UNIVERSITY OF THE SACRED HEART
NATURAL SCIENCES DEPARTMENT

COURSE DOCUMENT

COURSE TITLE: General Chemistry 2

CODE: Chem 102

PREREQUISITE: Chem 101

HOURS/CREDITS: Four credits per semester; three hours per week lectures and three hours per week laboratory sessions

COURSE DESCRIPTION

This course discusses the properties of solids, liquids and solutions. It covers the study of chemical kinetics and equilibrium with emphasis on aqueous reactions such as acid-base, precipitation and redox reactions and the variables that affect those reactions and their equilibrium state. The three laws of chemical thermodynamics and the properties of electrochemical systems are discussed.

This course has an on-line component. It is directed to students enrolled in the chemistry, biology and health sciences programs. This course will give these students a general view of the chemical and biological processes that occur in the world.

JUSTIFICATION

In order to understand the complex processes in our world, it is important to have a general knowledge related to the composition and properties of matter. The contemporary society is continuously developing and changing which means that human beings need to understand all of its components.

It is important that every scientific training in college includes a general chemistry course because chemistry is everywhere in our society. In addition, the study of chemistry is important to acquire knowledge to deal with more advanced courses and in careers such as medicine, engineering and biotechnology.

Rev. February 2008

OBJETIVES

At the end of this course, the student will be able to:

1. Describe the intermolecular forces that are found in the matter and how physical properties of solids and liquids are affected by them.
2. Explain the solution formation process and ways of representing the composition and concentration of a solution.
3. Identify the colligative properties of solutions and perform calculations related to those properties.
4. Determine the reaction rate, activation energy and the rate constant of a given reaction.
5. Explain the collision and transition state theories of a chemical reaction.
6. Define the equilibrium state of a reaction and apply the LeChatelier principle.
7. Explain the chemical meaning of the equilibrium constant.
8. Explain the theories related to acid-base reactions.
9. Explain the pH concept and perform pH calculations on a given solution.
10. Explain what an insoluble ionic compound is based on the solubility rules and solubility product and the factors that affect the solubility of a salt.
11. Describe the components of an electrochemical cell and the effects they have on the electric potential.
12. Compare a galvanic cell with an electrolytic cell.

COURSE CONTENT

I. Solid and Liquid State

- A. Intermolecular Forces
  - 1. London
  - 2. Dipole-dipole
  - 3. Ion-dipole
  - 4. Hydrogen Bond
- B. Liquid State
  - 1. Viscosity
    - a. Definition
    - b. Layer Model
    - c. Units
    - d. Examples

2. Surface Tension
    a. Definition
    b. Units
    c. Examples
3. Vapor Pressure
    a. Definition
    b. Units
    c. Examples
4. Heating Curve
5. Phase Diagrams
    a. Structure
    b. Sublimation
    c. Melting
    d. Boiling
    e. Condensation
    f. Deposition
    h. Freezing
    i. Phase Diagram of water, CO_2 and phosphorous

C. Solid State
1. Types of Solids
    a. Ionic solids
    b. Covalent solids
    c. Molecular solids
    d. Metallic solids
2. Solid State Structure
    a. Packing
    b. Examples
3. Units Cells
    a. Crystalline Systems
    b. Density of a solid

II. Solutions and Colligative Properties

A. Solution Concentration
1. Molarity

2. Molality
3. Molar Fraction
4. Weight percentage
5. Density

B. Saturated, unsaturated and supersaturated solutions.

C. Solution Phase Diagram

D. Colligative Properties

1. Vapor Pressure Lowering
    a. Raoult's Law
    b. Equation for Vapor Pressure Lowering
2. Boiling Point Elevation
    a. Molal Boiling Point Elevation Constant
    b. Equation for Boiling Point Elevation
3. Freezing Point Depression
    a. Molal Freezing Point Depression Constant
    b. Equation for Freezing Point Depression
4. Osmotic Pressure
    a. Definition
    b. Osmotic Pressure Measurement
    c. Equation for Osmotic Pressure

