FORMAT CO
Course Outline

General Chemistry II — SC161
Course Title — Dept. & Course Number

I. COURSE DESCRIPTION:

II. This course is the second 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, to some details, properties of gases, liquids, and solutions, chemical kinetics, chemical equilibria, descriptive inorganic chemistry, and an introduction to organic chemistry and biochemistry of the four major macromolecules in human body. 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.

III. SEMESTER CREDITS: 4

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

V. PRE-REQUISITE: SC160 with a C grade or better

V. STUDENT LEARNING OBJECTIVES:
With a minimum of 65% accuracy, upon completion of this course, the student will be able to:

1. Discuss atmospheric pressure, how a barometers work, measure and calculate pressure in various units
2. Describe the state or condition of a gas according to the four variables: pressure (P), volume (V), temperature (T), and quantity of gas (n).
3. Explain gas laws that relates the four variables and perform calculations involving these laws: Boyle's Law, Charles' Law, Avogadro's Law, Ideal Gas Law, Dalton's Law of Partial Pressures
4. Describe the fundamental assumptions and implications of the kinetic molecular theory.
5. Discuss the molar volume of an ideal gas, define STP, and apply these concepts and the ideal gas equation to calculate volume of gases at STP
6. Identify, discuss, describe effects of intermolecular forces on properties of liquid: Dipole-dipole, hydrogen bonding, London dispersion forces
7. Use knowledge of intermolecular forces to predict vapor pressure
8. Describe the following properties of liquids: surface tension, capillary action, viscosity, and vapor pressure
9. Relate the composition and structure of water molecules to their physical properties: universal solvent, higher boiling point than most

VI. COURSE CONTENT:

A. Gases
   1. Properties of Gases
   2. Pressure
   3. Gas Laws
   4. Kinetic-Molecular Theory (KMT) of Gases
   5. Gas Stoichiometry

B. Liquids
   1. Intermolecular forces
   2. Properties of Liquids
   3. Phase Changes
   4. Vapor Pressure
   5. Phase Diagram

substances, expands when it freezes, lower density in solid phase
10. Construct and interpret a phase diagram for a pure substance; explain the phase diagram of water.
11. Calculate energy changes when water goes through phase change: melting, freezing, boiling, condensing, vaporize, and sublimation

12. Give a qualitative comparison of the solid, liquid, and gaseous states of matter in terms of intermolecular forces, average kinetic energy, and degree of organization.
13. Identify and describe the various kinds of crystalline solids, discuss molecular units found in each type of solid, and explain the relative strengths of the intermolecular forces that act between them: ionic solids, molecular solids, and atomic solids

C. Solids
1. Properties of Solids
2. Types of Crystalline Solids
3. Crystalline solids
4. Bonding in solids

14. Explain (at the molecular level) the process of dissolving and why certain components dissolve in water
15. Define the following: saturated, unsaturated, concentrated, and dilute
16. Describe qualitative terms associated with the concentration of a solution: mass percent, mole fraction, molarity, molality, normality
17. Perform the following calculations: mass percent, mass solute, molarity, ion concentration from molarity, number of moles from molarity, mass from molarity, normality
18. Discuss the strategy for solving stoichiometric problems for solution reactions and calculate mass of reactants and products, determine limiting reactants and calculate mass of products
19. Demonstrate dilution and neutralization reactions and perform the following: calculate concentration of a solution made by diluting a stock solution, calculate volume in neutralization reactions
20. Discuss colligative properties and perform experiments to demonstrate such properties: boiling point elevation, freezing point depression, and osmotic pressure; write the mathematical expression that describes how each of these properties depends on concentration
21. Solve problems involving colligative properties applying Henry's law and Raoult's law
22. Describe a colloid

D. Solutions
1. Solution formation
2. Solubility
3. Solution Composition
4. Stoichiometry of Solution Reactions
5. Ways of Expressing Concentration
6. Colligative Properties
7. Colloid

23. Use the collision model to explain how chemical reactions occur
24. Define activation energy and discuss how

E. Chemical Equilibrium
1. Reaction Rates
2. Chemical Equilibrium

concentrations and temperature of reactants, and the presence of a catalyst affect reaction rates

