CHEM2008A: PRINCIPLES OF PHYSICAL CHEMISTRY

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Principles of Physical Chemistry

Subject Code
CHEM - Chemistry
Course Number
2008A

Academic Unit
Chemistry (CHEM)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
BCH2008A Principles of Physical Chemistry

Exclusive Courses
Nil

Additional Information
Note: CHEM2008A does not contain any practical component, and has a credit unit value of three (3).

Part II Course Details

Abstract

This course aims to:

- understand the states of matter through the ideal gas law and real gas equations of states, the kinetic theory and Boltzmann distribution of particles;
- describe the nature of and interactions between radiation and matter through elementary quantum theory;
- identify and comprehend the first and second and third laws of thermodynamics;
- apply the principles of introductory kinetics to analytical procedures in chemical reactions.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the states of matter through the ideal gas law and real gas equations of states, and apply the kinetic theory of particles, Boltzmann distribution and Graham’ s law of diffusion.	14	x	x	
2	Describe the duality nature of light particles and relate it to the interactions between radiation and matter through elementary quantum theory.	18	x	x	
3	Critically evaluate the enthalpy, entropy, Gibbs free energy and Helmholtz functions and their physical applications in energetic cycles and thermodynamics.	18	x	x	
4	Comprehend the first, second and third laws of thermodynamics.	18	x	x	
5	Relate the Gibb free energy with the spontaneity of chemical changes and equilibrium, and explain the dependence of chemical potential on pressure and temperature.	18	x	x	
6	Apply the concepts of chemical kinetics to determine the rate-determining steps and elucidate the mechanisms of chemical reactions.	14	x	x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures and assignments	Teaching and learning will be primarily based on lectures and assignments for the explanation of states of matter.	1	
2	Lectures and assignments	Teaching and learning will be based on lectures and assignments laying the basis for the duality nature of light particles and interactions between radiation and matter.	2	
3	Lectures and laboratory classes	Teaching and learning will be based on lectures and laboratory classes introducing the concepts of enthalpy, entropy, Gibb free energy and Helmholtz functions and their physical applications in terms of energy cycles.	3	
4	Lectures and assignments	Teaching and learning will be based on lectures and assignments for the explanation of the first, the second and the third laws of thermodynamics and their physical significances.	4	
5	Lectures and case studies	Teaching and learning will be primarily based on lectures and case studies for studying the relationship between Gibb free energy and the spontaneity of chemical changes and equilibrium.	5	
6	Lectures and laboratory classes	Teaching and learning will be based on lectures and laboratory classes for application of principles of introductory kinetics to analytical procedures in selected chemical reactions.	6	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tutorial assignments	1, 2, 3, 4, 5, 6	30	Continuous Assessment (30%): - Tutorial assignment - Quizzes
2	Laboratory classes and reports(CHEM2008 only)	3, 6		
3	Quizzes	1, 2, 3, 4, 5, 6		

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

3

Additional Information for ATs

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for courses offered by CHEM:
"A minimum of 40% in both coursework and examination components."

Assessment Rubrics (AR)

Assessment Task

Tutorial assignments and quizzes

Excellent (A+, A, A-)

Student is expected to show strong evidence of subject matter and great familiarity with knowledge.

Good (B+, B, B-)

Student is expected to demonstrate evidence of subject, evidence of familiarity with knowledge.

Fair (C+, C, C-)

Student is expected to show little evidence of the subject and little familiarity with knowledge.

Marginal (D)

Student is expected to demonstrate sufficient familiarity with the subject matter and limited evidence of knowledge.

Failure (F)

Student shows no evidence of familiarity with the subject matter and irrelevant understanding of knowledge.

Assessment Task

Practicals (CHEM2008 only)

Excellent (A+, A, A-)

Student is expected to show excellent understanding to experiments, finish the laboratory reports flawlessly and be well prepared in the classes.

