Butler Community College
Behavioral Science, Math, Science, and
Physical Education Division

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COURSE OUTLINE
College Chemistry I

Course Description
CH 110. College Chemistry I. 5 hours credit. Prerequisite: High school chemistry, or CH 105 with a C or better and two units of high school algebra or MA 120 with a C or better. This course will enable the student to understand the scientific method; improve knowledge of basic math skills; be able to read, communicate, and understand scientific materials; and apply scientific reasoning to real world problems. The student will study chemical principles and his/her application. There are three single/recitation periods with two, two hour labs per week.

Course Relevance
The impact of chemistry in everyday life is phenomenal. The ability to see chemistry in action on the micro (molecular) and macro scale is necessary to develop a fuller knowledge and understanding of the world around us. Chemistry will enrich the students appreciation of the world and help them better understand the studies of science and the scientific method.

Required Materials
Zumdahl, S. (2009). *Chemistry*. (8^{th}). Boston, MA: Houghton Mifflin Co.

Hayden, McNeil. *Student laboratory notebook*. Plymouth, MI: Hayden-McNeil.

Carlson, R. *College chemistry 1 lab experiments.*

* - For complete textbook information, refer to http://www.butlercc.bkstr.com

Learning Outcomes
The intention is for the student to be able to:
1. Use scientific method.
2. Read, discuss, and understand scientific materials.
3. Apply basic math skills.
4. Apply scientific reasoning to real world problems.

Learning PACT Skills that will be DEVELOPED and/or documented in this course Through involvement in this course, the student will develop his/her ability in the following PACT skill area(s):

Personal Development Skills

1. Personal management
   - Through the production of either an essay or questionnaire the student will reflect on his/her personal management skills.

Analytical Thinking Skills

1. Critical thinking
   - Through the production of various mathematical, graphical, experimental and written assignments, the student will demonstrate scientific reasoning.

Communication Skills

1. Creation and delivery of messages
   - Through a variety of methods using either the internet and/or computer the student will produce a product to express his/her findings in laboratory reports.

Technology Skills

1. General computer use
   - Through the production of electronic-facilitated research, preparing the graphs, and manipulation of data, the student develops basic computer skills

Major Summative Assessment Task(s)

These learning outcome(s) and the Learning PACT skill(s) will be demonstrated by

1. Completing the departmental comprehensive final.
2. Writing a research paper or project.
3. Completing a student self-assessment.

Course Content

I. Skills/Competencies – Actions that are essential to achieve the course outcomes:
   A. Apply basic mathematical concepts
   B. Write a research paper or project
   C. Prepare lab reports

II. Themes – Key recurring concepts that run throughout this course:
   A. Scientific method
   B. Scientific reasoning

III. Issues – Key areas of conflict that must be understood in order to achieve the intended outcome:
   A. The balance between the conceptual and mathematical models.
   B. The cumulative nature of science and the world.
   C. The cumulative influence of scientific discoveries and the subsequent application of the discoveries.
   D. The balance between “wet” lab science and computer interfacing, collection, and analysis of data.

IV. Concepts – Key concepts that must be understood to address the issues:
   A. Mathematics
   B. Scientific Method
   C. Scientific Reasoning
   D. Scientific Writing
   E. Scientific Principles
   F. MLA writing format
   G. Word Processing
   H. Excel spreadsheet
   I. Graphing

Learning Units

I. The process of the scientific method, and its application to the investigation of natural phenomena.

II. The design and significance of experiments leading to the adoption of modern atomic theory.

III. Isotopic notations and the relationship between average atomic mass and isotopic mass.

IV. Atomic mass as it relates to composition in terms of subatomic particles

V. Descriptive chemistry of ionic and covalent compounds
   A. Learn the names and symbols (or formulas) for often used elements, simple, and polyatomic ions, Arrhenius acids and bases, and simple ionic and covalent compounds
   B. Describe and identify Arrhenius, Bronsted-Lowery and Lewis acids and bases
   C. Identify conjugate acids and bases
   D. Determine the valence electron configuration of the *s* and *p* block elements and the 3*d* metals
   E. Determine oxidation states and assign oxidation numbers of atoms in simple ions, polyatomic ions and covalent compounds
   F. Use the valence electron configuration to predict common oxidation numbers of groups 1, 2, 3, 16, and 17 elements
   G. Define periodic trends in electronegativity, ionization energy, and electron affinity, and relate them to the electron configuration of the element

VI. Solutions
   A. Describe general properties of solutions
   B. Understand the forces that affect the aqueous solubility of materials
   C. Calculate the molar concentration of a solute
   D. Describe procedures for preparing a solution of known molarity