E. Colloidal State

1. Definition
2. Types of Colloids
    a. Sol
    b. Gel
    c. Emulsions

III. Chemical Kinetics

A. Reaction Rate

1. Average Rate
2. Instantaneous Rate
3. Rate Law
    a. Order
    b. Rate Constant

4. Reaction Rate Measurement

B. Rate as a function of Concentration

1. Zero order reaction

a. Equation

b. Concentration Profile

c. Half life

2. First Order Reaction

a. Equation

b. Concentration Profile

c. Half Life

3. Second Order Reaction

a. Equation

b. Concentration Profile

c. Half Life

C. Collision and Transition State Theories

1. Mathematical Definition of the Rate Constant

a. Collision frequency

b. Collision orientation

c. Temperature

d. Activation Energy

2. Activation Energy Determination

a. Ahrrenius equation

b. Ahrrenius equation in linear form

3. Mechanism and Energy Profile of a Reaction

a. Unimolecular and Bimolecular Processes

b. Rate Determining Step

c. Rate Law

D. Enzyme Kinetics

E. Radioactive Decay and radioisotopic Dating

IV. Chemical Equilibrium

A. Equilibrium State

1. Definition

2. Examples

3. The Equilibrium Constant

B. Homogeneous and Heterogeneous Equilibria

1. Equilibrium constant
2. Examples

C. Mass action expression Q vs. Kc

1. Definition
2. Reaction progress and Q
3. Examples

D. Kp as a function of Kc

1. Definition
2. Examples

E. Le Chatelier Principle

1. Concentration Changes
2. Temperature Changes
3. Volume and Pressure Changes
4. Addition of a Catalyst

F. Calculations involving equilibrium concentrations and Kc

V. Acid-Base Equilibria

A. Arrhenius Theory

a. Definitions
b. Acid base reactions in aqueous media
c. Acid base reaction in nonaqueous media

B. Acid and base ionization

1. Strong acids and bases in water
2. Weak acids and bases in water

a. Percent of ionization
b. Ka y Kb

C. Self-ionization in water

1. Definition
2. Kw

D. pH and pOH

E. Relationship between pKa and pKb of a conjugate pair and pKw

F. Calculations involving pH

1. Strong acid or strong base
2. Weak acid or weak base
3. Saline solutions
4. Buffers

G. Titration Curves

1. Strong acid-strong base
2. Strong base-strong acid
3. Weak acid-strong base
4. Weak base-strong acid
5. Buffer region
6. Equivalence Point
7. Acid base indicators

VI. Solubility Product

A. Solubility Rules

B. Solubility Equilibria

1. Solubility Process
2. Molar solubility
3. Common ion Effect
4. Ionic Product and Kps

VII. Thermochemistry and Thermodynamics

A. Energy system and surroundings

1. Energy Units
2. System and surroundings
3. Heat and PV Work
4. Signs Convention
5. State Variable and Changes

B. First Law of Thermodynamics

1. Internal Energy
2. Mathematical equation for the First Law
3. Examples

C. Enthalpy

1. Definition
2. Enthalpy Change

3. Constant pressure and Constant volume processes
4. Specific Heat Capacity
5. Bomb Calorimeter
6. Hess's Law
7. Enthalpy of Formation
    a. Definition
    b. Standard State
8. Enthalpy Change of a reaction
9. Born-Haber's Cycle

D. Entropy

1. Definition
2. Entropy and Spontaneous Processes
3. Second Law of Thermodynamics
4. Molar Entropy
5. Third Law of Thermodynamics
6. Entropy Change of a Reaction

E. Gibbs Free Energy

1. Definition
2. Gibbs Free Energy Change
3. Equilibrium Constant and Gibbs free energy
5. Equilibrium Constant as a function of Temperature

VIII. Electrochemistry

A. Balancing redox reactions

1. Oxidation number
2. Half reaction
3. Balancing in acidic solution
4. Balancing in basic solution

B. Electrochemical cells

1. Cell Potential
2. Salt Bridge
3. Electrodes: Cathode and Anode
4. Cell reaction
5. Galvanic Cell

C. Standard Potential

1. Definition and determination of E^o
2. Standard Hydrogen Electrode
3. Activity Series
4. Nerst Equation

D. Electrolytic Cell

1. Polarity
2. Faraday's constant

INSTRUCTIONAL STRATEGIES

Overheads
Lectures
Laboratory
Problem Sets
Discussions in classroom
On line resources

EVALUATION

Partial exams	40%
Problem Sets	10%
Laboratory	25%
Final exam	20%
Assistance	5%
Total	100%

REFERENCES

Text

Brown, LeMay, Bursten. Chemistry: The Central Science, 9th Edition, 2002, Prentice Hall.

Laboratory Manual

Torres, Vivian y Rodríguez Jovita. Química, Manual de laboratorio Curso Básico, Primera Parte, 5ta Edicion, 1993. Librería Universal

Additional References

Atkins, Meter y Jones, Loretta. Chemistry: Molecules, Matter and Change, Third edition, 1997, W. H. Freeman & Co., N. Y.

Chang, Raymond. Chemistry, Fifth edition, 1994, McGraw – Hill Inc., N. Y.

Silberberg, Martin. Chemistry: The Molecular Nature of matter and Change, 1996, Mosby-Year Book Inc.

Whitten, Gailey, Davis. General Chemistry, Fourth edition, 1992, Saunders College Pub.

The electronic database to which the Madre Maria Teresa Guevara Library is subscribed in conjunction with COBIMET includes documents, articles from journals, periodicals, and other information resources related to the course topics. To use these resources follow the next steps:

To access the library Web Page **from any place inside the campus**:

- Go to **http://biblioteca.sagrado.edu/**,
- Go to **Biblioteca Virtual** link and a page will appear from which access to the database will be granted. The database is organized according to discipline and in alphabetical order.

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- Enter your user name and password (The user name and password are requested in the Library).
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Electronic addresses

http://chemistry.about.com

http://academicinfo.net/chemorganic.html

http://www.iupac.org

If any student needs special accommodation he or she must request it to the Associate Dean of Students Affairs with special needs. The student should also notify the professor.

February 2008