PHYS1010

Modern Mechanics

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

School of Mathematical and Physical Sciences

Contents

General Information

Unit convenor and teaching staff
Convenor / Lecturer / Tutor
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Credit points
10

Prerequisites
(HSC Mathematics Advanced Band 4 and above or Extension 1 Band E2 and above or Extension 2 Band E2 and above) or MATH1000

Corequisites

Co-badged status

Unit description
This unit, together with PHYS1020, provides an overview of physics primarily for students intending to study physics and astronomy beyond first year, but also suitable for those specialising in any of the sciences. As well as broadening their experience in classical Newtonian physics of matter and waves, and Maxwell's theory of electromagnetism, students are introduced to the main theories underlying modern physics: quantum mechanics, thermal physics, and Einstein's theory of relativity, with an emphasis on understanding the interrelationship between these fundamental ideas. PHYS1010 deals with the laws of classical mechanics, thermodynamics and entropy, and the effects of energy quantisation. Fundamentals of experimental method and data analysis are taught in well-equipped laboratories which support and complement the lecture course.

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: apply Newton's laws of motion, in particular for systems in equilibrium, and to solve problems involving static equilibrium.

ULO2: solve kinetics problems involving linear and rotational motion using the concepts of forces, torques, work, and energy conservation.

ULO3: demonstrate an understanding of the physics concepts of temperature; heat; and, the thermal properties of matter, including thermal expansion and heat capacities.

ULO4: perform physical measurements, record experimental data, display data graphically, analyse data, and draw written conclusions in a clear, concise, and systematic manner.

ULO5: identify, record and explain sources of uncertainty in physical measurements; and to undertake appropriate uncertainty analysis of results, including statistical analysis.

ULO6: clearly explain physics concepts learned and illustrate these to peers.

General Assessment Information

The 'estimated time on task' for each assessment item is an estimate of the additional time needed to complete each assessment outside of all scheduled learning activities. These estimates assume that you actively engage with all scheduled learning activities and spend an additional 28 hours of self-led study during the session.

To pass this unit you must obtain a total mark equal to or greater than 50% across all assessments.

SGTAs

SGTA attendance and engagement is very strongly recommended.

Timing: Each week, during the scheduled SGTA time. SGTAs start in Week 1, and each one is 1 hour and 50 minutes long.

Weighting: The Problem-Solving Portfolio, which is based on practice quiz and practice quiz-like questions, will be worth 20% of your mark for the unit.

Format: The Problem-Solving Portfolio will be submitted electronically via iLearn.

Each week, through the online iLearn system, a number of problems will be set to be worked through in the SGTAs. You need to study the physics from the previous week's lectures, including carefully reading the appropriate sections of the textbook, and try the set problems before each SGTA, so that you can follow through the exposition by the teaching staff and

contribute to problem solving discussions and write-up. Solutions to tutorial questions will be provided after the SGTA on iLearn. It is the methodology in these solutions that you need to learn to complete a successful portfolio (see below).

In addition to these problems for SGTAs, you will also be given separate assessment problems. During the SGTAs each week there will be a short (20 min) in-class practice quiz involving multiple choice, with written problem solving, based on the lecture material from the previous week, or, in the case of Week 1, the lecture material from Week 1. You will be asked to show your written work on the quiz sheet. While the quizzes will not officially count toward your grade, they will be marked and you will receive feedback. The marked hardcopies will be returned and the solutions gone over in class, generally by the following week. Solutions to the quizzes will **not** be posted on iLearn.

Of these practice quizzes, 6 quizzes (3 from the first half of the unit, 3 from the second half of the unit) will be selected by the lecturers for the Problem-Solving Portfolio. In this portfolio, students will produce out detailed, hand-written solutions for these quiz problems, providing explanations of each step with labelled diagrams as appropriate, as demonstrated in the provided solutions to the SGTA problems.These solutions will be marked based on the clarity and correctness of the method, as well as the thoroughness of the step-by-step explanations, and not on the correctness of the solutions. While the portfolio will be due at the end of the session, students are strongly encouraged to write out their solutions during the course of the semester, while recent quiz problems and their relevant material are still fresh in their minds.