VII. Chemical reactions and stoichiometry
   A. Classify chemical reactions and predict whether simple chemical reactions will proceed
   B. Employ stoichiometric reasoning in evaluating reactions of gases, liquids, and solids
   C. Perform calculations that employ relationships involving masses, formula units, and the mole relationships
   D. Determine empirical and molecular formula from appropriate data
   E. Demonstrate the ability to balance chemical equations
   F. Discuss solubility rules
   G. Write net ionic equations based on solubility rules

VIII. Balance simple acid-base reactions

A. Define oxidation and reduction. Balance simple redox reactions and determine the identity of the oxidizing and reducing agents
B. Determine limiting reagents from stoichiometric data, calculate the maximum product yield, and leftover reagent
C. Calculate theoretical yield from stoichiometric data

IX. Properties of solids, liquids, and gases
A. Describe the origins and relative magnitudes of intermolecular forces
B. Relate phase behavior to nature of intermolecular forces
C. Compare general properties of solids, liquids, and gases; including density, compressibility, heat capacity, and randomness intermolecular forces.
D. Describe phase transitions
E. Understand general properties of gases
F. Describe properties and temperature of gasses to kinetic molecular theory
G. Understand and employ ideal gas laws
H. State general properties of liquids
I. State general properties of solids
1. Compare properties of ionic, molecular, and metallic solids
2. Contrast properties of ionic, molecular and metallic solids

X. Performance of calculations involving the following basic concepts of thermodynamics
A. Heat capacity
B. Calorimetry
C. Heat/work/energy
D. Enthalpy/standard states
E. Hess's Law
F. Heat of formation
G. Phase changes/energy
H. Use of other thermodynamic cycles in the determination of thermodynamic quantities, such as the lattice energy of an ionic solid

XI. Spectroscopic observation of atoms as related to quantum mechanical theories
A. Describe the historical development or and distinction between classical wave mechanics
B. Describe the radial and angular dependence of solutions to the Schroedinger equation for hydrogneic atoms (s, p, d orbitals)
C. Describe the behavior of photons and electrons during electronic transition between principle quantum levels and calculate the wavelength and frequency of light involved in these transitions
D. Using the Aufbau principle, write the electron configuration of many electron atoms and monatomic ions
E. Relate quantum mechanical theory to the organization of the periodic table and the periodic properties of elements

XII. Molecular Bonding and Structure

A. Describe the characteristics of ionic and covalent bonding
B. Draw Lewis dot structures for atoms, simple ionic and molecular compounds
C. Predict the shape of simple ions using VSEPR theory
D. Explain how electronegativity differences relate to bond polarity
E. Identify polar and non-polar molecules
F. Understand valence bond descriptions of molecular structure and bonding
G. Understand hybridization, including, sp^3, sp^2 and *sp* hybridization
H. Predict hybridization from the VSEPR structures
I. Determine bond orders and relate them to relative bond strength
J. Describe the MO theory description of bonding and antibonding orbitals
K. Relate MO theory to concepts such as structural, energetic, spectroscopic, and magnetic properties of molecules.

Learning Units - Laboratory

I. Work in the laboratory in accordance with good laboratory practices
   A. Dress in an appropriate manner as to promote safety in the laboratory, wearing appropriate laboratory attire and goggles when anyone is working with chemicals in the laboratory
   B. Follow written directions accurately
   C. Work safely and effectively, using equipment and chemical carefully and correctly
   D. Demonstrate use of required techniques
   E. Dispose of waste products in a proper manner
   F. Know how to find and understand MSDS's for the chemicals used in a particular laboratory

II. Gather and record qualitative and quantitative data accurately
   A. Acquire data using balances and volumetric glassware
   B. Make and record visual observations
   C. Use computers, when appropriate, as data acquisition tools
   D. List or describe experimental assumptions made and any deviations from the written experimental procedures.

III. Handle and evaluate data in logical, productive, and meaningful ways
   A. Create notebooks and laboratory reports that are clear, understandable, and accurately represent the data collected
   B. Display computer data in a spreadsheet or graphically, as appropriate
   C. Correlate observations with chemical or physical processes
   D. Carry out suitable calculations with quantitative data, recognizing when data and calculations are within a reasonable range.
   E. Use observations of experimental data to present relevant conclusions pertaining to the experimental procedure

IV. Correlate laboratory work with principles in Chemistry I lecture

Learning Activities

Independent and collaborative learning activities will be assigned to achieve the

intended course outcomes. Classroom discussion, lecture, and textbook reading assignments will also contribute to the learning process.

Grade Determination

Grade determination will be based on the research paper, tests, lab reports, and comprehensive final exam. Other methods such as quizzes, homework may be used at the discretion of the instructor. The departmental final, and student self evaluation is a department requirement.