FORMAT CO
Course Outline

General Chemistry I — Course Title

SC160 — Dept. & Course No.

I. COURSE DESCRIPTION:
This course is the first part of a two-semester course that covers fundamental principles in chemistry. This course provides the beginning student with an adequate foundation in the fundamentals of chemistry. Topics include measurements, fundamental properties of matter, states of matter, chemical reactions, chemical stoichiometry, solutions, periodicity of elemental properties, atomic structure, chemical bonding, molecular structure, and an introduction to thermodynamics. Laboratory investigations are an integral part of this course and reinforce fundamental principles of general chemistry, introduction of the scientific method, experimental design, data collection and analysis, and preparation of laboratory reports.

II. SEMESTER CREDITS: 4

III. CONTACT HOURS PER WEEK: 3 Lecture | 3 Lab | 6 Total

IV. PRE-REQUISITE: SC119 with grade C or better and MA105

V. STUDENT LEARNING OUTCOMES:

With a minimum of 65% accuracy, upon completion of this course, the student will be able to:

1. Explain the importance of chemistry principles and their applications in the world around us.
2. Distinguish science from pseudoscience
3. Define and utilize metric units of measurement for chemical computations; use unit conversion factors and carry out unit conversions and other calculations involving proportional relations
4. Classify matter according to the states of matter and describe molecular properties of each state of matter; classify matter according to their molecular structure; pure substances and mixtures; compare and contrast homogeneous and heterogeneous mixtures; differentiate between extensive and intensive properties and give examples
5. Summarize the contributions of the following chemistry pioneers to the development of the modern atomic structure model: Democritus, John Dalton, J. J. Thomson, Robert Millikan, Ernest Rutherford, James Chadwick
6. Define atomic number, mass number, neutron number; illustrate how these are related and can be found from standard nuclide notation.
7. Calculate average atomic weight of a mixture of isotopes; calculate composition of a mixture of two isotopes from the average atomic

VI. COURSE CONTENT:

A. Introduction to Chemistry
   1. Importance of Chemistry
   2. Science vs. Pseudoscience

B. Measurement & Matter
   1. Metric and English systems of measurements
   2. Properties & Classification of Matter

C. Atoms, Elements, Molecules, & Compounds
   1. Discovery of Atomic Structure
      a. Atomic mass unit, atomic number, and mass number
      b. Isotopes, nuclide, and average atomic mass
   2. Periodic table
   3. Formulas
      a. Molecules and Molecular Compounds
      b. Ion and Ionic Compounds
   4. Chemical Nomenclature

weight.

8. Identify the basic components and summarize and identity the different grouping within the modern periodic table: metals, nonmetals, metalloids, alkali metals, alkaline earth metals, transition metals, inner transition metals, halogens, and noble gases
9. Apply systematic rules for naming inorganic compounds nomenclature and name and/or write formulas for various inorganic compounds including ionic, covalent, binary and polyatomic ions, acids, bases, and hydrates.

a. Naming compounds: ionic, covalent, binary ionic, polyatomic ions, acids, bases, and hydrates
b. Writing proper formulas for both covalent and ionic compounds.

10. Define "stoichiometry" and briefly summarize Antoine Lavoisier's main contribution to this area of chemistry
11. Summarize the law of conservation of mass and relate it to balancing of chemical equations
12. Balance chemical equations of different types of reactions including precipitation, acid-base, and oxidation-reduction reactions.
13. Recognize and/or predict products of different types of reactions: combustion, combination, and decomposition
14. Perform the following mole related calculations: atomic weight from isotopes, formula weights, percent composition from formulas, mass percent of atoms in a formula, number of atoms of an element in a given mole of substance, mass in grams of substance from a given mole, mole of substance from a given mass, molar mass from a formula
15. Perform conversions of mass to moles to number of molecules; perform conversions of number of molecules to moles to mass
16. Calculate empirical formulas of chemical substances from given mass percent of elements making up the substance
17. Calculate the molecular formula of a substance from a given molecular weight of the substance
18. Calculate molecular formula of a substance from given percentages of the elements making up the substance
19. Calculate the quantities of substances consumed or produced in chemical reactions; identify limiting reactants in reactions; calculate percent yield of reactions

D. Stoichiometry
1. Balancing chemical equations
2. Patterns of Chemical Reactivity
   a. Combustion
   b. Combination or synthesis
   c. Decomposition
3. Atomic and Molecular Weights
4. The Mole
5. Empirical and Molecular Formulas
6. Limiting Reactants.