Regular attendance and participation in SGTAs is a a critically important way for students to keep up with and master the material covered in lectures, as well as to develop their physics problem-solving skills.

Laboratory Work

Timing: During your scheduled laboratory session. See the lab schedule on iLearn for dates.

Weighting: **Your Laboratory Work will be worth a total of 30% of your mark for the unit.**

Format: Laboratory Work will be recorded in a Laboratory Notebook.

Laboratory work entails hands-on practical activities that are undertaken during scheduled laboratory classes. The first laboratory session will introduce you to the to the lab program and the skills you will develop. It also includes important workplace health and safety information. Students may also be assigned to lab groups, lab books will be handed out, and computer access will be checked. Session 1 needs to be attended by *all* students. It will be shorter than the other sessions, but attendance is mandatory ***– you cannot do subsequent lab sessions if you have not completed the introductory one.***

The next *nine* lab sessions involve experimental work and will be assessed. Preparation is required for each of these lab sessions and you will find the Prelab activities in the Laboratory Resources section of iLearn.

All laboratory work will be documented in the lab book provided to you. The teaching staff will assist you throughout each lab session, providing feedback, allocating “points” for pre-lab work,

for demonstrating particular skills during class, and for the documentation in your lab book. The points will be recorded in your lab book after each class so that you can track your progress. You can earn up to 20 “points” for your work each lab session, and your final mark for the Laboratory work will be determined from these points. To achieve full marks you would need to attend all lab sessions and achieve 20 points in all nine practical lab sessions. **Your laboratory work accounts for 30% of your final mark for the unit.**

A limited number of catch-up labs will be offered for students who miss a lab session. These will be held during the mid-session break, and towards the end of semester. A student can request ***no more than three*** catch up labs, via an online form on iLearn. Further details will be made available in the Lab Resources section of iLearn and during the first Lab session.

Final Examination

Timing: University Examination Period

Weighting: 50% of your mark for the unit.

Format: The Final Examination will be an invigilated written test.

You are expected to present yourself for examination at the time and place designated in the University Examination Timetable (https://iexams.mq.edu.au/).

The final examination will be three hours long and will cover content from the entire unit.

The use of calculators in examinations for this unit is permitted but, in accordance with the Faculty's policy, calculators with a full alphabet on the keyboard are not allowed.

If you receive **Special Consideration** for the final exam, a supplementary exam will be scheduled after the end of the normal exam period. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period, and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. Approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

Late Assessment Submissions

For any late submission of assessments, please notify the convenor and apply for Special Consideration as soon as possible: https://connect.mq.edu.au (see below for more details). Unless a Special Consideration request has been submitted and approved, late submissions / late work will not be accepted:

- **Problem-Solving Portfolio –** Late submissions of the Problem-Solving Portfolio will not be accepted without Special Consideration.
- **Laboratory Work -** Laboratory Work not completed by the end of Week 13 will not receive marks without Special Consideration.

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 assessments in this unit on time, please inform the convenor and submit a Special Consideration request through https://connect.mq.edu.au.**

Assessment Tasks

Name	Weighting	Hurdle	Due
Problem-solving Portfolio	20%	No	Week 12
Laboratory Work	30%	No	See Lab Timetable for details
Final examination	50%	No	University Examination Period

Problem-solving Portfolio

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 10 hours
Due: **Week 12**
Weighting: **20%**

A set of SGTA style problems that focus on problem-solving skills.

On successful completion you will be able to:

- apply Newton's laws of motion, in particular for systems in equilibrium, and to solve problems involving static equilibrium.
- solve kinetics problems involving linear and rotational motion using the concepts of forces, torques, work, and energy conservation.
- demonstrate an understanding of the physics concepts of temperature; heat; and, the thermal properties of matter, including thermal expansion and heat capacities.
- clearly explain physics concepts learned and illustrate these to peers.

