



CBMS307

Physical and Environmental Chemistry II

S2 Day 2017

Dept of Chemistry & Biomolecular Sciences

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Disclaimer

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General Information

Unit convenor and teaching staff

Unit Convenor

Ian Jamie

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F7B 236

Anytime

Credit points

3

Prerequisites

6cp at 200 level including CBMS207

Corequisites

Co-badged status

Unit description

This unit explores the underlying principles that govern the properties and behaviour of chemical processes. Using environmental chemistry examples and contexts, we explore the what, why and how fast of chemistry: structure, energy, and rate. The theoretical foundations of these topics are respectively, quantum mechanics; thermodynamics and equilibrium statistical mechanics; and chemical kinetics. There is an emphasis on the chemistry of global climate change; ozone depletion; dispersal and transformation of chemicals in the environment; equilibrium and non-equilibrium processes in the world's oceans; and other environmentally relevant topics. The measurement and modelling of these systems is described and practiced.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at <https://www.mq.edu.au/study/calendar-of-dates>

Learning Outcomes

On successful completion of this unit, you will be able to:

At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry

concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.

Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.

By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.

At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

Assessment Tasks

Name	Weighting	Hurdle	Due
Laboratory/Workshops	25%	Yes	See "Description"
Assignments	15%	No	Week 8 and Week 11
In-semester Tests	10%	No	Week 7 and Week 12
Final Examination	50%	No	University Examination Period

Laboratory/Workshops

Due: **See "Description"**

Weighting: **25%**

This is a hurdle assessment task (see [assessment policy](#) for more information on hurdle assessment tasks)

Laboratory exercises are designed to provide a concrete example of the abstract topics covered in the course work, and to give you the opportunity to discover the principles and applications for yourself. Laboratory exercises also offer the opportunity to explore the uncertainty inherent in scientific investigations and the limitations of models and theories by allowing comparison with real systems. Practicals are composed of a laboratory session, in which an experiment is conducted and data acquired (or a workshop in which data are given) and a practical report in which the acquired data is presented, along with manipulations of that data to provide information on a chemical process.

The practical component is a "hurdle" requirement. You must complete the laboratory component of CBMS307 to a satisfactory level to be able to pass the unit overall. That is, the aggregate mark for your practical component must be 50% or greater to allow a pass mark to be awarded for the unit.

There are five practicals. Pracs 1 (Workshop) will be due on the day of the practical session. Pracs 2-5 will be due 14 days after the practical session, except if this falls in the mid-semester recess, in which case it will be due at your next practical session.

Practicals will commence of Week 3 (A Group) or Week 4 (B Group).

On successful completion you will be able to:

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
- Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
- By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.
- At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

Assignments

Due: **Week 8 and Week 11**

Weighting: **15%**

Two assignments related to (a) Quantum Chemistry and Kinetics and (b) Statistical Thermodynamics.

On successful completion you will be able to:

- At the completion of this unit you will be able to explain some of the underlying molecular

and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.

- Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
- By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.

In-semester Tests

Due: **Week 7 and Week 12**

Weighting: **10%**

Two online, multiple-choice tests covering (a) Quantum Chemistry and Kinetics and (b) Statistical Thermodynamics.

On successful completion you will be able to:

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
- Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
- By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.

Final Examination

Due: **University Examination Period**

Weighting: **50%**

On successful completion you will be able to:

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
- Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
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Delivery and Resources

Classes

Timetable: Please check www.timetables.mq.edu.au for the official timetable of the unit.

Lectures: The material presented in the lectures is important and you should not assume that all examinable material is available in the textbook or in printed notes. On the other hand, do not assume that all examinable material is to be found in the lecture notes.

Tutorial: Attendance at the lecture and tutorial is compulsory. Tutorial problems, which may form part of the material submitted for assessment, will be distributed by the lecturer.

Laboratory Work: You will undertake both experiments at the bench (wet-labs) and dry-lab workshops. The wet-labs will initially be held in E7B 347, the 2nd/3rd Year teaching Laboratories.

