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. State 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 entropy of a reaction

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

VI. Electrochemistry

A. Balancing redox reactions
1. Oxidation number
2. Half reaction
3. Balance in acid medium
4. Balance in basic medium

B. Electrochemical cell
1. Potential of a cell
2. Saline bridge
3. Electrodes, cathode and anode
4. Reaction of a cell
5. Galvanic cell

C. Standard reduction potential

1. Definition and determination of the standard potential
2. Normal H electrode
3. Activity series
4. Nerst equation

D. Electrolytic cell
1. Polarity of the electrodes
2. Faraday constant

LABORATORY EXPERIENCES

A. Introduction to the General Chemistry Laboratory, Evaluation Criteria and Laboratory Safety
B. Sublimation
C. Colligative properties
D. Kinetics
E. Equilibrium
F. Acid base titration
G. Determine the Buffer Capacity of an antacid
H. Entropy
I. Redox
J. Qualitative analysis
K. Oxidation-Reduction Reactions

METHODOLOGY

The following active learning methodology strategies are recommended:

- Simulations
- Problem-based learning
- Web-supported learning
- Bibliographic research
- Conceptual maps
- Use of Web resources and tools: Blog
- Conference
- 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 practical exercises
- Self-assessment and peer assessment

- Application of theories
- Graphs and functions

EVALUATION

Partial works	40%
Midterm exams (30%)	
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 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.

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ELECTRONIC REFERENCES

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

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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.