Laboratory Work

Assessment Type [1]: Lab book
Indicative Time on Task [2]: 10 hours
Due: **See Lab Timetable for details**

Weighting: **30%**

Assessment of in-lab record of experimental activities, as well as any pre-lab work.

On successful completion you will be able to:

- perform physical measurements, record experimental data, display data graphically, analyse data, and draw written conclusions in a clear, concise, and systematic manner.
- identify, record and explain sources of uncertainty in physical measurements; and to undertake appropriate uncertainty analysis of results, including statistical analysis.

Final examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **University Examination Period**
Weighting: **50%**

Examination in the exam period covering all content from the unit.

On successful completion you will be able to:

- apply Newton's laws of motion, in particular for systems in equilibrium, and to solve problems involving static equilibrium.
- solve kinetics problems involving linear and rotational motion using the concepts of forces, torques, work, and energy conservation.
- demonstrate an understanding of the physics concepts of temperature; heat; and, the thermal properties of matter, including thermal expansion and heat capacities.

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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

Classes

Lectures (beginning in Week 1, in-person, on campus, and streamed / recorded on Echo360):

There are two one-hour lectures each week.

SGTAs (beginning in Week 1, in-person, on campus, not recorded; attendance and engagement are strongly encouraged):

There is one SGTA each week, lasting 1 hour and 50 minutes.

Laboratory Sessions (beginning in Week 1, In-person, on campus; register for one):

There are two laboratory sessions offered each week, each lasting 3 hours. Students should register for **one** session (morning or afternoon).

The timetable for classes can be found on the University website at: https://publish.mq.edu.au/.

Enrolment can be managed using eStudent at: https://students.mq.edu.au/support/technology/systems/estudent

Information About the Laboratory Sessions: The laboratory component is an essential component of your studies and so counts for an appreciable fraction of your final assessment. You will be introduced to some of the basic skills and techniques required of practicing physicists, scientists and engineers. You will be issued with a Laboratory Notebook, provided with instructional material in the form of Laboratory Notes, which can be found in the Laboratory Resources section of iLearn, and assisted in the laboratory by a team of demonstrators. For each laboratory session, except in Week 1, you are required to complete some preparatory work (Pre-Lab) before attending your nominated Lab session. To figure out which Prelab to do, please consult the Laboratory Schedule on iLearn.

Laboratory Safety: You are required to follow all safety guidelines given in the first Lab session, your lab notes, and the lab staff. **Food and drink cannot be consumed in the lab, and closed-toe shoes must be worn in the labs (that is, no sandals, thongs, crocs, etc.); students without suitable covered footwear will be refused admission.**

NB: Required laboratory introduction sessions and SGTAs with an introductory quiz will occur in Week 1. Full laboratories and SGTAs will commence in Week 2 of the semester. You must complete the Week 1 laboratory introduction before you will be allowed to attend any further labs.

Required and Recommended Texts and/or Materials

Required Text

Matter and Interactions, 4th Edition, by Ruth Chabay and Bruce Sherwood (Wiley, 2015).

Hardcopy options for the textbook for this unit include Volume 1 (paperback) or the combined Volumes 1 and 2 (hardbound). There are also fully electronic versions available directly from the publisher (see iLearn for more information). Note that Volume 2 will be the required text for PHYS1020 in Semester 2. Earlier editions may also be used but readers need to be aware that section numbers, question numbers and some content may be different in earlier editions.

Required Resources

The PHYS Laboratory Notes will be available online using iLearn before the laboratory sessions begin in the first week of the semester.

Web Resources

More information on the required text as well as additional resource material can be found at:

http://www.matterandinteractions.org/

There are also other high quality learning resources on the web which we would recommend to you to use in your studies. The HyperPhysics site hosted by the Department of Physics and Astronomy at Georgia State University is widely acclaimed and used. The site also has mathematics learning resources on under "maths used in physics".

http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html (Mechanics, and Electricity & Magnetism).