A laboratory roster will be issued to indicate which experiments you will be undertaking in which week.

Before commencing a new experiment you are required to complete a laboratory preparation exercise. You must have the pre-lab exercises checked by a lecturer BEFORE the lab session starts. You will not be allowed to commence the experimental work until the preparation exercise is completed in a satisfactory manner. A delay in starting the experimental work due to poor pre-lab preparation may have a detrimental effect on your ability to perform the laboratory work satisfactorily. You should attempt the pre-lab exercises well in advance of each practical class. You are advised to read each experiment carefully.

Students unable to attend laboratory classes due to illness or misadventure (as defined in the Handbook of Undergraduate Studies) and who are unable to catch up in a reserve session must provide formal documentary evidence to the University as soon as possible after the absence. For any unjustified absences a mark of zero will be given. You will need to submit a "special consideration request".

Some practical work will be undertaken before the corresponding material has been covered in lectures. The notes have been written with this in mind and some allowance will be made in the marking of reports.

Reports must be submitted no later than 5 pm, 14 days after completion of each experiment. Penalties for late submission will accumulate at the rate of 10% per day overdue. Reports are to be word-processed and submitted via iLearn. All supplementary files (spreadsheets, spectra, etc) are to be uploaded along with the report.

Required and Recommended Texts and/or Materials

Recommended Text Book: We recommend that you obtain Atkins & de Paula "Atkins' Physical Chemistry" 10th ed, Oxford University Press. The 9th edition is also acceptable.

Recommended Supplementary Text: The University Co-Op Bookshop carries copies of Monk "Maths for Chemistry: a Chemist's Toolkit of Calculations".

Alternative Text Book: Raymond Chang "Physical Chemistry for the Chemical and Biological Sciences", 3rd ed, University Science Books (2000) is reasonable, and somewhat more readable than "Atkins' Physical Chemistry", but is a bit light in the spectroscopy section.

You can find a number of textbooks with "Physical Chemistry" in the title in the University library. All cover similar material, but often use different notation. You may find that some of these other books explain certain topics more clearly. Some students find "Physical Chemistry" by R.A. Alberty and R.J. Silbey provides readable introductions to some topics, but is less helpful when it comes to problem solving. Two older books that can provide an alternative introduction to aspects of molecular spectroscopy are "Fundamentals of Molecular Spectroscopy" by C.N. Banwell and "Introduction to Molecular Spectroscopy" by G. M. Barrow.

Texts entitled *Environmental Chemistry* or similar tend to be too broad with respect to the chemistry, and there is limited depth of discussions on Physical Chemistry aspects. However, good background information on the broader aspects of Chemistry in the environmental context can be obtained from these texts. Examples of good Environmental Chemistry texts are S.E.

Manahan "Environmental Chemistry" (TD193.M36), G.W. VanLoon and S.J. Duffy
"Environmental Chemistry: A Global Perspective" (TD193.V36) and C. Baird and M. Cann
"Environmental Chemistry" (TO192.B35)

There are also many web resources, but material placed on the web is not necessarily checked for accuracy, so be careful when using it.

Technology Used and Required

Your reports will be submitted electronically (through iLearn), so it is important that you have access to a word processor, and the ability to manipulate PDF files.

It is important that you have a scientific calculator as hand-held calculators will be used in tutorials, practicals, for assignments, tests and in the final examination. Note that text-retrieval calculators are not allowed in the final examination.

Use will be made of Excel and other data processing and display software. Computers carrying this software are available in the teaching laboratories. Items of interest and links to other on-line material will be placed on the unit iLearn website.

General use computers are provided by the University, but it would be advantageous to have your own computer and internet access.

