School of Environmental and Life Sciences

CHEM2410: Physical Chemistry

Callaghan
Semester 2 - 2023

COURSE OUTLINE

OVERVIEW

Course Description

This course introduces students to the core area of physical chemistry, based around the themes of systems, states and processes. Topics covered are quantum mechanics and structure, chemical thermodynamics, phase changes, and chemical kinetics. Throughout the course, the relationship between physical phenomena and the molecular structure and reactions underpinning advanced materials will be highlighted. This content is designed to complement other 2000 level Chemistry courses which have a synthetic focus. The laboratory component provides training in a range of theoretical and applied physical chemistry techniques which are relevant to both industrial and research settings.

A good understanding of physical chemistry is important to students intending to complete a major or minor study in chemistry, and will also be valuable for students studying engineering.

Requisites

Students must have completed MATH1002 or MATH1110 or MATH1120 or MATH01210 or MATH1220 to enrol in this course.

Assumed Knowledge

CHEM1010 and CHEM1020

Contact Hours

Callaghan
Laboratory *
Face to Face On Campus
3 hour(s) per Week for Full Term

Lecture
Face to Face On Campus
2 hour(s) per Week for Full Term

Tutorial
Face to Face On Campus
1 hour(s) per Week for Full Term

* This contact type has a compulsory requirement.

Unit Weighting

10

Workload

Students are required to spend on average 120-140 hours of effort (contact and non-contact) including assessments per 10 unit course.

CONTACTS

Course Coordinator

Callaghan
Prof Erica Wanless
Erica.Wanless@newcastle.edu.au
(02) 4033 9355
Consultation: Email for an appointment

Teaching Staff

Other teaching staff will be advised on the course Canvas site.

School Office

School of Environmental and Life Sciences
Room C228 Chemistry Building
Callaghan
Science-SELS@newcastle.edu.au
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9am-5pm (Mon-Fri)

SYLLABUS

Course Content

The course involves study of:

Quantum Mechanics and Structure:
- Principles of quantum mechanics
- Atomic structure
- Molecular structure and bonding

Chemical Thermodynamics:
- First and second laws
- Gibbs free energy
- Chemical potentials
- Chemical equilibria

Phase Changes:
- Phases and components
- Degrees of freedom
- Electrochemical systems
- Ions in solution

Chemical Kinetics:
- First and second order reactions
- Integrated rate laws
- Reaction rate theories
- Steady state approximation
- Chain reactions
- Catalysis

Course Learning Outcomes

On successful completion of this course, students will be able to:
1. Explain and apply concepts of physical chemistry;

2. Explain the broad role of the chemist and chemical engineer in physical chemical measurements and processes;

3. Solve problems in physical chemistry by using appropriate methodologies;

4. Demonstrate procedures and methods applied in analytical, computational and practical tasks of physical chemistry;

5. Apply the scientific process in the design, conduct, evaluation and reporting of experimental investigations;

6. Assess and mitigate risks when working with chemicals and hazardous substances;

7. Contribute to team and group work for scientific investigation and reporting;

8. Independently integrate qualitative and quantitative concepts of physical chemistry.

Course Materials

Recommended Reading:

- P. Monk, "Maths for Chemistry", Oxford University Press.

Recommended Text:

- P. W. Atkins and J. De Paula, "Elements of Physical Chemistry", Oxford University Press.

COMPULSORY REQUIREMENTS

In order to pass this course, each student must complete ALL of the following compulsory requirements:

Contact Hour Requirements:

- Laboratory There is a compulsory attendance requirement in this course. Students must attend at least 90% of the wet and dry laboratory sessions. Students who will not meet the compulsory requirement will be given the opportunity to make up upon presentation of an evidence of misadventure.
- Laboratory Induction Requirement - Students must attend and pass the induction requirements before attending these sessions.

Course Assessment Requirements:

- Assessment 1 - Formal Examination: Minimum Grade / Mark Requirement - Students must obtain a specified minimum grade / mark in this assessment item to pass the course. Students must obtain a minimum passing grade of 40% in the final, end-of-semester examination for the course.

- Assessment 3 - Report: Pass Requirement - Students must pass this assessment item to pass the course. Students must submit all reports and obtain an overall mark of at least 50% to pass the course.

- Assessment 3 - Report: Attempt / Submission Requirement - Students must attempt/submit this assessment item to pass the course.