Increasingly there are excellent web-based interactive simulations available – some are in the on-line resources that support the textbook. We encourage you to conduct your own web searches for others, and to develop your own critical judgment of which sites provide high quality resources that assist your learning. Two that we recommend to you are:

• http://www.explorelearning.com/ The Explorelearning Gizmos: follow links to Grade 9-12, Physics, Motion and Force; and Electricity & Magnetism. You will have to register to use this site.

• http://phet.colorado.edu/simulations/index.php?cat=Featured_Sims The University of Colorado, Boulder, Physics Education Technology (PhET) Simulations: follow the links to Motion; Energy, Work & Power; and Electricity, Magnets and Circuits. This site also contains maths resources, for example vector addition.

Technology Used and Required

Unit Web Page: The web page for this unit can be accessed via the PHYS1010 iLearn page. Please check this web page regularly for material available for downloading.

iLearn Announcements and General Discussion Forum: Important announcements will appear on the iLearn page, and will be sent to your university e-mail -- please be sure to check your university e-mail regularly, as many announcements are time-sensitive! There is also an iLearn discussion forum, where you can post questions and queries (as well as answers!).

Teaching and Learning Strategy

This unit is taught through lectures and SGTAs and through undertaking laboratory experiments.

We **strongly** encourage students to attend lectures -- ideally in person, but if that's not possible, then via live streaming -- because they provide a much more interactive and effective learning experience than simply reading a text book. The lecturer is able to interpret the physics that you will be learning, showing you the relationships between different components/concepts and emphasising the key physics principles involved. Questions during and outside lectures are strongly encouraged in this unit - please do not be afraid to ask, as it is likely that your classmates will also want to know the answer. You should aim to read the relevant sections of the textbook before and after lectures and discuss the content with classmates and lecturers.

This unit includes an experimental component. The experiments are stand-alone investigations and may include topics not covered by the lecture content of this course. They are an important part of the learning for this unit and the skills learned are essential for a well-rounded physics graduate.

You should aim to spend at least an average of 2-3 hours per week understanding the material and working on the SGTA problems and the problems set for practice quiz preparation. You may wish to discuss your SGTA and quiz preparation problems with other students, the tutors and the lecturers. SGTA and quiz preparation problems are provided as key learning activities for this unit. They are not there just for assessment. **It is by applying knowledge learned from lectures and textbooks to solve problems that you are best able to test and develop your skills and understanding of the material.**

Unit Schedule

Schedule of Topics

The unit is divided into two sections; the first part will be taught primarily by Professor Daniel Zucker and the second part by Professor Orsola De Marco.

The textbook sections covered are listed as follows. As a **rough** guide we will be progressing through the listed chapters at a rate of one every week. You should use this as a guide to plan your textbook reading.

The content of the unit is based on the following chapters of the text by Chabay and Sherwood:

Week	Topics Covered
1	Interactions and motion: basic mechanics and momentum
2	The momentum principle: Newton’s second law
3	The fundamental interactions: gravitational field, electric field, strong interaction
4	Contact interactions: solids, tension, stress, strain etc, friction, mass--spring oscillation
5	Rate of change of momentum: forces in a system, statics
6	The energy principle: mechanical energy, potential energy in multiparticle systems, gravitational potential energy, electric potential energy

7	Internal energy: spring potential energy, path independence of potential energy, thermal energy, energy flow due to temperature,
8	Energy quantisation: photons, electronic energy levels, the effect of temperature, vibrational levels, rotational levels, other energy levels
9	Multiparticle systems: motion of the centre of mass, rotational kinetic energy, analysing real systems
10	Collisions: internal interactions, inelastic and elastic, head--on with equal / unequal mass.
11	Angular momentum: angular momentum principle, multiparticle systems, systems with zero / non--zero torque, angular momentum quantisation
12	Entropy: limits on the possible: solids, thermal equilibrium, second law, heat capacity, Boltzmann distribution
13	Revision

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

Hurdles have been eliminated, and there are now only three assessments: a Problem-Solving Portfolio related to the SGTAs, Laboratory Work and a Final Exam.

Unit information based on version 2025.03 of the Handbook