Microsoft Office is available free-of-charge to Macquarie University students. See <https://wiki.mq.edu.au/display/microsoftstu/About>

Unit Web Page: The URL of the CBMS307 web site is: ilearn.mq.edu.au. You will be asked for a username and password. Your username is your student MQID. Your MQID and password have been mailed to you by the University. If you have lost them go to the student portal: my.mq.edu.au

Unit Schedule

The schedule below is tentative and may be altered as circumstances require.

A timetable and syllabus will be handed out in the first week.

Tutorials will commence in Week 1.

Workshops/Practicals will start in Week 3.

MQ Week Num	Week starting	C5A 313 (12 Second Way) 11:00 am – 1:00 pm	X5B 138 (29 Wallys Walk) 3:00 – 4:00 pm	E7B 354 2:00 - 6:00 pm		
1	31-Jul-17	Spectroscopy	Spectroscopy	-		
2	7-Aug-17	Spectroscopy	Spectroscopy	Data Analysis		
3	14-Aug-17	Spectroscopy	Spectroscopy	Molecular Symmetry Workshop		

4	21-Aug-17	Spectroscopy	Spectroscopy	Molecular Symmetry Workshop		
5	28-Aug-17	Kinetics	Spectroscopy	POL/A		
6	4-Sep-17	Kinetics	Kinetics	POL/B		
7	11-Sep-17	Stat Thermo	Kinetics	FLU/A	In-Semester Test 1	
	18-Sep-17	Recess		Recess		
	25-Sep-17					
8	2-Oct-17	Kinetics	Kinetics	FLU/B	Assignment 1	
9	9-Oct-17	Stat Thermo	Stat Thermo	PAN/A		
10	16-Oct-17	Stat Thermo	Stat Thermo	PAN/B		
11	23-Oct-17	Transport and Fate	Stat Thermo	HCG/A	Assignment 2	
12	30-Oct-17	Transport and Fate	Transport and Fate	HCG/B	In-Semester Test 2	st
13	6-Nov-17	Transport and Fate	Transport and Fate			

Learning and Teaching Activities

Practicals

Laboratory exercises are designed to provide a concrete example of the abstract topics covered in the course work, and to give you the opportunity to discover principles and applications for yourself. Laboratory exercises also offer the opportunity to explore the uncertainty inherent in scientific investigations and the usefulness and limitations of models and theories by allowing comparison with real systems. The practical component is a "hurdle" requirement. You must complete the laboratory component of CBMS307 to a satisfactory level to be able to pass the unit overall. That is, the aggregate mark for your practical component must be 50% or greater to allow a pass mark to be awarded for the unit overall. If an individual practical report is given a grade of 40-50% you will be entitled to resubmit the report. This must be done within two weeks of feedback on the report being given to you. If a report receives a grade lower than 40%, the option to resubmit the report may be given at the discretion of the unit convenor. Without appropriate medical or other permitted reasons for absence, an unattended practical session will result in a grade of zero being given for that practical as no practical report can be submitted. One missed practical, for valid reasons, will be allowed, in which case the mark given will be the

average taken over the other practicals. Students unable to attend laboratory classes due to illness or misadventure (as defined in the Handbook of Undergraduate Studies) and who are unable to catch up in another session must provide formal documentary evidence to the University as soon as possible after the absence. You will need to submit a “Disruption to Studies” notification, information on which is given below.

Lectures/Tutorials

The lecture/tutorials will be run in a largely “active learning” mode, which means that after a brief introduction to the topic you will work through exercises designed to deepen your understanding of the subject. You are required to attend the lecture/tutorials and laboratory classes. You are expected to be active participants in all these fora. This means that you are expected to ask questions during lectures and, particularly, at tutorials and laboratory classes. Learning is an active process, and as such, you must engage with the material. This means reading the text book (and beyond) before and after lectures, attempting the assignment questions and other questions, discuss the concepts with your classmates and lecturers. Do not be afraid to ask questions – your classmates will probably want to ask the same thing.

Assignments

Assignment questions are issued so that you will have the opportunity to use the information provided in the lectures and textbook to test your degree of understanding of those topics. The assignments are designed to help you learn the material during the semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.