20. Identify components of solutions: solute and solvent
21. Differentiate between an electrolyte and non-electrolyte; give examples of strong and weak electrolytes
22. Examine chemical reactions between aqueous solutions and classify as: precipitation, acid-base, and redox

E. Solutions
1. Properties of Aqueous Solutions
2. Patterns of Chemical Reactivity in Solutions
   a. Precipitation
   b. Acid-base
   c. Redox
3. Concentrations of Solutions
4. Titration

23. Analyze different aqueous reactants, determine whether or not reaction will take place, and predict products if chemical reaction will happen; write balanced equation for all reactions
24. Calculate molarity of solutions, molar concentrations of electrolytes, initial volume of concentrated solution need for dilution to a given molarity
25. Interconvert between molarity, moles, and volume of solutions
26. Use proper titration procedures, use a standard solution to determine concentration of a solution

F. Thermochemistry
1. Thermodynamics (Nature of Energy)
2. The First Law of Thermodynamics
3. Enthalpy
4. Enthalpies of Reaction (Heat of Reaction)
5. Calorimetry
6. Hess's Law
7. Enthalpies of Formation

27. Examine ways in which matter can possess energy and explain how energy can be transferred from one piece of matter to another
28. Give a precise definition of the energy of a system; discuss the meaning and physical significance of the First Law of Thermodynamics, $\Delta E=q+w$.
29. Given amount of heat added to or liberated from the system and work done, calculate ΔE of the system, determine if reaction is endothermic or exothermic; define "state function" and give examples
30. Define the enthalpy, and explain why it is more widely used than the internal energy.
31. Given initial and final heat gained or lost, calculate the change in enthalpy, ΔH; from the calculated ΔH, determine whether process is endothermic or exothermic.
32. Use a calorimeter to determine experimental value of heat that a substance has gained or lost (experimental value of ΔH)
33. Apply Hess's law and calculate the ΔH for a reaction from the tabulated ΔH values of other reactions
34. Define the standard enthalpy of formation of a substance; use enthalpies of formation to calculate enthalpies of reaction

G. Electronic Structure of Atoms
1. Wave Nature of Light
2. Quantized Energy and Photons
3. Electromagnetic spectrum
4. Bohr hydrogen atom
5. Wave Behavior of Matter
6. Quantum Mechanics and Atomic Orbitals
7. Representations of Orbitals
8. Orbitals of Many-Electron Atoms
9. Electron Configurations

35. Define "electromagnetic radiation", identify the different types of radiant energy, state the speed of radiant energy through a vacuum
36. Describe and be able to calculate the following properties of light: wavelength, frequency, speed
37. Use the Planck constant to relate the energy of a photon to its frequency and calculate the smallest quantum of energy that an object can absorb or give off.
38. Summarize Niels Bohr's theoretical explanation of line spectra; briefly describe the main

postulates of Bohr's model of the hydrogen atom, also known as "microscopic solar system" and the experimental evidence that led to it; describe its principle defects.

39. Summarize, in words and in an equation if provided, Louis de Broglie's theory of the wave properties of an electron and Werner Heisenberg's uncertainty principle; explain how these contributed to modification of the atomic structure model proposed by Niels Bohr
40. Explain the quantum mechanical model of the hydrogen atom and many-electron atoms; describe the four sets of quantum numbers represented by n, l, m_l, and m_s—their physical significance and the rules that govern the values they can have.
41. Use the ***Aufbau principle*** to work out a plausible electron configuration for any atom or element; draw orbital diagram representation for the electron configurations of different representative elements.

