INTER AMERICAN UNIVERSITY OF PUERTO RICO
_____ CAMPUS
DEPARTMENT OF _____
CHEMISTRY PROGRAM

SYLLABUS

I. GENERAL INFORMATION

Course title	:	General Chemistry I
Code and number	:	CHEM 1111
Crédits	:	4 credits
Academic term	:	
Professor	:	
Office hours	:	
Office telephone	:	787-250-1912, ext. 2323
Email	:	

II. DESCRIPTION

Study of matter, its relationship with energy, its properties and its behavior from a macroscopic and microscopic qualitative approach. Formulation of basic concepts of chemistry through laboratory experience. Requires 45 hours of lecture and 45 hours of closed presential lab. Prerequisite: GEMA 1200.

III. OBJECTIVES

It is expected that, upon completion of the course, the student will be able to:

1. Demonstrate an understanding of the chemical principles that govern matter in terms of the relationships between structure (at the atomic, molecular, and macroscopic level) and the physical and chemical properties of substances.
2. Develop basic concepts of chemistry, based on experimentation, recognize patterns of behavior and evaluate hypotheses.
3. Develop and apply theories about the behavior of matter at the microscopic and macroscopic level.
4. Develop critical thinking and systematic data analysis to evaluate and solve new situations or problems using the basic concepts of chemistry.
5. Recognize the geometric structures of common compounds and ions.
6. Integrate basic concepts and principles of chemistry into everyday life.

GRADUATE PROFILE COMPETENCES ADDRESSED IN THIS COURSE

- Act in accordance with ethical standards and the laws that regulate the practice of the profession.

IV. CONTENTS

1. Define, differentiate and use the properties of matter and its various systems of measurement and conversions.

1.1. Carry out mass, volume, time, pressure and temperature measurements, using the appropriate instruments and the units of the International System of Measurements.

1.2. Differentiate between a mathematical number and a measure.
1.3. Differentiate between precision and accuracy.
1.4. Compare measuring instruments according to their precision and accuracy.
1.5. Make correct use of significant figures in calculations using experimental measurements.
1.6. Recognize and establish the difference between homogeneous and heterogeneous matter.
1.7. Differentiate between extensive and intensive properties.
1.8. Use the appropriate units to describe the results of the measurements.
1.9. Use the unit factor method to perform unit conversions.
1.10. Describe ways to measure temperature on various scales and make conversions between them.
1.11. Perform temperature change and heat change calculations.

2. Analyze the chemical properties, their classifications, the chemical formula, their nomenclature and the stoichiometry of composition.

2.1. Distinguish between substances (element and compounds) and mixtures (heterogeneous solutions and mixtures).
2.2. Recognize the states of matter and the conditions that determine that state.
2.3. Know the constituent particles of atoms that are related to chemical reactivity.
2.3.1. Distinguish between atomic number and mass number.
2.3.2. Distinguish between isotope, ion, cation, and anion.
2.3.3. Establish the number of protons, neutrons and electrons in an atom or ion, given its symbolic representation.
2.4. Know the concept of mole and molar mass and apply them appropriately to chemical formulas.

3. Use the concept of the chemical equation and the concentration of solutions by calculating quantities of substances using the stoichiometry of a reaction.

3.1. Correctly represent element symbols and formulas for molecular compounds and ionic compounds.
3.2. Distinguish between molecular formulas, empirical formulas and structural formulas write them correctly.
3.3. Determine the percentage composition of the elements and calculate chemical formulas from the composition.
3.4. Recognize the symbolism and meaning of a chemical equation.
3.5. Know the Law of Conservation of Matter and apply it in the process of representing chemical reactions with balanced equations.
3.6. Write names and formulas of common compounds and in solution.

4. Differentiate between different types of chemical reactions in solution, predict and calculate the products to be formed in these types of reactions.

4.1 Establish stoichiometric relationships (amount of substance) between reactants and / or products given a balanced chemical equation.
4.2 Determine limiting reagent and theoretical yield.
4.3 Determine performance percentage.
4.4 Know and calculate the different expressions of concentration of solutions.
4.5 Prepare solutions whose concentrations are given in units of molarity (M), percent by mass, and percent by volume.
4.6 Determine the relationship between the different units of concentration.
4.7 Prepare solutions by dilution.
4.8 Establish stoichiometric relationships between reactants and / or products given a chemical reaction in solution.