In-Semester Tests

The in-semester tests are designed to help you learn the material during the semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.

Final Examination

The final examination is an opportunity for you to display the knowledge that you have acquired over the course of the unit. It provides a challenge for the dedicated student and an incentive to learn the topics of the unit.

Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central](#). Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy_2016.html

Grade Appeal Policy <http://mq.edu.au/policy/docs/gradeappeal/policy.html>

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.html

Disruption to Studies Policy (in effect until Dec 4th, 2017): http://www.mq.edu.au/policy/docs/disruption_studies/policy.html

Special Consideration Policy (in effect from Dec 4th, 2017): <https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policies/special-consideration>

In addition, a number of other policies can be found in the [Learning and Teaching Category](#) of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/support/student_conduct/

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in [eStudent](#). For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit <http://students.mq.edu.au/support/>

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- [Workshops](#)
- [StudyWise](#)
- [Academic Integrity Module for Students](#)
- [Ask a Learning Adviser](#)

The **Numeracy Centre** (C5A 225, www.maths.mq.edu.au/numeracy/) offers assistance for difficulties with the mathematical aspects of this unit.

Help on writing, **EDUCGATEWAY**, the Gateway to Academic Literacy is a useful resource (<http://online.mq.edu.au/pub/EDUCGATEWAY/>).

Student Services and Support

Students with a disability are encouraged to contact the [Disability Service](#) who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the [Acceptable Use of IT Resources Policy](#). The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
- Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
- By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.
- At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

Assessment tasks

- Laboratory/Workshops
- Assignments
- In-semester Tests
- Final Examination

Learning and teaching activities

- Laboratory exercises are designed to provide a concrete example of the abstract topics covered in the course work, and to give you the opportunity to discover principles and applications for yourself. Laboratory exercises also offer the opportunity to explore the uncertainty inherent in scientific investigations and the usefulness and limitations of models and theories by allowing comparison with real systems. The practical component is a "hurdle" requirement. You must complete the laboratory component of CBMS307 to a satisfactory level to be able to pass the unit overall. That is, the aggregate mark for your practical component must be 50% or greater to allow a pass mark to be awarded for the unit overall. If an individual practical report is given a grade of 40-50% you will be entitled to resubmit the report. This must be done within two weeks of feedback on the report being given to you. If a report receives a grade lower than 40%, the option to resubmit the report may be given at the discretion of the unit convenor. Without appropriate medical or other permitted reasons for absence, an unattended practical session will result in a grade of zero being given for that practical as no practical report can be submitted. One missed practical, for valid reasons, will be allowed, in which case the mark given will be the average taken over the other practicals. Students unable to attend laboratory classes due to illness or misadventure (as defined in the Handbook of Undergraduate Studies) and who are unable to catch up in another session must provide formal documentary evidence to the University as soon as possible after the absence. You will need to submit a "Disruption to Studies" notification, information on which is given below.
- Assignment questions are issued so that you will have the opportunity to use the information provided in the lectures and textbook to test your degree of understanding of those topics. The assignments are designed to help you learn the material during the semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.
- The in-semester tests are designed to help you learn the material during the semester,

rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.

- The final examination is an opportunity for you to display the knowledge that you have acquired over the course of the unit. It provides a challenge for the dedicated student and an incentive to learn the topics of the unit.

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
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- Assignment questions are issued so that you will have the opportunity to use the information provided in the lectures and textbook to test your degree of understanding of those topics. The assignments are designed to help you learn the material during the

semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.

- The in-semester tests are designed to help you learn the material during the semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.
- The final examination is an opportunity for you to display the knowledge that you have acquired over the course of the unit. It provides a challenge for the dedicated student and an incentive to learn the topics of the unit.