42. Describe the contributions of the following scientists to the development of the modern periodic table of elements: Dmitri Mendeleev, Lothar Meyer, and Henry Moseley
43. Examine the correspondence between the quantum models of the atom and electron shells with the sizes, ionization energy, and electron affinity of atoms
44. Describe periodic trends of the following properties as increasing or decreasing as one move across a period and/or a family in the Periodic Table of Elements: atomic radius, ionization energy and electron affinity, and metallic
45. Use the periodic table and knowledge of electron configurations to examine the chemistry of alkali metals, alkaline earth metals, hydrogen, oxygen group, halogens, and the noble gases

46. Describe and recognize the three different types of chemical bonds: ionic, covalent, and metallic; identify the number of valence electrons of different atoms; apply the octet rule and draw Lewis symbols for different atoms
47. Use Lewis electron-dot symbols to show how ionic bonds and covalent bonds form
48. Explain the lattice energy involved in ionic bond formation; explain bond enthalpy of covalent bonds
49. Explain the importance of sizes of ions in terms of lattice energy of solids and their solubility; identify factors that influences the size of ion;

H. Periodic Properties of the Elements
   1. Development of Periodic Table
   2. Periodic Trends
      a. Electron Shells and Sizes of Atoms
      b. Ionization energy
      c. Electron affinity
   3. Metal, Nonmetal, and Metalloids
   4. Group Trends for Active Metals
   5. Group Trends for Selected Nonmetals

I. Basic Concepts of Chemical Bonding
   1. Chemical Bonds, Lewis Symbols, and the Octet Rule
   2. Ionic Bonding
   3. Sizes of Ions
   4. Covalent bonds
   5. Bond Polarity and Electronegativity
   6. Lewis Structures
   7. Exceptions to Octet Rule
   8. Strength of Covalent Bonds

describe the trend of atomic sizes across a period and family

50. Define covalent bond; draw Lewis structures showing single, double, and triple covalent bonds
51. Describe bond polarity; calculate difference of electronegativity between bonded atoms to determine whether the bond is polar or nonpolar; calculate dipole moment and bond length of a polar molecule;
52. Draw the Lewis structures for different ionic and molecular compounds; draw all possible resonance structures for different molecules and explain their physical meaning.
53. Know the limitations of the Octet Rule and the excepts to the Octet Rule in situations involving covalent bonding; draw Lewis structures for compounds exempt from the Octet Rule
54. Describe and predict the shapes of molecules using the VESPR Model
55. Examine a model of molecular bonding (the valence-bond theory), explain why molecules form bonds, and explain why they have the shapes
56. Provide insight into the electronic structures of molecules by discussing a model of chemical bonding (molecular orbital theory)

J. Molecular geometry
   1. Molecular Shapes
   2. Valence Shell Electron Pair Repulsion (VSEPR) Model
   3. Polarity of Polyatomic Molecules
   4. Covalent Bonding and Orbital Overlap
   5. Hybrid Orbitals
   6. Multiple Bonds
   7. Molecular Orbitals
   8. Second-Row Diatomic Molecules

VI. MATERIALS & EQUIPMENT

A. Laboratory and related equipment
B. Standard classroom teaching supplies & equipment
C. Prepared handouts
D. TV, VCR, and DVD player
E. LCD Projector
F. Laptop
G. Internet access

VII. TEXT AND REFERENCES

A. Required Student Textbook

Brown, Theodore E., H. Eugene LeMay, Bruce E. Bursten, Catherine Murphy, Patrick Woodward, and Matthew E. Stoltzfus. 2015. *Chemistry: The Central Science, 13th edition*. USA: Pearson (Chapters 1-13)

VIII. METHODS OF INSTRUCTION

A. Lectures (Classroom & Lab)
B. Online course website companion
C. Demonstrations (Classroom & Lab)
D. Laboratory and/or Field Investigations
E. Investigation Report writing

