# PHYS1010

## Modern Mechanics

Session 1, In person-scheduled-weekday, North Ryde 2023

*School of Mathematical and Physical Sciences*

## Contents

# General Information

Unit convenor and teaching staff
Convenor / Lecturer / Tutor
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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 or WFMA0003

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.**

This unit has hurdle requirements, specifying a minimum standard that must be attained in several aspects of the unit. To pass this unit you must obtain a mark of at least:

**50% in the unit overall**, as well as

- **at least 40% in the final examination, and**
- **at least 40% in each of the individual laboratory activities, and**
- **a non-zero mark in 10 of 13 quizzes (which also captures attendance and engagement requirements).**

**Second-chance hurdle examinations will be offered to eligible students.** If you are given a second opportunity to sit the final examination as a result of failing to meet the minimum mark required, you will be offered that chance during the supplementary examination period. You will be notified of the exact day and time after the publication of final results for the unit.

## Tutorials

Due: **Each week, during SGTA.**

Weighting: **25%**

**This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks).**

**Tutorial attendance and engagement is compulsory.**

**It is a hurdle requirement to attend and participate in at least 10 out of 13 tutorials**. This includes obtaining a non-zero mark for the quiz. Full attendance is strongly encouraged.**

**Tutorials start in Week 1, and are 1 hour 50 minutes long each week.**

Each week, through the online iLearn system, a number of problems will be set to be worked through in the tutorials. You are **strongly encouraged** to study the physics from the immediate past two lectures*, including study of the appropriate sections of the textbook, and to try the set problems before each tutorial, so that you can follow through the exposition by the tutor and contribute to problem solving discussions and write-up.

In addition to these problems for tutorial, you will also be given separate assessment problems. During the tutorials each week (usually at the beginning, except in Week 1, when it will be at the end) there will be a short (< 20 min) in-class quiz involving multiple choice, with written problem solving, based on the assessment problems given out in the previous week, or, in the case of Week 1, the problems given out in the Week 1 tutorial. You will be asked to show your written work on the quiz sheet. The quizzes will be graded both on the multiple-choice answer, and on the clarity and correctness of your written solution. The marks will be uploaded into iLearn and the marked hardcopies will be returned in class, generally by the following week.

All quizzes will be graded (13 quizzes**) and we will take the best 10 scores for the semester to contribute to your overall tutorial grade (25%).

**Satisfactory attendance and participation in tutorials is a hurdle requirement. We require effective participation in tutorials, entailing a focused work effort and attendance for the full session. If you do not participate effectively in a given week, for example leaving the tutorial early without extenuating circumstances, it will be grounds for receiving a score of zero for that week's quiz, and that quiz will then not count towards passing the hurdle requirement. You must obtain a recorded, non-zero mark in at least 10 out of the 13 scheduled quizzes** to have the potential to pass the unit. No additional quizzes will be offered for those who fail to meet this requirement.**

* Unless an unavoidable disruption to the normal class schedule occurs.

**There will be 13 tutorials and quizzes unless unavoidable circumstances prevent this being achieved, in which case the hurdle requirement will be adjusted accordingly.

# Laboratory Work

Due: **During class. See the lab schedule on iLearn for dates.**

Weighting: **20%**

**This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks).**

**The first lab session is in Week 1. You must wear enclosed/covered footwear to the**

**laboratory (i.e., no thongs, sandals, open-toed shoes, etc.).**

There are ten lab sessions. (The Video Exposition assessment will be scheduled during weeks when there are no formal labs, during normal lab session times.)

Satisfactory completion of laboratories is a **hurdle requirement**. You must attend **all ten** laboratory sessions. **The first lab session is in Week 1** and includes work 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 regardless of whether this is their first Physics unit or not. It will be shorter than the other sessions, but **attendance is absolutely mandatory – you cannot do subsequent lab sessions if you do not attend the introductory one.** The next 9 lab sessions involve experimental work and will be assessed. You must obtain a mark of **at least 40%** for each of the laboratory sessions in order to have the potential to pass the unit.

**Preparation is required** for each of the lab sessions 2-10. You will find the Prelab activities in the Laboratory Resources section of the PHYS1010 iLearn webpage. Your prelab work will account for some of the assessment marks for each laboratory session.

**If you miss a session or fail to achieve at least 40% for any lab session**, you must complete a **"Request to schedule a Catch-up laboratory session"** form, which can be found on iLearn. See iLearn for full details about catch up classes and when they are scheduled. **No more than 3 catch ups are allowed for missed labs/lab hurdles, except where Special Consideration has been approved.** If you fail to attend the catch-up class you are booked into, then that will count as another missed lab.

# Video Exposition

Due: **End of Week 13**

Weighting: **5%**

The purpose of these projects is to assist in your understanding of the topics studied by developing a clear focused, video exposition on a particular subject, also including a demonstration, e.g., see the Veritasium YouTube channel.