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.
- At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

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- Laboratory exercises are designed to provide a concrete example of the abstract topics covered in the course work, and to give you the opportunity to discover principles and applications for yourself. Laboratory exercises also offer the opportunity to explore the

uncertainty inherent in scientific investigations and the usefulness and limitations of models and theories by allowing comparison with real systems. The practical component is a "hurdle" requirement. You must complete the laboratory component of CBMS307 to a satisfactory level to be able to pass the unit overall. That is, the aggregate mark for your practical component must be 50% or greater to allow a pass mark to be awarded for the unit overall. If an individual practical report is given a grade of 40-50% you will be entitled to resubmit the report. This must be done within two weeks of feedback on the report being given to you. If a report receives a grade lower than 40%, the option to resubmit the report may be given at the discretion of the unit convenor. Without appropriate medical or other permitted reasons for absence, an unattended practical session will result in a grade of zero being given for that practical as no practical report can be submitted. One missed practical, for valid reasons, will be allowed, in which case the mark given will be the average taken over the other practicals. Students unable to attend laboratory classes due to illness or misadventure (as defined in the Handbook of Undergraduate Studies) and who are unable to catch up in another session must provide formal documentary evidence to the University as soon as possible after the absence. You will need to submit a "Disruption to Studies" notification, information on which is given below.

- The lecture/tutorials will be run in a largely "active learning" mode, which means that after a brief introduction to the topic you will work through exercises designed to deepen your understanding of the subject. You are required to attend the lecture/tutorials and laboratory classes. You are expected to be active participants in all these fora. This means that you are expected to ask questions during lectures and, particularly, at tutorials and laboratory classes. Learning is an active process, and as such, you must engage with the material. This means reading the text book (and beyond) before and after lectures, attempting the assignment questions and other questions, discuss the concepts with your classmates and lecturers. Do not be afraid to ask questions – your classmates will probably want to ask the same thing.
- Assignment questions are issued so that you will have the opportunity to use the information provided in the lectures and textbook to test your degree of understanding of those topics. The assignments are designed to help you learn the material during the semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.
- The in-semester tests are designed to help you learn the material during the semester,

rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
- Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
- By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.
- At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

Assessment tasks

- Laboratory/Workshops
- Assignments
- In-semester Tests

- Final Examination

Learning and teaching activities

- Laboratory exercises are designed to provide a concrete example of the abstract topics covered in the course work, and to give you the opportunity to discover principles and applications for yourself. Laboratory exercises also offer the opportunity to explore the uncertainty inherent in scientific investigations and the usefulness and limitations of models and theories by allowing comparison with real systems. The practical component is a "hurdle" requirement. You must complete the laboratory component of CBMS307 to a satisfactory level to be able to pass the unit overall. That is, the aggregate mark for your practical component must be 50% or greater to allow a pass mark to be awarded for the unit overall. If an individual practical report is given a grade of 40-50% you will be entitled to resubmit the report. This must be done within two weeks of feedback on the report being given to you. If a report receives a grade lower than 40%, the option to resubmit the report may be given at the discretion of the unit convenor. Without appropriate medical or other permitted reasons for absence, an unattended practical session will result in a grade of zero being given for that practical as no practical report can be submitted. One missed practical, for valid reasons, will be allowed, in which case the mark given will be the average taken over the other practicals. Students unable to attend laboratory classes due to illness or misadventure (as defined in the Handbook of Undergraduate Studies) and who are unable to catch up in another session must provide formal documentary evidence to the University as soon as possible after the absence. You will need to submit a "Disruption to Studies" notification, information on which is given below.
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- The in-semester tests are designed to help you learn the material during the semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.
- The final examination is an opportunity for you to display the knowledge that you have acquired over the course of the unit. It provides a challenge for the dedicated student and an incentive to learn the topics of the unit.

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
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- At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical

chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

Assessment tasks

- Laboratory/Workshops
- Assignments
- In-semester Tests
- Final Examination

Learning and teaching activities

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- The final examination is an opportunity for you to display the knowledge that you have acquired over the course of the unit. It provides a challenge for the dedicated student and an incentive to learn the topics of the unit.

