PHYS8902

Statistical Physics

Session 1, In person-scheduled-weekday, North Ryde 2025

School of Mathematical and Physical Sciences

Contents

General Information

Unit convenor and teaching staff
Co-lecturer and convener
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Credit points
10

Prerequisites
Admission to GradDipResFSE or GradCertResFSE

Corequisites

Co-badged status

Unit description
This unit introduces thermodynamics and statistical physics. The first half covers state functions and macroscopic variables like temperature, pressure, and volume, introducing the equation of state. Entropy is defined using an information-theoretic argument, applied to counting microstates. The zeroth to third laws of thermodynamics and T dS relations are introduced. The role of potentials in thermodynamic predictions is explored, along with reversible and irreversible engines, refrigeration cycles, the ideal gas law, and first-order corrections for the Van der Waals gas.

In the second half, thermodynamic equilibrium is introduced as a postulate of statistical mechanics, with the partition function derived from maximum entropy. The Gibbs paradox and macro, micro, and grand canonical ensembles are explained using examples of ideal and Van der Waals gases. A brief introduction to quantum statistical mechanics covers Fermi-Dirac and Bose-Einstein distributions. The unit also explores interacting statistical systems, such as ferromagnetism, and introduces order parameters and phase transitions.

Learning in this unit enhances student understanding of global challenges identified by the United Nations Sustainable Development Goals (UNSDGs) Quality Education; Affordable and Clean Energy; Climate Action

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:

ULO1: interpret and apply the 0th-3rd laws of thermodynamics, some principal ideas from kinetic theory and the postulates of statistical mechanics

ULO2: explain the relationship between the different levels of description of thermodynamics and statistical mechanics, and construct models for selected physical systems using these descriptions.

ULO3: apply mathematical approaches to solve ideal and practical problems in kinetic theory, thermal and statistical physics.

ULO4: use the properties and mathematical descriptions of key systems including ideal gases, quantum gases, Bose and Fermi statistics and apply the concepts to physical systems.

ULO5: present physical arguments in thermostatistics through explanation of tutorial and assignment questions at the whiteboard.

General Assessment Information

Requirements to Pass this Unit

To pass this unit you must achieve a total mark equal to or greater than 50%. There are no hurdles.

Late Assessment Submission Penalty

Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark) will be applied each day a written assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of 0 will be awarded even if the assessment is submitted. Submission time for all written assessments is set at 11:55 pm. A 1-hour grace period is provided to students who experience a technical concern. For late submission of time-sensitive tasks, such as scheduled tests/exams, students need to submit an application for Special Consideration.

Assessments where Late Submissions will be accepted:

Assignments – YES, Standard Late Penalty applies

Mid semester Test – NO, unless Special Consideration is granted

Examination – NO, unless Special Consideration is granted

All classes commence in week 1.

Assessment Tasks

Name	Weighting	Hurdle	Due
Practical Skills	10%	No	weekly problem solving classes
Problem-based assignments	30%	No	weeks 3, 5, 7, 10, 12
In-session exam	30%	No	week 7
Final examination	30%	No	final examination period

Practical Skills

Assessment Type [1]: Practice-based task
Indicative Time on Task [2]: 0 hours
Due: **weekly problem solving classes**
Weighting: **10%**

Students will demonstrate their learning by engaging in practice based skills and conversation that encourages approaches to problem solving.

On successful completion you will be able to:

- present physical arguments in thermostatistics through explanation of tutorial and assignment questions at the whiteboard.

Problem-based assignments

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 36 hours
Due: **weeks 3, 5, 7, 10, 12**
Weighting: **30%**

Sets of problems based on lecture content

On successful completion you will be able to:

- interpret and apply the 0th-3rd laws of thermodynamics, some principal ideas from kinetic theory and the postulates of statistical mechanics
- explain the relationship between the different levels of description of thermodynamics

and statistical mechanics, and construct models for selected physical systems using these descriptions.
- apply mathematical approaches to solve ideal and practical problems in kinetic theory, thermal and statistical physics.
- use the properties and mathematical descriptions of key systems including ideal gases, quantum gases, Bose and Fermi statistics and apply the concepts to physical systems.

In-session exam

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 22 hours
Due: **week 7**
Weighting: **30%**

A short test on content covered up to the midsession break.

On successful completion you will be able to:
- interpret and apply the 0th-3rd laws of thermodynamics, some principal ideas from kinetic theory and the postulates of statistical mechanics
- explain the relationship between the different levels of description of thermodynamics and statistical mechanics, and construct models for selected physical systems using these descriptions.
- apply mathematical approaches to solve ideal and practical problems in kinetic theory, thermal and statistical physics.
- use the properties and mathematical descriptions of key systems including ideal gases, quantum gases, Bose and Fermi statistics and apply the concepts to physical systems.

Final examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 21 hours
Due: **final examination period**
Weighting: **30%**

Final examination covering content from the second half of the unit.

On successful completion you will be able to:
- interpret and apply the 0th-3rd laws of thermodynamics, some principal ideas from kinetic theory and the postulates of statistical mechanics

- explain the relationship between the different levels of description of thermodynamics and statistical mechanics, and construct models for selected physical systems using these descriptions.
- apply mathematical approaches to solve ideal and practical problems in kinetic theory, thermal and statistical physics.
- use the properties and mathematical descriptions of key systems including ideal gases, quantum gases, Bose and Fermi statistics and apply the concepts to physical systems.

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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

There are two 2-hour workshops each week. Three hours each week will be allocated for lectures, and these will allow plenty of opportunity for questions and discussion. Lecture notes will be available on ilearn and the recommended texts are also available from the library. We will designate one hour each week for problem-solving classes and we will post questions each week to be presented by students to the class on a whiteboard or similar. The practical skills mark is allocated for these presentations and class discussions. Lectures and Problem-solving classes begin in week 1. We will communicate with you via your student email and through the announcements or discussion forum on ilearn.

Special Consideration

The Special Consideration Policy aims to support students who have been impacted by short-term circumstances or events that are serious, unavoidable and significantly disruptive, and which may affect their performance in assessment. If you experience circumstances or events that affect your ability to complete the written assessments in this unit on time, please inform the convenor and submit a Special Consideration request through https://connect.mq.edu.au

Unit Schedule

Weeks 1-3 Kinetic Theory, Judith

Weeks 4-6 Thermodynamics, Judith

Week 7 Revision and mid semester test, Judith

Weeks 8-13 Statistical Mechanics, Gavin

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) 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 connect.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

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

Academic Success

Academic Success provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues
- Student Advocacy provides independent advice on MQ policies, procedures, and processes

Student Enquiries

Got a question? Ask us via the Service Connect Portal, or contact Service Connect.

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.

Changes from Previous Offering

We have re-arranged the lecture content, which we hope will be more logical for students. A new lecturer has taken on the second part of the unit.

Unit information based on version 2025.06 of the Handbook