F. Assigned reading in textbook
G. In-class and take-home assignments based on textbook readings & class discussions
H. Internet Resources

X. METHODS OF EVALUATION

GRADE COMPONENT	WEIGHT
Objective and essay examinations (lecture and laboratory tests)	25%
Laboratory works with written laboratory reports which may include graphing, performing calculations, evaluation of data, and answering given questions.	25%
Quizzes & Assignments	15%
Class and lab participation in activities and discussions	10%
Final Examination (cumulative)	25%

Grade Scale

PERCENT	LETTER GRADE
90-100%	A
80-89%	B
70-79%	C
65-69%	D
0-64%	F

Form NC-2
TASK LISTING SHEET

SC160 General Chemistry 1 (Course No. & Title)	Credits: 3 (Lecture)	1 (Lab)	48 (Total Lab Hrs.)

OBJECTIVES/TASKS	HOURS
1. Lab Report Guidelines – provide clear, written lab expectations, lab report guidelines, tentative lab topics & schedule, and deadline dates for submitting lab reports a. Explain the importance of keeping a lab journal for all scientific investigations b. Provide guidelines for the required format to follow when writing lab reports for this course c. Provide examples for each section of the lab report d. Provide calendar for all proposed lab investigations and schedule of when to submit reports	3
2. Accuracy & Precision in Scientific Measurements – demonstrate the importance of accuracy and precision in scientific measurements and the difference between them; understand absolute deviation, average deviation, uncertainty, and percentage of error a. Calculate values from experimental measurements b. Organize data in a reliable manner by compiling it in tables c. Calculate an average value from class data, and use it to calculate absolute deviation and average deviation	6
3. Mass and Mole Relationships in Chemical Reactions – calculate the number of moles of reactant and product in a simple chemical reaction; investigate mass and mole relationships in reactants and products of a reaction a. Establish a control that allows you to determine the variables of the experiment b. Experimentally determine the mole ratio of reactant and product	3
4. Periodic Table – gain familiarity with the elements and the periodic table by completing the following tasks: a. Organize a set of atoms similar to how Mendeleev categorized elements on his periodic table. b. Identify and briefly describe the properties of the following family of elements: alkali metals, alkaline earth metals, oxygen group, halogens, noble gases, lanthanides, and actinides	3
5. Survey of Chemical Reactions: Combustion, Combination, & Decomposition a. Perform an example of each reactions: combustion, combination, and decomposition b. Analyze each chemical reactions by performing the following: a. Predict product(s) of each reaction by writing a complete and balanced chemical equation b. Identify the limiting reactant(s) c. Calculate product(s) percent yield	6
6. Survey of Chemical Reactions: Precipitation, Acid-Base, and Redox a. Perform an example of each of the reactions b. Analyze each chemical reactions by performing the following: a. Write a complete and balanced chemical equation	6

b. Identify the limiting reactant c. Calculate product(s) percent yield	
7. Titration (Solution Concentration) – understand procedures necessary to standardize the concentration of a basic solution; gain experience in calculating the average molarity of an unknown solution a. Measure dispensed solution by calibrating two pipettes with precision and accuracy b. Observe the quantity of solution remaining in a buret when the equivalence point is reached c. Analyze data of three different trials by comparing it to the predicted results of the experiment	6
8. Calorimetry (Thermochemistry) – Use proper procedures, depending on calorimeter design to determine heat absorbed or released by different substances a. Calculate specific heat of an unknown solid elements by measuring the heat exchanged in a calorimeter	6
9. Chemical Bonds – learn the properties of ionic and covalent bonds a. Analyze the data and rank substances according to their melting point b. Observe compounds for their solubility or insolubility c. Classify compounds tested as ionic or covalent	6
10. Molecular Geometry a. Write Lewis (electron dot) diagrams for molecules and ions formed by representative elements. b. Predict the polarity of bonds and molecules formed by representative elements c. Predict bond angles and shapes of molecules and polyatomic ions d. Construct models for some covalently bonded species	3

COURSE LEARNING OUTCOMES
SC160 General Chemistry 1
PALAU COMMUNITY COLLEGE

Directions: At the end of the course experience, please rate the student to indicate the degree of competency. Circle one for each competency. The numerical ratings of 5, 4, 3, 2, and 1 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on the level of student performance for each of the competencies listed below.