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
- Upon completion of this unit you will be able to solve problems in kinetics (complex reactions and transition state theory), quantum mechanics (spectroscopy, group theory), thermodynamics (statistical mechanics) and chemical transport, by identifying the essential parts of, and formulating a strategy for solving, them. You will be able to

rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.

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- At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

Assessment tasks

- Laboratory/Workshops
- Assignments
- In-semester Tests
- Final Examination

Learning and teaching activities

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- The final examination is an opportunity for you to display the knowledge that you have acquired over the course of the unit. It provides a challenge for the dedicated student and an incentive to learn the topics of the unit.

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and

their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.

- By the unit's conclusion you will be able to discuss the use of models in developing theory and be able to critical analyse the strengths and weaknesses of the models used in the context of this unit.
- At the completion of this unit you will be able to undertake laboratory-based experiments, data measurement and evaluation of results using the fundamental concepts of physical chemistry and employing modern equipment and techniques, use research literature to support experiment analysis, and work within the paradigm of safe laboratory practices.

Assessment tasks

- Laboratory/Workshops
- Assignments
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Learning and teaching activities

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Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
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- The final examination is an opportunity for you to display the knowledge that you have acquired over the course of the unit. It provides a challenge for the dedicated student and an incentive to learn the topics of the unit.

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcomes

- At the completion of this unit you will be able to explain some of the underlying molecular and quantum processes relating to kinetics, spectroscopy and thermodynamics, and their application to environmental areas. You will be able to connect these chemistry concepts to large-scale environmental effects such as climate change and transport and transformation of chemicals in the environment.
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Changes from Previous Offering

There will be one fewer practical sessions.

About this Unit

This unit explores the underlying principles that govern the properties and behaviour of chemical processes. Using environmental chemistry examples and contexts, we explore the what, why and how fast of chemistry: structure, energy, and rate. The theoretical foundations of these topics are: quantum mechanics; thermodynamics, equilibrium statistical mechanics; and chemical kinetics. There is an emphasis on the chemistry of global climate change; ozone depletion; dispersal and transformation of chemicals in the environment; equilibrium and non-equilibrium processes in the World's oceans; and other environmentally relevant topics. The measurement and modelling of these systems is described and practiced.

This unit follows on from CBMS207 Physical and Environmental Chemistry I, broadening and deepening some the topics from that unit, and introducing some new topics.

Physical chemistry is the science that develops an understanding of the structure, properties and transformations of matter, from bulk behaviour down to the atomic level. It is the role of the physical chemist to collect, collate and analyse experimental data from all branches of chemistry and to construct predictive models. As such, physical chemistry underpins much of modern science and it drives advances in a very wide range of fields. Building on information and concepts from chemistry, physics and mathematics, physical chemistry contributes to and is stimulated by areas such as medicine, molecular biology, biochemistry, molecular engineering, chemical engineering, materials science and earth sciences.

Modern chemistry provides tools for elucidating structure at the molecular scale, for understanding the way in which reactions occur, and for analysing complex molecular systems. Chemists can determine the structures of simple molecules through to large assemblies, such as metal complexes, biological macromolecules and industrial polymers. This unit deals with tools that chemists use to investigate the sizes, shapes and amount of molecules and the rates of their reactions with other molecules.

The topics covered are:

- the transport and fate of chemicals in the environment;
- molecular spectroscopy, including molecular symmetry, electronic transition theory, fluorescence and Raman spectroscopies;
- chemical reaction kinetics, including complex reactions and competing reactions;
- thermodynamics, including statistical mechanics;

Office Hours

There are no formal office hours for this unit. Dr Jamie and Dr McRae are happy to receive students outside of the formal lecture and tutorial times but please be aware that we are not

always to be found in our offices. It is generally wise to organise an appointment in advance, if possible.