25. Define chemical equilibrium, explain how it is established in a system, and describe the characteristics of a chemical equilibrium
26. Summarize the law of chemical equilibrium (law of mass action), write equilibrium expressions for different reactions, and calculate values for equilibrium constant
27. Describe the role that liquids and solids play in constructing the equilibrium expression and write equilibrium expressions for heterogeneous equilibria
28. Restate the Le Chatelier principle, and utilize it to predict the changes that occur when a system at equilibrium is disturbed: change in concentration, change in volume, and change in temperature
29. Calculate the following: equilibrium concentration using equilibrium expressions, and solubility product of a salt if given its solubility and vice versa

3. Heterogeneous Equilibria
4. Le Chatelier's Principle
5. Application Equilibrium Constant

30. Describe the two models of acids and bases (Arrehenius and Bronsted-Lowry), explain the relationship of conjugate acid-base pairs, and be able to identify conjugate acid-base pairs
31. Explain what acid strength means, and describe the relationship between acid strength and the strength of conjugate base
32. Define amphoteric, explain how water is ionized, and calculate ion concentration in water
33. Define pH and pOH, and calculate the quantitative values of pOH and pH for various substances
34. Describe the general characteristics of buffered solutions

F. Acids, Bases, and pH
1. Acid Strength
2. Water as an Acid and a Base
3. pH Scale
4. Buffered Solutions

35. Explain the concept of spontaneous processes in chemistry, describe the driving forces of spontaneous processes at the molecular level, explain entropy and why it is a state function, relate structure and behavior of molecules to their entropy; calculate entropy change for reactions
36. Explain Gibbs free energy and why it is a state function, tabulate standard free energies of formation for substances; explain how change in free energy is affected by change in temperature and calculate free energy for reactions at different temperatures; explain the relationship between free energy, standard free energy, and equilibrium; use the relationship to explain temperature dependency of equilibrium constants

G. Spontaneous Change: Entropy & Free Energy
1. Spontaneous Processes
2. Entropy and the Second Law of Thermodynamics
3. Gibbs Free Energy
4. Free Energy and Temperature
5. Free Energy and Equilibrium Constant

37. Elaborate on metal-nonmetal oxidation-reduction reactions and identify oxidation and reduction in a reaction
38. Explain how oxidation states (oxidation numbers) are assigned and assign oxidation states for different molecules or ions
39. Describe oxidation and reduction in terms of oxidation states and identify oxidizing and reducing agents
40. Describe half-reactions and balance oxidation-reduction equations by using half-reactions method
41. Define electrochemistry and identify the components of a n electrochemical (galvanic) cell
42. Describe the composition and operation of commonly used batteries
43. Describe the process of electrolysis and explain the commercial preparation of aluminum

H. Oxidation-Reduction and Electrochemistry
1. Oxidation — Reduction Reactions
2. Applications of Oxidation-Reductions
3. Electrochemistry
4. Battery & Corrosion
5. Electrolysis

44. Describe the types of bonds formed by the carbon atom and differentiate between saturated and unsaturated hydrocarbons
45. Write general formulas, draw structural and condensed formulas of different hydrocarbons and their isomers, and give IUPAC names for each structure.
46. Describe various types of chemical reactions that hydrocarbons undergo and predict products of such reactions
47. Describe the common functional groups in organic molecules, write general formulas for the functional groups, identify functional groups in condensed structural formulas, and apply IUPAC guidelines to name molecules containing functional groups: halohydrocarbon (alkyl halide), alcohol, ether, aldehyde, ketone, carboxylic acid, ester, amine
48. Describe and apply the processes of how some alcohols are made: distillation and esterification
49. Describe polymers, different polymerization reactions, and applications or uses of polymers

I. Organic Chemistry
1. Carbon Bonding
2. Hydrocarbons
3. Functional Groups
4. Nomenclature
5. Polymer

50. Define protein; describe the primary, secondary, and tertiary structures of proteins; explain various functions of proteins in the human body
51. Explain how enzymes work in the human body
52. Describe a carbohydrate and its fundamental properties (identify functional groups present in a structure of a carbohydrate)
53. Identify the three most important polysaccharides and briefly describe its one, their chemical structures, and why they are important in the human body: starch, cellulose, and glycogen