RATING SCALE:

4– Accomplished 3 – Competent 2 – Developing 1 – Beginning

CLO #1: KNOWLEDGE IN GENERAL CHEMISTRY – Student gains knowledge in the fundamental concepts and principles in chemistry including, but not limited to, classification of matter, formation of molecules and ions, nomenclature, stoichiometry, thermochemistry, electronic structure, bonding, molecular geometry

4	Complete all of the following tasks with 90% accuracy or better: • *Examine the fundamental ways in which matter is classified and described (qualitatively and quantitatively);* • *Examine the basic structure of the atom, formation of molecules and ions, apply systematic procedures to name compounds;* • *Examine the quantitative nature of chemical formulas and chemical reactions;* • *Examine ways in which dissolved substances exist in water; examine chemical processes occurring in aqueous solutions: precipitation reactions, acid-base reactions, and redox reactions;* • *Examine relationships between chemical reactions and energy changes;* • *Describe the development of quantum theory and how it led to a consistent description of the electronic structures;* • *Apply the quantum mechanics tools to configure electrons in elements;* • *Briefly summarize the history of the periodic table;* • *Describe how properties of elements change as we move across a period or down a group of the periodic table;* • *Examine how the arrangement of electrons help to determine an elements chemical properties;* • *Examine the relationships among electronic structure, chemical bonding forces, and the properties of substances;* • *Discuss three models (VSEPR, valence-bond theory, molecular orbital theory) that relate to molecular geometry and bonding*
3	Complete all of the above with an accuracy of 70-89% or better
2	Complete all of the above with an accuracy of 65-69% or better
1	Complete all of the above with an accuracy of less than 65%

CLO #2: SCIENTIFIC INQUIRY – Students demonstrate the ability to incorporate the proper investigative protocols, select the most appropriate instruments to increase experimental data precision and accuracy, enforces safety regulations, and demonstrates professional affective skills when conducting scientific experiments or investigations to solve a problem or identify the best solution(s) to a problem.

4	Complete all of the following tasks with 90% accuracy or better:

	• *Able to follow a predesigned scientific investigation protocol using the proper instruments and independently make necessary revisions or substitutions with instructor's approval when necessary to achieve better data precision and accuracy;* • *Demonstrates responsibility by enforcing safety precautions and using all applicable protective gear;* • *Demonstrate clear reasoning through the use of self-designed and properly labeled tables and/or graphs to summarize data collected;* • *Demonstrates understanding of chemistry concepts and principles by incorporating chemistry fundamentals to discussion of results of scientific investigation;* • *Demonstrates ability to critique investigation protocols and make appropriate recommendations to achieve better results*
3	Complete all of the above with an accuracy of 70-89% or better
2	Complete all of the above with an accuracy of 65-69% or better
1	Complete all of the above with an accuracy of less than 65%

CLO #3: SCIENTIFIC REPORT WRITING – Student demonstrates the ability to communicate findings of scientific investigations in formal written scientific reports

4	Complete all of the following with 90% accuracy or better: • *Report title is self-explanatory,* • *Establish fundamental concept of the investigation,* • *Effectively presents purpose of investigation or hypothesis,* • *Gives enough details to allow for replication of procedures,* • *Successfully integrates verbal and visual representations of results,* • *Sufficiently addresses questions and other issues pertinent to investigation, convincing conclusion;* • *Report contains accurate measurements and analysis of data and presents data in properly designed and labeled tables, graphs, and figures that are self-explanatory;* • *Report is written in scientific style, clear and to the point, with correct grammar and spelling*
3	Complete all of the above with an accuracy of 70-89% or better
2	Complete all of the above with an accuracy of 65-69% or better
1	Complete all of the above with an accuracy of less than 65%