Course Outline
CHM/CHL 304 Physical Chemistry
May 2011

Department: Chemistry and Physical Sciences
Credit Hours: 3
Prerequisites: CHM/CHL 182, Corequisites: MTH 135/136 and PHS/PLA 201/202
General Education: 7.1 Scientific Literacy
Learning Outcomes: I.C, II.B, II.D

I. Course Description:

Considers the basic concepts of thermodynamics and kinetics with emphasis on applications in the life sciences. Designed for premedical or predental students or those with a concentration in biology. Three hour lecture. Three hour lab.

II. Purpose of the Course:

This course is designed to give an overview of physical chemistry for the science majors.

III. College Learning Outcomes and Objectives:

L.O. I. Knowledge of Human Cultures and the Physical and Natural World
Students will engage the big questions, both contemporary and enduring, and gain an understanding of the diversity of human experience and the physical and natural world in order to become well-educated citizens in a global society.
They can:

C. Use knowledge and the methods of inquiry and analysis appropriate to physical or natural sciences, the social sciences, and mathematics to develop well reasoned solutions to local and global issues.

L.O. II. Intellectual and Practical Skills
Students will frame meaningful questions and to answer them will gather pertinent information using appropriate technological tools. They will analyze, synthesize and reflect on that information and effectively apply and communicate the results.
They can:

B. Comprehensively and objectively analyze and evaluate appropriate data (e.g., issues, texts, artifacts, and events) in order to develop an informed conclusion.
D. Use mathematical or formal reasoning to answer questions or to achieve desired goals.

IV. Course Objectives:

By the end of this course, the student should be able to:

1. Perform gas law calculations involving non-ideal gases. (L.O. IC, IIB, IID)
2. Understand the consequences of the laws of thermodynamics. (L.O. IC, IIB, IID)
3. Calculate entropy, enthalpy and free energy changes for reactions. (L.O. IC, IIB, IID)
4. Know the basic principles of quantum mechanics. (L.O. IC, IID)
5. Apply molecular orbital theory to simple molecules. (L.O. IC, IIB)
6. Derive kinetic equations from basic kinetic theory. (L.O. IC, IIB, IID)
7. Understand the physical processes of spectroscopy. (L.O. IC, IIB)
8. Interpret phase diagrams for single substances and mixtures. (L.O. IC, IIB)

V. Topical Outline:

I. Introduction
- A. Topics to be Covered
- B. Units

II. Gas Law
- A. Ideal Behavior
- B. Kinetic Molecular Theory
- C. Motion of Gas Particles
- D. Non- Ideal Behavior
  1. Van der Waals
  2. Viral Coefficients
- E. Fugacity

III. Solids and Liquids
- A. Structures
  1. X ray diffraction
- B. Properties
- C. Phase Transitions
  1. Clausis - Clapeyron Equation
  2. Phase Rule
- D. Law of Corresponding States

IV. Thermodynamics
- A. Zeroth Law
- B. First Law
  1. Applications
- C. Second Law
  1. Applications
     a. heat death of the universe
     b. efficiencies of engines
     c. spontaneity
     d. relation between time and entropy?
- D. Third Law
  1. Demagnetization of a paramagnetic salt

V. Solutions
- A. Concentration vs. Activity
- B. Partial Molar Quantities
- C. Properties of Solutions
  1. Electrolytes vs. non- electrolytes
  2. Colligative Properties
     a. vapor pressure depression
     b. boiling point elevation
     c. freezing point depression
     d. osmotic pressure
- D. Chemical Potential

VI. Equilibrium
- A. Conditions
- B. Extent
- C. Equilibrium Constant
- D. Chemical Potential
- E. Factors which Influence
- F. Temperature

VII. Kinetics
- A. Orders of Reactions
- B. Mechanisms and Order
- C. Complex Orders
- D. Concentration and Time
    1. Zero Order
    2. First Order
    3. Second Order
    4. Subsequent Reactions
    5. Steady State Approximations
- E. Methods for the Study of Kinetics

VIII. Quantum Mechanics
- A. Failure of Classical Mechanics
- B. Development of Quantum Mechanics
- C. De Broglie Wavelengths
- D. Heisenberg Uncertainty Principle
- E. Particle in a 1-D Box
- F. Particle in a 3-D Box
- G. Wave Equations for Electrons in Hydrogen
- H. Aufbau Principle

IX. Bonding
- A. Atomic Orbital Hybridization
- B. Molecular Orbitals
    1. Variation Principle
    2. Application to Simple Molecules

- C. Band Theory for Conductors, Semi-conductors and Insulators

X. Electrochemistry
- A. Review of Oxidation and Reduction
- B. Electrochemical Potentials
- C. Activity
- D. Diffusion of Electrolytes
- E. Double Layer Theory

XI. Acid-Base Equilibrium
- A. Review of Definitions
- B. Activity vs. Concentration
- C. Thermodynamics

XII. Spectroscopy
- A. Absorption and Emission
- B. Transitions and the Electromagnetic Spectrum
- C. Atomic vs. Molecular Transitions
- D. Applications of Selection Rules