J. Biochemistry of Macromolecules
1. Proteins
2. Enzymes
3. Carbohydrates
4. Nucleic Acids
5. Lipids

54. Compare and contrast the fundamental nucleic acid structures and their functions in the human body: DNA, RNA
55. Identify and describe the four classes of lipids and their importance in the human body: fats, phospholipids, waxes, and steroids

VII. MATERIALS & EQUIPMENT:

A. Laboratory and related equipments
B. Standard classroom teaching supplies & equipment
C. Prepared handouts
D. Audio visual aids in Video cassettes, DVD, CD formats
E. TV and DVD player
F. LCD Projector
G. Laptop
H. Internet access

VIII. 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 14-24)

IX. METHODS OF INSTRUCTION:

A. Lecture
B. Online course website companion
C. Classroom and laboratory demonstrations
D. Performance of correlated experiments
E. Laboratory 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:

A. Grade – Semester grade will be based on the following components, with percentage weighing as show:

Grade Components	*Weight*
Tests (Lecture & Lab)	25%
Lab Reports	25%
Assignments & Quizzes	15%
Participation	10%
Final Exam, cumulative	25%

B. Transmutation of percent score to letter grade will correspond to the following conversion:

Grade Scale	*Letter Grade*
90%-100%	A
80% - 89%	B
70% - 79%	C
65% - 69%	D
0% - 64%	F

Form NC-2
TASK LISTING SHEET

SC161 General Chemistry II — Credits: 3 (Lecture) 1 (Lab) 48 (Total Lab Hrs)
Course No. & Title

TASKS	HOURS
1. Lab Orientation & Reporting 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. **SLO #3 & 5:** Properties of Gas & Verification of Gas Laws – determine the molar volume of gas at room temperature and pressure from experimental data a) Generate hydrogen gas by reacting measured mass of metallic magnesium with excess hydrochloric acid b) Measure volume of gas produced using eudiometer c) Use Boyle's and Dalton's laws to correct the measured volume and obtain the volume of dry hydrogen at room temperature d) Calculate number of moles of hydrogen produced from the mass of magnesium reacted e) Calculate molar volume of hydrogen produced at room temperature	6
3. **SLO 20 & 21**: Colligative Properties of Solutions – investigate the effect of the addition of solute to the boiling and freezing points of a solvent a) Measure the freezing point of a pure substance b) Determine freezing point of a solution by graphical method c) Knowing the molal freezing-point constant and having determined experimentally the mass of an unknown solute, mass of unknown solvent, and the freezing-point depression, calculate the molar mass of the solute	6
4. **SLO #27-29:** Chemical Equilibrium – investigate how outside forces acting on a system at equilibrium provoke changes within the system (Le Chatelier's Principle) a) Observe qualitatively the effect of changing the concentration of one or more substances in a chemical equilibrium b) Given the equation for the chemical equilibrium, predict and explain on the basis of LeChatelier's Principle, the direction of a shift in the position of an equilibrium caused by a change in the concentration on one species	6
5. **SLO #3 & 34:** Measurement of pH – use different techniques to determine the pH values of various substances: pH indicator standards, pH paper, and pH digital meter a) Prepare a set of pH indicator standards b) Measure the pH of an unknown solution by using indicator standards c) Use the pH paper and digital meter to verify the calculated pH of the unknown solution	6

6. **SLO #37-39:** Oxidation-Reduction Reactions a) Determine experimentally the relative strengths of a selected group of oxidizing agents	6
7. **SLO #41-43:** Electrochemistry – investigate the electrolysis of solutions a) Describe how conductivity of a solution may be tested b) Observe conductivity of several solutions and classify the observed solutions as strong electrolyte, weak electrolyte, or non-electrolyte c) Explain the presence or absence of conductivity in an aqueous solution	6
8. Preparation and Properties of a Soap a) Starting with vegetable oil, prepare a soap in the laboratory b) Examine the chemical properties of the soap you prepared	9

COURSE LEARNING OUTCOMES
SC161 General Chemistry II
PALAU COMMUNITY COLLEGE

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, properties of gas, liquid, and solid substances, intermolecular forces, solution formation and the energy involved in the dissolution process, determination of acids and bases, pH and pOH value calculations, entropy and free energy involved in spontaneous processes, chemical equilibrium and factors that influences the rate of chemical reaction, nomenclature of organic molecules, and chemical structure of living matter