4.9 Distinguish between reactions that proceed completely to products and reactions that establish chemical equilibrium.
4.10 Recognize and distinguish between different types of chemical reactions: total combustion, acid-base, oxidation-reduction, and precipitation.
4.11 Identify acids and bases; strong and weak.
4.12 Predict the products of a reaction between acids and bases.
4.13 Correctly represent chemical equations between acids and bases.
4.14 Use the solubility rules to determine the formation of precipitates (insoluble) or soluble substances.
4.15 Predict the products of a precipitation reaction.
4.16 Correctly represent chemical equations of precipitation.
4.17 Know and calculate the oxidation state of the elements in various species.
4.18 Determine the oxidizing agent and the reducing agent given a redox type reaction.
4.19 Experimentally determine an activity series (relative reactivity).

5. Define, describe and evaluate the properties and variables that govern the behavior of gases and the theories that explain it.

5.1. Distinguish properties of gases, liquids and solids.
5.2. Establish algebraic relationships between pressure, volume and temperature variables for gas samples.
5.3. Integrate the relationships between pressure, volume, temperature, and quantity of substance into the ideal gas law.
5.4. Use the ideal gas law to predict the behavior of gases under conditions in which one or more of the variables changes (pressure, temperature, volume, amount of substance, molar mass).
5.5. Determine and explain the limitations of the ideal gas law.
5.6. Calculate properties of gas mixtures.
5.7. Describe the properties of gases based on the Kinetic-Molecular Theory.

6. Identify, measure and calculate various types of energies involved in chemical reactions and dissolution processes.

6.1. Recognize the various types of energy and the Law of Conservation of Energy.
6.2. Know the concepts of work and heat and apply them to the study of thermochemistry.
6.3. Use calibration procedures in calorimetric determinations.
6.4. Use concepts of standard enthalpies of formation in the determination of the heats of reaction.

7. Recognize, describe and evaluate the interaction of electromagnetic radiation with matter.

7.1. Establish the experimental evidence, achievements and limitations of the different atomic models throughout history.
7.2. Establish the usefulness of the different atomic models.
7.3. Calculate the atomic masses of the elements from the isotopic abundance.
7.4. Describe the wave properties of light and the relationship between energy, frequency, and wavelength. and their different interactions with matter.
7.5. Infer the electronic configuration of electrons at energy levels, given the ionization energies of an atom.
7.6. Differentiate between continuous and line (emission and absorption) spectra.
7.7. Compare the properties of particles and the properties of waves.
7.8. Distinguish between an orbit and an orbital of an electron.
7.9. Justify the need for a quantum-mechanical model.

7.10. Establish a correspondence between quantum numbers, the number of coordinates to locate a point in space and the types of orbitals.

8. Apply quantum mechanics to the distribution of electrons in atoms to determine their chemical properties.

8.1. To know the historical trajectory of the Periodic Table of the Elements to the present day and the limitations and achievements of the different assumptions of scientists in this process.
8.2. Represent the electronic configuration of the representative elements and the first period of the transition elements using the principles and rules that govern these.
8.3. Represent energy levels of electrons in an atom using orbitals.
8.4. Graph (draw) atomic orbitals and how these wave functions might interact to generate covalent bonds in single molecules.
8.5. Establish the relationship between electronic configurations of the atoms of the elements with their position (location) in families and periods in the Periodic Table commonly used.
8.6. Relate the electronic configurations of the atoms of an element with the physical and chemical properties exhibited by the element.

9. Evaluate and relate the characteristics of the elements that give rise to their properties and organization.

9.1. Use macroscopic properties (state of the element at ambient conditions and density) and microscopic properties (atomic size, charge of common ions, ionization energy, relative atomic mass, electronic affinity, and electronegativity) to establish relationships between elements.

10. Apply the concepts covered in the conference experimentally, in a research-based environment.

10.1. Formulate and demonstrate a hypothesis and the importance of the accuracy, precision, and reproducibility of such experimentation.
10.2. Generate and analyze data using concrete and / or abstract reasoning for interpretation and how to effectively communicate the results of the analyzes.
10.3. Develop laboratory skills and how to use them according to laboratory safety procedures.