SCHEDULE

Week	Week Begins	Topic	Learning Activity	Assessment Due
1	17 Jul	Quantum Mechanics and Molecular Structure (AP) Principles of quantum mechanics	Lectures, tutorial and compulsory lab (computer lab)	
2	24 Jul	Quantum Mechanics and Molecular Structure (AP) Electronic Structure of Atoms	Lectures, tutorial and compulsory lab (computer lab)	AP Homework #1 Week 1 excel exercise
3	31 Jul	Quantum Mechanics and Molecular Structure (AP) Bonding in ionic and molecular compounds	Lectures, tutorial and compulsory lab (computer lab)	AP Homework #2 Comp chem workshop 1
4	7 Aug	Quantum Mechanics and Molecular Structure (AP) Bonding in ionic and molecular compounds	Lectures, tutorial and compulsory lab (computer lab)	AP Homework #3 Comp chem workshop 2
5	14 Aug	Kinetics (EW) Revision of CHEM1020 kinetics, first and second order reactions	Lectures, tutorial and compulsory lab (wet lab #1)	AP Homework #4 Comp chem workshop 3 Lab safety induction (compulsory)
6	21 Aug	Kinetics (EW) Half-life, Arrhenius equation, reaction rate theories, steady state approximation	Lectures, tutorial and compulsory lab (dry lab #1)	EW Homework #1
7	28 Aug	Kinetics (EW) Chain reactions, explosions, polymerisation kinetics	Lectures, tutorial and compulsory lab (wet lab #2)	EW Homework #2 Wet Lab 1 report
8	4 Sep	Kinetics (EW) Heterogeneous and homogeneous catalysis	Lectures, tutorial and compulsory lab (dry lab #2)	EW Homework #3
9	11 Sep	Thermodynamics (SD) Review of Level 1000, combining first and second laws	Lectures, tutorial and compulsory lab (wet lab #3)	EW Homework #4 Wet Lab 2 report

10	18 Sep	Thermodynamics (SD) Physical transformations of pure substances, simple mixtures	Lectures, tutorial and compulsory lab (dry lab #3)	SD Homework #1
Mid Term Break				
Mid Term Break				
11	9 Oct	Thermodynamics (SD) Phase diagrams, chemical equilibrium	Lectures, tutorial and compulsory lab (wet lab #4)	SD Homework #2 Wet Lab 3 report
12	16 Oct	Thermodynamics (SD) Thermodynamics of electrochemical systems	Lectures, tutorial and compulsory lab (dry lab #4)	SD Homework #3
13	23 Oct			SD Homework #4 Wet Lab 4 poster
Examination Period				
Examination Period				

ASSESSMENTS

This course has 3 assessments. Each assessment is described in more detail in the sections below.

	Assessment Name	Due Date	Involvement	Weighting	Learning Outcomes
1	Formal exam*	Formal examination period	Individual	45%	1, 3, 8
2	Written assignments	The beginning of each lecture (from week 2). Week 12 HW is due 1 week after the week 12 lecture.	Individual	15%	1, 2, 3
3	Workshop & Laboratory reports*	Computer lab reports 1 - 4 and Wet lab reports 1-3: Due at the start of the subsequent lab session. Wet Lab 4 poster report due via Canvas upload one week after last lab session and to be presented at Chemistry showcase on Friday of Week 13.	Individual	40%	1, 2, 3, 4, 5, 6, 7

* This assessment has a compulsory requirement.

Late Submissions The mark for an assessment item submitted after the designated time on the due date, without an approved extension of time, will be reduced by 10% of the possible maximum mark for that assessment item for each day or part day that the assessment item is late. Note: this applies equally to week and weekend days.

Assessment 1 - Formal exam

Assessment Type Formal Examination
Purpose The final formal examination is designed to test the individual student's knowledge of the course material and their ability to describe, analyse and hypothesise from this material.
Description Quantum Mechanics and Molecular Structure 15%, Kinetics 15%, Thermodynamics 15%.
Weighting 45%
Compulsory Requirements Minimum Grade / Mark Requirement - Students must obtain a specified minimum grade / mark in this assessment item to pass the course.
Length 2 hours
Due Date Formal examination period
Submission Method Formal Exam
Assessment Criteria The examination is divided into three equal value parts according to the three lecture blocks into which the course is arranged. Questions require short written answers and calculations and should wherever relevant be accompanied by pertinent diagrams. Part marks will be

	awarded according to the level of completeness, understanding and accuracy of a response. While inaccurate or non-applicable responses will not attract specific demerits, unless it is explicitly stated to that effect in the question, they will be regarded as relevant to assessment of the student's understanding of the topic under test.
Return Method	Not Returned
Feedback Provided	No Feedback
Opportunity to Reattempt	Students WILL be given the opportunity to reattempt this assessment. Students with an exam criterion fail (but passing over-all) will be given the opportunity to re-attempt.

Assessment 2 - Written assignments

Assessment Type	Written Assignment
Purpose	Short weekly homework designed to embed skills associated with each section of the course. Mixture of short descriptive questions and calculations as appropriate.
Description	Quantum Mechanics and Molecular Structure 5%, Kinetics 5%, Thermodynamics 5%.
Weighting	15%
Length	Several short questions
Due Date	The beginning of each lecture (from week 2). Week 12 HW is due 1 week after the week 12 lecture.
Submission Method	In Class Online As advised by each lecturer.
Assessment Criteria	Written assessments meet the course objectives of knowledge acquisition and demonstrated assimilation of data, upon reflection and analysis, to produce articulate and concise documents which convey evidence-based understanding of the concepts and topics.
Return Method	In Person Online
Feedback Provided	Returned Work - Returned Work - Weekly. Feedback will be written on marked homework.