4	Integrate, analyze, and apply all of the following general chemistry concepts and principles with an accuracy of 90% or better: • *Describe physical characteristics of gases to some detail and explain how they differ from characteristics of solid and liquid substances; explain how properties of gas relate to the kinetic molecular theory;* • *Identify and describe the different types of intermolecular forces that exist between molecules; explain how attractions between molecules arise; relate composite and structure of solid and liquid molecules to their physical properties;* • *Explain what happens at the molecular level when a solution is formed, why heat is released or absorbed during formation of a solution, why some substances dissolve in a particular solvent whereas others do not, identify the factors that affect the extent to which particular solute dissolves in a particular solvent, and how concentration of solution affects the physical properties of the solution such as freezing and boiling points* • *Describe the factors that control rates of chemical reactions, determine the rates of reactions and express them mathematically, and summarize how reactions occur at the molecular level* • *Describe the relationship between the rates of opposing reactions and how it leads to chemical equilibrium, describe the factors that determine relative concentrations of reactants and products at equilibrium, and express equilibrium position of a reaction in quantitative terms* • *Explain how acids and bases are identified and characterized; describe properties of acids and bases in terms of their structure and bonding, and chemical equilibria in which they participate* • *Explain the concept of spontaneous processes in chemistry, describe the driving forces of spontaneous processes at the molecular level, explain entropy and why it is a state function, relate structure and behavior of molecules to their entropy; calculate entropy change for reactions* • *Explain Gibbs free energy and why it is a state function, tabulate standard free energies of formation for substances; explain how change in free energy is affected by change in temperature and calculate free energy for reactions at different temperatures; explain the relationship between free energy, standard free energy, and equilibrium; use the relationship to explain temperature dependency of equilibrium constants* • *Explain how a chemical reaction is determined as an oxidation-reduction reaction; for a particular oxidation-reduction reaction, identify the substances that are oxidized and reduced, and indicate which are oxidizing agents and which are reducing agents; balance equations by the method of half-reactions* • *Describe the types of bonds formed by the carbon atom and differentiate between saturated and unsaturated hydrocarbons; Write general formulas, draw structural and condensed formulas of different hydrocarbons and their isomers, and give IUPAC names for each structure; Describe various types of chemical reactions that hydrocarbons undergo and predict products of such reactions; Describe the common functional groups in organic molecules, write general formulas for the functional groups, identify functional groups in condensed structural formulas, and apply IUPAC guidelines to name molecules containing functional groups: halohydrocarbon (alkyl halide), alcohol, ether, aldehyde, ketone, carboxylic acid, ester, amine; Describe and apply the processes of how some alcohols are made: distillation and esterification; Describe polymers, different polymerization reactions, and applications or uses of polymers* • *Define protein, describe the primary, secondary, and tertiary structures of proteins, and explain various functions of proteins in the human body; Explain how enzymes work in the human body; Describe a carbohydrate and its fundamental properties (identify functional groups present in a structure of a*

	carbohydrate); Identify the three most important polysaccharides (starch, cellulose, and glycogen) and briefly describe its one, their chemical structures, and why they are important in the human body; Compare and contrast the fundamental nucleic acid structures (DNA and RNA) and their functions in the human body; Identify and describe the four classes of lipids (fats, phospholipids, waxes, and steroids) and their importance in the human body
3	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy of 70-89% or better
2	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy of 65-69% or better
1	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy 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	Integrate, analyze, and apply all of the general chemistry concepts and principles described below with an accuracy of 90% or better: • *Students demonstrate ability 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* • *Students demonstrates responsibility by enforcing safety precautions and using all applicable protective gears* • *Students demonstrate clear reasoning through the use of self-designed and properly labeled tables and/or graphs to summarize data collected* • *Students demonstrates understanding of chemistry concepts and principles by incorporating chemistry fundamentals to discussion of results of scientific investigation* • *Students demonstrates ability to critique investigation protocols and make appropriate recommendations to achieve better results*
3	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy of 70-89% or better
2	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy of 65-69% or better
1	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy less than 65%

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

4	Integrate, analyze, and apply all of the general chemistry concepts and principles described below with an accuracy of 90% 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	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy of 70-89% or better

2	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy of 65-69% or better
1	Integrate, analyze, and apply all of the above described general chemistry concepts and principles with an accuracy less than 65%