香港城市大學
City University of Hong Kong

SYL

Course Syllabus

offered by Department of Chemistry
with effect from Semester A 2021/22

This form is for the completion by the *Course Leader*. The information provided on this form is the official record of the course. It will be used for the City University's database, various City University publications (including websites) and documentation for students and others as required.

Please refer to the Explanatory Notes on the various items of information required.

Prepared / Last Updated by:

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Part I Course Overview

Course Title:	Principles of Physical Chemistry
Course Code:	CHEM2008 (and CHEM2008A)
Course Duration:	1 semester
Credit Units:	4 (3) credits
Level:	B2
Proposed Area: *(for GE courses only)*	☐ Arts and Humanities ☐ Study of Societies, Social and Business Organisations ☐ Science and Technology
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	BCH2008 (and BCH2008A) Principles of Physical Chemistry
Exclusive Courses: *(Course Code and Title)*	Nil

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

Part II Course Details

1. Abstract

(A 150-word description about the course)

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.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*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%	✓	✓	
2.	Describe the duality nature of light particles and relate it to the interactions between radiation and matter through elementary quantum theory.	18%	✓	✓	
3.	Critically evaluate the enthalpy, entropy, Gibbs free energy and Helmholtz functions and their physical applications in energetic cycles and thermodynamics.	18%	✓	✓	
4.	Comprehend the first, second and third laws of thermodynamics.	18%	✓	✓	
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%	✓	✓	
6.	Apply the concepts of chemical kinetics to determine the rate-determining steps and elucidate the mechanisms of chemical reactions.	14%	✓	✓	
	** If weighting is assigned to CILOs, they should add up to 100%.*	100%			

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

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 self-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.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5	6	
Lectures and assignments	Teaching and learning will be primarily based on lectures and assignments for the explanation of states of matter.	✓						
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.		✓					
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.			✓				
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.				✓			
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.					✓		
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.						✓	

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5	6		
Continuous Assessment: 30%								
Tutorial assignments	✓	✓	✓	✓	✓	✓	8%	
Laboratory classes and reports (CHEM2008 only)			✓			✓	10%	
Quizzes	✓	✓	✓	✓	✓	✓	12%	
Examination: 70% (duration: 3 hours)								
** The weightings should add up to 100%.*							100%	

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."

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Tutorial assignments and quizzes		Student is expected to show strong evidence of subject matter and great familiarity with knowledge.	Student is expected to demonstrate evidence of subject, evidence of familiarity with knowledge.	Student is expected to show little evidence of the subject and little familiarity with knowledge.	Student is expected to demonstrate sufficient familiarity with the subject matter and limited evidence of knowledge.	Student shows no evidence of familiarity with the subject matter and irrelevant understanding of knowledge.
2. Practicals (CHEM2008 only)		Student is expected to show excellent understanding to experiments, finish the laboratory reports flawlessly and be well prepared in the classes.	Student is expected to have good understanding to experiments, finish the laboratory reports satisfactorily, and be prepared in the classes.	Student is expected to demonstrate some understanding to experiments, complete the laboratory reports.	Student shows little understanding to experiments and hand in the laboratory reports and little preparation in the classes.	Student shows no understanding to experiments and/or do not hand in the laboratory reports.
3. Examination		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.	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.	Student is expected to show little evidence of the subject, little evidence of critical capacity and analytic ability; fair understanding of issues.	Student is expected to demonstrate sufficient familiarity with the subject matter to enable the student to progress without repeating the course.	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 (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

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.

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

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

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

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

Annex
(for GE courses only)

Please specify the Gateway Education Programme Intended Learning Outcomes (PILOs) that the course is aligned to and relate them to the CILOs stated in Part II, Section 2 of this form:

GE PILO	**Please indicate which CILO(s) is/are related to this PILO, if any** ***(can be more than one CILOs in each PILO)***
PILO 1: Demonstrate the capacity for self-directed learning	
PILO 2: Explain the basic methodologies and techniques of inquiry of the arts and humanities, social sciences, business, and science and technology	
PILO 3: Demonstrate critical thinking skills	
PILO 4: Interpret information and numerical data	
PILO 5: Produce structured, well-organised and fluent text	
PILO 6: Demonstrate effective oral communication skills	
PILO 7: Demonstrate an ability to work effectively in a team	
PILO 8: Recognise important characteristics of their own culture(s) and at least one other culture, and their impact on global issues	
PILO 9: Value ethical and socially responsible actions	
PILO 10: Demonstrate the attitude and/or ability to accomplish discovery and/or innovation	

GE course leaders should cover the mandatory PILOs for the GE area (Area 1: Arts and Humanities; Area 2: Study of Societies, Social and Business Organisations; Area 3: Science and Technology) for which they have classified their course; for quality assurance purposes, they are advised to carefully consider if it is beneficial to claim any coverage of additional PILOs. General advice would be to restrict PILOs to only the essential ones. (Please refer to the curricular mapping of GE programme: http://www.cityu.edu.hk/edge/ge/faculty/curricular_mapping.htm.)

A. Please select an assessment task for collecting evidence of student achievement for quality assurance purposes. Please retain at least one sample of student achievement across a period of three years.

Selected Assessment Task