Assessment 3 - Workshop & Laboratory reports

Assessment Type	Report
Purpose	Report in the prescribed format describing the activities, outcomes and conclusions from each lab undertaken.
Description	Individual computer lab reports 1-4 (3.4% each). Wet labs 1 - 4 (6.6% each); Individual reports.
Weighting	40%
Compulsory Requirements	Pass Requirement - Students must pass this assessment item to pass the course. Attempt / Submission Requirement - Students must attempt/submit this assessment item to pass the course.
Length	To be discussed in class
Due Date	Computer lab reports 1 - 4 and Wet lab reports 1-3: Due at the start of the subsequent lab session. Wet Lab 4 poster report due via Canvas upload one week after last lab session and to be presented at Chemistry showcase on Friday of Week 13.
Submission Method	In Class Online Specific Location Canvas/Laboratory report box submission & poster presentation in week 13.
Assessment Criteria	Practical laboratory work and computational simulation are the central components of chemistry by which knowledge is advanced and the means by which professional chemists contribute to an understanding of real-world problems. Assessment of practical performance, the quality of results and observational skills, and the ability to explain results together with the related theoretical background should stimulate discussion with demonstrators, lecturers and fellow students.
Return Method	In Class
Feedback Provided	Returned Work - Returned Work - Two weeks after submission of report. Feedback will be written on marked homework.
Opportunity to Reattempt	Students WILL be given the opportunity to reattempt this assessment. Students with valid adverse circumstance will be given the opportunity to re-attempt this assessment.

ADDITIONAL INFORMATION

Grading Scheme

This course is graded as follows:

Range of Marks	Grade	Description
85-100	High Distinction (HD)	Outstanding standard indicating comprehensive knowledge and understanding of the relevant materials; demonstration of an outstanding level of academic achievement; mastery of skills*; and achievement of all assessment objectives.
75-84	Distinction (D)	Excellent standard indicating a very high level of knowledge and understanding of the relevant materials; demonstration of a very high level of academic ability; sound development of skills*; and achievement of all assessment objectives.
65-74	Credit (C)	Good standard indicating a high level of knowledge and understanding of the relevant materials; demonstration of a high level of academic achievement; reasonable development of skills*; and achievement of all learning outcomes.
50-64	Pass (P)	Satisfactory standard indicating an adequate knowledge and understanding of the relevant materials; demonstration of an adequate level of academic achievement; satisfactory development of skills*; and achievement of all learning outcomes.
0-49	Fail (FF)	Failure to satisfactorily achieve learning outcomes. If all compulsory course components are not completed the mark will be zero. A fail grade may also be awarded following disciplinary action.

*Skills are those identified for the purposes of assessment task(s).

Attendance

Attendance/participation will be recorded in the following components:

- Laboratory (Method of recording: Demonstrator notes)

Communication Methods

Communication methods used in this course include:

- Canvas Course Site: Students will receive communications via the posting of content or announcements on the Canvas course site.
- Email: Students will receive communications via their student email account.
- Face to Face: Communication will be provided via face to face meetings or supervision.

Course Evaluation

Each year feedback is sought from students and other stakeholders about the courses offered in the University for the purposes of identifying areas of excellence and potential improvement.

Oral Interviews (Vivas)

As part of the evaluation process of any assessment item in this course an oral examination (viva) may be conducted. The purpose of the oral examination is to verify the authorship of the material submitted in response to the assessment task. The oral examination will be conducted in accordance with the principles set out in the Oral Examination (viva) Procedure. In cases where the oral examination reveals the assessment item may not be the student's own work the case will be dealt with under the Student Conduct Rule.

Academic Misconduct

All students are required to meet the academic integrity standards of the University. These standards reinforce the importance of integrity and honesty in an academic environment. Academic Integrity policies apply to all students of the University in all modes of study and in all locations. For the Student Academic Integrity Policy, refer to https://policies.newcastle.edu.au/document/view-current.php?id=35.

Adverse Circumstances

The University acknowledges the right of students to seek consideration for the impact of allowable adverse circumstances that may affect their performance in assessment item(s). Applications for special consideration due to adverse circumstances will be made using the

online Adverse Circumstances system where:

1. the assessment item is a major assessment item; or
2. the assessment item is a minor assessment item and the Course Co-ordinator has specified in the Course Outline that students may apply the online Adverse Circumstances system;
3. you are requesting a change of placement; or
4. the course has a compulsory attendance requirement.

Before applying you must refer to the Adverse Circumstance Affecting Assessment Items Procedure available at:
https://policies.newcastle.edu.au/document/view-current.php?id=236

Important Policy Information

The Help button in the Canvas Navigation menu contains helpful information for using the Learning Management System. Students should familiarise themselves with the policies and procedures at https://www.newcastle.edu.au/current-students/no-room-for/policies-and-procedures that support a safe and respectful environment at the University.

This course outline was approved by the Head of School. No alteration of this course outline is permitted without Head of School approval. If a change is approved, students will be notified and an amended course outline will be provided in the same manner as the original.

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