Tabulated summary of content:

Topics-Chapter	Thematic Content-Subtopics	Chapter (4th Edition)
1. Matter, Measurements and Problem Solving	*Atoms and molecules, scientific method, classification of matter, physical and chemical properties, physical and chemical changes, units of measurements (length, time, temperature, volume), prefixes, density, reliability of a measurement (significant figures, rounding, precision and accuracy), troubleshooting (unit conversion, etc.).*	Ch. 1 (1.1-1.4, 1.6-1.8)
2. Atoms, Elements and the Mol	*Atoms and elements: modern atomic theory, laws of modern atomic theory, structure of the atom (subatomic particles, isotopes and ions), periodic table, atomic mass, molar mass - the mole.*	Ch. 2 (2.2-2.9)

Topics-Chapter	Thematic Content-Subtopics	Chapter (4th Edition)
3. Molecules, Compounds, and Chemical Equations	*Molecules and Compounds: chemical bonds, chemical formula, molecular formula, ionic compounds and their formulas, nomenclature of ionic and molecular compounds, formula mass and molar mass of compounds, percentage composition and determination of molecular formulas. Balancing chemical equations.*	Ch. 3 (3.2-3.3, 3.5-3.11)
PARTIAL EXAM # 1		
4. Chemical Quantities and Reactions in aqueous solution	*Stoichiometry, limiting reagent, theoretical yield, percentage yield, concentration-molarity and stoichiometry in solution, types of solutions, solubility of ionic compounds, precipitation reactions, acid-base reactions, representing reactions in aqueous solution, oxidation-reduction reactions.*	Ch. 4 (4.2-4.9)
5. Gases: Properties and Behavior	*Pressure and pressure units, simple gas laws, ideal gas law, applications of the ideal gas law (density and molar mass of gas), gas mixtures - Dalton's law, gases in chemical reactions, molecular kinetic theory, velocity diffusion - Graham's law, effusion, behavior of real gases.*	Ch. 5 (5.1-5.10)
PARTIAL EXAM # 2		
6. Thermochemistry	*Energy types, energy conservation and transfer, energy units, first law of thermodynamics, heat, work, change in internal energy (ΔE), constant volume calorimetry, enthalpy and endothermic and exothermic processes, constant pressure calorimetry, Law of Hess, determine enthalpies of reaction (ΔH) - enthalpies of standard formation (ΔH_f).*	Ch. 6 (6.1-6.9)
7. Atomic Model: Quantum Mechanics	*Wave properties of light, electromagnetic spectrum, corpuscular properties of energy, Bohr model, wave properties of matter (de Broglie, Heisenberg), quantum mechanics, orbitals.*	Ch. 7 (7.2-7.6)
8. Periodic properties of the elements	*Development of the periodic table, electronic configurations (electron spin, Pauli exclusion principle, energy of sublevels and configurations in multielectronic atoms, valence electrons.*	Ch. 8 (8.2-8.4)
PARTIAL EXAM # 3		
9. Periodic Trends	*Orbital blocks in the periodic table, transition elements and internal transition), atomic radius, ions (electron configurations of ions, ionic radius, ionization energy), electronic affinity, metallic character.*	Ch. 8 (8.6-8.8)
COMPREHENSIVE FINAL EXAM: Topics 1-8 (90%); 9 (10%)		

V. ACTIVITIES

A. Laboratory practices

1. Introduction to the General Chemistry Laboratory: Safety Rules, SDS, Standards and Evaluation Criteria
2. Uncertainty in measurements and numerical analysis
3. What is Matter?

4. How much are the pennies worth? (Experimental part)
5. How much are the pennies worth? (Graphics Workshop)
6. How is limestone produced?
7. Do ions change their partners?
8. How strong is my gastric juice?
9. Why does the floor feel colder than the carpet?
10. What is the best air bag?
11. The color of materials
12. Practical test

B. Teaching Strategies

It is recommended to use strategies such as the following:

1. team work
2. cooperative learning
3. directed discovery
4. demonstrations
5. group data collection and discussion
6. films
7. simulations
8. software application for data processing and group discussions
9. conceptual maps

VI. EVALUATION

1. The course evaluation consists of:

    A. A theory part composed of three (3) partial exams (100 points each) and a final exam of 125 points. These exams correspond to 70% of the final grade.
    B. A part of experimental practice that corresponds to 30% of the final grade.