Good (B+, B, B-)

Student is expected to have good understanding to experiments, finish the laboratory reports satisfactorily, and be prepared in the classes.

Fair (C+, C, C-)

Student is expected to demonstrate some understanding to experiments, complete the laboratory reports.

Marginal (D)

Student shows little understanding to experiments and hand in the laboratory reports and little preparation in the classes.

Failure (F)

Student shows no understanding to experiments and/or do not hand in the laboratory reports.

Assessment Task

Examination

Excellent (A+, A, A-)

Student is expected to show strong evidence of original thinking; good organization, capacity to analyse and synthesize the subject matter; superior grasp of knowledge is required.

Good (B+, B, B-)

Student is expected to demonstrate evidence of grasp of subject, some evidence of critical capacity and analytic ability; reasonable understanding of issues; evidence of familiarity with knowledge.

Fair (C+, C, C-)

Student is expected to show little evidence of the subject, little evidence of critical capacity and analytic ability; fair understanding of issues.

Marginal (D)

Student is expected to demonstrate sufficient familiarity with the subject matter to enable the student to progress without repeating the course.

Failure (F)

Student shows no evidence of familiarity with the subject matter; weakness in critical and analytic skills; limited, or irrelevant understanding of knowledge.

Part III Other Information

Keyword Syllabus

Introduction
Units. The Mole. Atoms, ions, molecules, isotopes. Relative atomic and Molecular Masses.

State of Matter
Ideal Gas Law. Intermolecular Force. Potential Energy Curve. Dalton Law of Partial Pressure. Condensation and Isotherms. Real Gas Equations of State. Gas Viscosity. Graham's Law.

Kinetic Theory of Gases
Molecular Speeds. Partition of Energy. Boltzmann Distribution Law. Maxwell Speed Distribution, Molecular Collision and Mean Free Path. Diffusion and Effusion.

Radiation and Matter
Electromagnetic Spectrum. Wave Nature of Light. Photoelectric Effect. Photon. Quantized Energy levels. Elementary Quantum Theory. de Broglie Hypothesis. Uncertainty Principle. Wave-Particle Duality of Matter. Line Spectra of H-atom. Bohr’ s Atomic Model. Rydberg Formula.

Thermodynamics
Energy Conversion. The First Law. Enthalpy. State and Path functions. Heat Capacities. Adiabatic and Isothermal Gas Expansion and Compression. Thermochemistry. Bond Energies. Hess Law. Energy cycle applications. Spontaneous processes. Entropy. Carnot Cycle. The Second Law. Entropy changes. The Third Law. Standard Entropies. Gibbs Free and Helmholtz Energies. Dependence of Gibbs Free energy on Pressure and Temperature. Chemical Potential. Criteria of Spontaneous Changes and Equilibrium. Chemical Equilibrium and Gibbs Free Energy change. van't Hoff equation.

Chemical Kinetics
Reaction Rate Law, Reaction order. Zeroth-, First- and Second-order Reactions. Half-life and its Determination. Arrhenius Equation. Activation Energy. Simple Collision Theory. Molecularity. Collisional Activation. Rate-determining Step. Steady State Approximation. Reaction Mechanism.

Reading List

Compulsory Readings

	Title
1	Physical Chemistry, Engel & Reid, Pearson, 3rd Ed., 2012.

Additional Readings

	Title
1	Student's Solutions Manual for Physical Chemistry, Engel & Reid, Pearson, 2012.
2	Atkins’ Physical Chemistry, Atkins & de Paula, Oxford University Press, 9th Ed., 2010.Website: www.oup.com/
3	Physical Chemistry, I. N. Levine, Mc Graw Hill, 5th Ed., 2002.
4	Physical Chemistry, J. W. Moore, Prentice Hall, 5th Ed., 1972.
5	Physical Chemistry with Applications to Biological System, R. Chang, Macmillan Publisher, 2nd Ed., 1977.
6	Website: www.oup.com/
7	Website: www.aw-bc.com