A list of 10-15 topics for the video exposition will be given out in the first half of the session. Students work as a combined group (maximum 4 in a group), on a particular topic. Normal laboratory class time toward the end of the session (check iLearn for more information) will be available to all students, **so groups should be formed from within your laboratory class**. Groups will choose their topics and enter a group name, list of members, and a topic. There will be a starting set of equipment provided in the laboratory sessions for all of the topics on the list, to be used to develop the exposition and plan/execute the demonstration for video recording. Before recording students will be asked to have their exposition script reviewed by either a lab demonstrator or lecturer. Groups will be asked to prepare a video of their exposition (max. 5 minutes) - either using their own phone or via a camera in the lab - by the end of Week 13 and upload it to iLearn or to an online folder. The video will be graded based on the clarity of their exposition and not on their skills at video recording.

## Final Examination

Due: **University Examination Period**

Weighting: **50%**

**This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks).**

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

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.

**The final examination is a hurdle requirement. You must obtain a mark of at least 40% in the final exam to be eligible to pass the unit.** If your mark in the final examination is between 30% and 39% inclusive, you may be a given a second and final chance to attain the required level of performance; the mark awarded for the second exam towards your final unit mark will be capped at 40%, and you will be allowed to sit the second exam only if this mark would be sufficient to pass the unit overall.

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.

If you are given a second opportunity to sit the final examination as a result of failing to meet the minimum mark required, you will be offered that chance during the same supplementary examination period and will be notified of the exact day and time after the publication of final results for the unit.

# Assessment Tasks

| Name | Weighting | Hurdle | Due |
|---|---|---|---|
| Weekly quiz | 25% | Yes | Weekly, during the SGTA |
| Laboratory Record | 20% | Yes | See Lab Timetable |
| Video exposition | 5% | No | End of Week 13 |
| Final examination | 50% | Yes | University Examination Period |

## Weekly quiz

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 0 hours
Due: **Weekly, during the SGTA**
Weighting: **25%**
**This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)**

A series of short quizzes, taken in SGTAs.

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.

## Laboratory Record

Assessment Type [1]: Lab book
Indicative Time on Task [2]: 10 hours
Due: **See Lab Timetable**
Weighting: **20%**
**This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)**

Assessment of in-lab record of each experimental activity, as well as any prelab preparation.

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.

## Video exposition

Assessment Type [1]: Media presentation
Indicative Time on Task [2]: 10 hours
Due: **End of Week 13**
Weighting: **5%**

Producing a video exposition on a relevant area of physics, including a demonstration.

On successful completion you will be able to:

- clearly explain physics concepts learned and illustrate these to peers.

## Final examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **University Examination Period**
Weighting: **50%**
**This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)**

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 (in-person, on campus, and streamed / recorded on Echo360):**

Lecture 1: **Tuesday 11 AM - 12 PM**, 10 Hadenfield Avenue - T1

Lecture 2: **Tuesday 1 PM - 2 PM**, 29 Wallys Walk - T1 Theatre

**SGTA/Tutorial (In-person, on campus; attendance and engagement are compulsory):**

**Thursday 11 AM - 1 PM**, 01 CC - 210

**Laboratory Sessions (In-person, on campus; register for one):**

**Friday 9 AM - 12 PM**, 14 SCO - 114+127+130 Physics Labs

**Friday 1 PM - 4 PM**, 14 SCO - 114+127+130 Physics Labs

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 **students without suitable covered footwear will be refused admission.**

**NB: Required laboratory introduction sessions and tutorials with an introductory quiz will occur in Week 1. Full laboratories and tutorials 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.**

**Video Exposition Laboratories**

These will take place in your scheduled lab time toward the end of the session - please check iLearn for more information.

# 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.

# Teaching and Learning Strategy

This unit is taught through lectures and tutorials and through undertaking laboratory experiments and a video exposition activity. 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 a compulsory 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 tutorial problems and the problems set for quiz preparation. You may wish to discuss your tutorial and quiz preparation problems with other students, the tutors and the lecturers, but you are required to be able to show your own work for assessment (see the note on plagiarism). Tutorials 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 | Revision of first part of the unit |
| 9 | Energy quantisation: photons, electronic energy levels, the effect of temperature, vibrational levels, rotational levels, other energy levels |
| 10 | Multiparticle systems: motion of the centre of mass, rotational kinetic energy, analysing real systems |
| 11 | Collisions: internal interactions, inelastic and elastic, head--on with equal / unequal mass. |
| 12 | Angular momentum: angular momentum principle, multiparticle systems, systems with zero / non--zero torque, angular momentum quantisation |
| 13 | Entropy: limits on the possible: solids, thermal equilibrium, second law, heat capacity, Boltzmann distribution |

# 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 ask.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/

## The Writing Centre

The Writing Centre 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 AskMQ, 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.