Assumed Knowledge

Assumed knowledge for this unit is 200-level Physical and Environmental Chemistry I and 100-level General Chemistry. Some analytical and some organic chemistry is involved, but support for students weak in these areas will be provided. Some mathematics is inherent in this unit, but supporting material will be provided. A familiarity with high school level physics concepts would be an advantage but is not required.

Graduate Capabilities Statement

Graduate Capabilities: The course work and laboratory work in this unit will help you to develop the graduate capabilities that “the University’s graduates would need to develop to address the challenges, and to be effective, engaged participants in their world”. Graduate capabilities are viewed as essential for all graduates, irrespective of their course of study. Thus, in conjunction with discipline-specific skills and knowledge, they are the building blocks for developing the attributes valued in a university graduate. Some of the attributes and skills that CBMS307 can help you develop are:

- *Discipline Specific Knowledge and Skills:* The topics explored in CBMS307 are fundamental to the discipline of chemistry. You will be applying problem-solving skills in the chemistry context, applying chemistry theory to practice in order to design and carry out laboratory experiments, using chemistry specific apparatus and techniques, and to apply safe laboratory practices, performing data analysis applying appropriate statistical treatment to data and using standard and specialised computer programs in the analysis of data and presentation of results.
- *Critical, Analytical and Integrative Thinking:* Within this unit you will develop and practice your ability to apply strategic problem-solving in situations where there is a clear solution and in situations demanding critical, analytical and integrative thinking. You will be solving problems by analysing the information given or discovered, looking for other sources of information to apply, looking for the scope and limitation of the context in which the problem and solution lie. In many cases you will be using standard and specialised IT technology for the discovery of information, the analysis of data and the presentation of results.
- *Problem Solving and Research Capability and being Creative and Innovative:* In both the theory and the laboratory component of this unit you will have ample opportunities to develop your problem solving skills and research capabilities. Through set assignment and prac write-up problems, and through performing the laboratory experiments, where procedures, data collection and data analysis will require you to make various decisions, you will be deeply involved in problem solving and research processes in the chemistry context.
- *Effective Communication:* CBMS307 will help equip you with both oral and written communication skills, through your written prac write-ups and your assignments, and through the communications you will be engaged with your lecturers, your demonstrators and your class-

mates. Part of your assessment will be concerned with your ability to communicate in clear, concise and appropriate, context-dependent modes (formal reports, informal team discussions, formal presentations, etc).

· *Engaged and Ethical Local and Global citizens:* Engaged and ethical behaviour will be addressed in the professional chemist context, that is, you will be concerned with collecting data and information with appropriate acknowledgement of sources, you will learn ways of performing experiments and recording outcomes in a manner that conforms to the expectations of the profession and community at large. You will be working with people from a variety of cultural and economic backgrounds and you will be expected to be able to form cohesive and effective teams with anybody in your class. In the theory section of the course we will touch upon issues of interest to contemporary society, such as climate change, chemical processes in the body, and new materials, from the perspective of their underlying chemistry.

· *Socially and Environmentally Active and Responsible:* You will be working in small teams for much of CBMS307, especially in the laboratory component of the course, giving you the opportunity to develop your ability to work with others as a leader and a team player and to have a sense of connectedness and mutual obligation with others.

This unit deals explicitly with aspects of environmental science, allowing you to develop an understanding of environmental processes uninfluenced and influenced by human activity, giving you the knowledge and skills to formulate opinions and personal ideologies relating to the environment.

· *Capable of Professional and Personal Judgement and Initiative:* Especially during your laboratory work, you will be expected to develop discernment and common sense in your professional and personal judgement. You will also be given assignment and test questions that will give you the opportunity to exhibit these capabilities, especially in the context of the application of “models” in scientific knowledge and theorising.

· *Commitment to Continuous Learning:* We hope that you will have your enquiring minds and curiosity extended by CBMS307, and that the topics covered and skills developed will lead you to continue to pursue knowledge for its own sake. You will be have opportunities to reflect on your experiences, learn from them, and grow personally, professionally and socially.