Evaluation Criteria	Points	%
Partial Exam # 1	100	17.5
Partial Exam # 2	100	17.5
Partial Exam # 3	100	17.5
FINAL exam (comprehensive)	125	17.5
Laboratory	100	30

2. A poor grade (54.4% or less in either of the two parts of the course: theory or laboratory) means failure of the course.

3. The following evaluation scale will be applied in the final grade.

    100-85 A
    84-75 B
    74- 65 C
    64-55 D
    54-0 F

VII. SPECIAL NOTES

A. **Auxiliary services or special needs:** All students who require auxiliary services or special assistance must request them at the beginning of the course or as soon as they become aware that they need them, through the corresponding registry, in the Guidance Office with _____.

B. **Honesty, fraud and plagiarism:** Dishonesty, fraud, plagiarism, any other inappropriate behavior in relation to academic work constitute major infractions sanctioned by the General Student Regulations. Major offenses, according to the General Student Regulations, may result in suspension from the University for a defined period of more than one year or permanent expulsion from the University, among other sanctions.

C. **Use of electronic devices:** Cell phones and any other electronic device that could interrupt the teaching and learning processes or alter the environment conducive to academic excellence will be disabled. Urgent situations will be addressed, as appropriate. The handling of electronic devices that allow accessing, storing or sending data during evaluations or exams is prohibited.

D. **Compliance with the provisions of Title IX:** The Federal Higher Education Law, as amended, prohibits discrimination on the basis of sex in any academic, educational, extracurricular, athletic activity or in any other program or employment, sponsored or controlled by an institution of Higher education regardless of whether it is carried out on or off the premises of the institution, if the institution receives federal funds.

In accordance with current federal regulations, our academic unit has appointed an Assistant Title IX Coordinator who will provide assistance and guidance in relation to any alleged incident that constitutes discrimination based on sex or gender, sexual harassment or sexual assault. . You can contact the Assistant Coordinator _____, extension _____ or email _____

The Normative Document entitled **Norms and Procedures to Address Alleged Violations of the Provisions of Title IX** is the document that contains the institutional rules to channel any complaint that is presented based on this type of allegation. This document is available on the website of the Inter American University of Puerto Rico (www.inter.edu).

VIII. EDUCATIONAL RESOURCES

a. Text book

Tro, N.J.; *Chemistry: A Molecular Approach*; 4th Edition, Pearson Education, Inc: USA, 2017.
ISBN-10: 0134112830
ISBN-13: 978-0134112831

b. Laboratory Manual

General Chemistry I Laboratory Manual; Brito, R. D., Ed .; Inter American University of Puerto Rico, Metropolitan Campus: San Juan, PR, 2018.

IX. BIBLIOGRAPHY

a. Textbooks

1. Chang, R. and Goldsby, K., *General Chemistry: The Essential Concepts*, 7th Edition, (2013), McGraw Hill Co.
2. Chang, R. and Goldsby, K., *Chemistry*, 12th Edition, (2015), McGraw Hill Co.
3. Burdge, J. *Chemistry,* Third Edition, (2014), McGraw Hill Co.

4. Darrell D. Ebbing,Steven D. Gammon, *General Chemistry*, 9th edition, (2007), McGraw Hill Co.
5. Ebbing, D. D. & Gammon, S.D. (2011). *General Chemistry Enhanced Edition* (9th Ed.). Belmont, CA: Brooks/Cole Cengage Learning.
6. Tro, N.J., *Principles of Chemistry: A Molecular Approach*, 3rd Edition (2016), Prentice Hall.
7. Tro, N.J. , *Chemistry: Structure and Properties*, 1st Edition, (2015), Prentice Hall
8. Petrucci, R.H., Herring G., Madura, J.D., Bissonnette C., *General Chemistry: Principles and Modern Applications*, 10th Edition, (2011), Prentice Hall
9. D. D. Ebbing, *Química General*, 5ta Edición, McGraw Hill, Mejico,1997.
10. Boikess, R., *How to Solve General Chemistry Problems*, 8th Edition, 2009, Prentice Hall
11. Brown,T., Lemay, H., Bursten, B., Murphy, C., Woodward, P. (2012). *Chemistry: The Central Science*, 12th Edition, Boston: Prentice Hall.

b. Electronic Resources

1. Explore Chemistry with ChemEd DL http://www.chemeddl.org/
2. MSDS Safety http://www.msdsonline.com/msds-search
3. Models http://www.chemeddl.org/resources/models360/models.php

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