Relationship between Assessment and Learning Outcomes

Assessment: The grades and corresponding mark range, as defined in the Handbook, are as follows:

Grade	Mark	Description
HD High Distinction	85-100	Work of outstanding quality. This may be demonstrated in areas such as criticism, logical argument, interpretation of materials or use of methodology. This grade may also be awarded to recognise a high order of originality or creativity in student performance

D Distinction	75-84	Work of superior quality in the same areas of performance as above. This grade may also be awarded to recognise particular originality or creativity in student performance
Cr Credit	65-74	Work of predominantly good quality, demonstrating a sound grasp of content together with efficient organisation, selectivity and use of techniques
P Pass	50-64	Satisfactory achievement of unit objectives
F Fail	0-49	Failure to achieve unit objectives.

Your final grades will be based on the mark from the aggregation of the individual assessments, but you must obtain a Pass grade or better in the **laboratory** component to be awarded an overall Pass grade or better. That is, you must pass the laboratory component to be able to pass overall.

Levels of Achievement: The lowest passing level is to be able to identify and use correctly the appropriate formulae from those supplied, in familiar circumstances (i.e., problems similar to those practised in tutorial questions or from past exams). In this case you would expect to obtain a low Pass grade.

A creditable level of achievement is to display knowledge of the meaning and significance of the topics in relation to molecular parameters, and to correctly use formulae in unfamiliar situations.

The highest level of achievement is to display a deep knowledge of the models being used, its uses and limitations, and to apply knowledge from beyond that which is taught in the unit, and even to challenge the material presented.

The assignments and in-semester tests are designed to help you learn the material during the semester, rather than trying to cram on the day before the examination. They are relatively low risk (a small component of the aggregate score) but they are very valuable for you as measures of your understanding of the topics.

The laboratories and workshops will allow you to put the material that you have been exposed to in the lectures into practice. They will provide concrete expositions of theory. They also provide the opportunity for you to continue your development of bench, data collection and data analysis skills. Writing up the experiments will give you skills in communicating in the chemistry context.

Examinations: The final examination will cover all sections of the unit (lectures, tutorials, assignments and laboratory exercises).

The date of the final examination will be posted by the University during the semester. You are expected to present yourself for examination at the time and place designated in the University Examination Timetable. The timetable will be available in Draft form approximately eight weeks before the commencement of the examinations and in Final form approximately four weeks before the commencement of the examinations. The examination timetable can be found at

http://students.mq.edu.au/student_admin/exams/

The only exception to sitting an examination at the designated time is because of documented illness or unavoidable disruption. If you feel you may have been disadvantaged due to an event or illness, or not able to reach your usual demonstrated performance level, you can notify Macquarie of a [Disruption to Studies](http://students.mq.edu.au/student_admin/exams/disruption_to_studies/) (previously known as Special Consideration). Your notification will be assessed for further support if it is of a “Serious and Unavoidable” nature and it disrupted your ability to perform an assessment activity. Students need to attach evidence or supporting documentation as clarified in the [Disruption to Studies Supporting Evidence Schedule](http://www.mq.edu.au/policy/docs/disruption_studies/schedule_evidence.html) (http://www.mq.edu.au/policy/docs/disruption_studies/schedule_evidence.html). The intent of this updated policy and process is to provide an easy way for students to notify Macquarie of all potential disruptions and gain consistent support for their case.

To submit a Disruption to Studies notification, you will need to:

1. Log in as a Current Student at ask.mq.edu.au
2. Click 'Disruption to Studies' from the 'Submit' menu on the left
3. Fill in the required fields as prompted. Once you have completed filling out the information, please click on 'Submit'

You will be required to upload supporting documentation electronically after you have submitted the form. All supporting documentation must be submitted electronically within 5 working days. You will receive an automated receipt email after submission to your Macquarie University student email account.

It is Macquarie University policy to **not set early examinations** for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, that is, the final day of the official examination period.