PHYS107

Modern Mechanics

S1 Day 2015

Dept of Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff Tutor Gavin Brennen gavin.brennen@mq.edu.au Contact via gavin.brennen@mq.edu.au E6B 2.611 Tuesday 1-5 Lab Technical Coordinator Danny Cochran danny.cochran@mq.edu.au Contact via danny.cochran@mq.edu.au E7B 122 First Year Lab Academic Coordinator James Downes james.downes@mq.edu.au Contact via james.downes@mq.edu.au E6B 2.710 Lecturer Alex Fuerbach alex.fuerbach@mq.edu.au Contact via alex.fuerbach@mq.edu.au E6B 2.608 By appointment Unit Convenor Jason Twamley jason.twamley@mq.edu.au Contact via jason.twamley@mq.edu.au E6B 2.612 Thursdays 10--11am; other times by appointment. Alex Fuerbach alex.fuerbach@mq.edu.au	
Credit points 3	

Prerequisites	HSC Mathematics Band 4 or HSC Mathematics Extension 1 Band E3 or HSC Mathematics Extension 2
Corequisites	MATH132 or MATH133 or MATH135 or MATH136
Co-badged status	
Unit description	This unit, together with PHYS106, provides an overview of physics both for students primarily intending to study physics, astronomy or photonics beyond first year, and for engineering students who wish to explore physics at a greater depth. As well as broadening their experience in basic classical Newtonian physics of matter and waves, and Maxwell's theory of electromagnetism, in this pair of units students are introduced to the main theories underlying modern physics: quantum mechanics, thermodynamics and statistical mechanics, and Einstein's theory of relativity, with an emphasis on understanding the interrelationship between these fundamental ideas. Fundamentals of experimental method and data analysis are taught in well-equipped laboratories using examples 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:

- Use the vector notation to describe physical systems and solve 3-dimensional problems in mechanics.
- Understand and be able to apply Newton's laws of motion.
- Demonstrate an understanding of and be able to solve problems involving friction, kinetic energy, work, potential energy and energy conservation, linear momentum of individual particles and systems of particles.
- Describe and solve problems in rotational motion, including rolling, torque and angular momentum.
- Describe the conditions for equilibrium and solve problems involving static equilibrium.
- Demonstrate an understanding of gravitational attraction and gravitational potential energy.
- Have an understanding of the physics concepts of temperature, heat and the thermal

properties of matter , including thermal expansion and heat capacities.

Be able to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved.

Be able to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

Be able to clearly explain concepts learned and illustrate them to their peers.

Assessment Tasks

Name	Weighting	Due
Assignments (2)	5%	TBA
Laboratory Work	20%	See lab timetable
Tutorials	10%	Each week
Video Exposition	5%	Week 12
Final Examination	45%	University Examination Period
Mid-Term Exam	15%	Week 7

Assignments (2)

Due: **TBA**
Weighting: **5%**

During the unit you will be asked to submit two (2) assignments for assessment (one in each half of the semester). These assignments will be accessible through the online system but must be completed and submitted for assessment in hardcopy. Together with other problems assigned for study, these are designed to help you to systematically follow and understand the theoretical material. Do not copy another person's solutions; this does not help you to understand the work. We do encourage you to talk with other students about the assignments; however the final version you hand in must be your own work. Your assignment papers, with feedback, will be returned to you during your laboratory session, within two weeks of the due date.

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Laboratory Work

Due: **See lab timetable**
Weighting: **20%**

The marker (one of the demonstrators) will place a marking sticker at the end of your work and here they will note any issues with your lab work and provide any other feedback. Be sure to check this feedback when you return for your next laboratory class. A maximum mark of 10 will be awarded for each of the lab sessions. To receive full marks you will need to a) record your results and analysis clearly and concisely, and b) demonstrate (through your analysis) a good understanding of the physical principles involved in the experiment.

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systematic manner.

- Be able to clearly explain concepts learned and illustrate them to their peers.

Tutorials

Due: **Each week**
Weighting: **10%**

Each week, through the online system, you will be given a number of problems that will be worked through in the tutorials by the tutor. You are encouraged to try them before the tutorials so that you can follow thru the exposition by the tutor.

During the tutorials each week will be a short (<10min), single question/multiple choice in-class quiz which is based on the problems solved in the previous week's tutorial. You will have the opportunity of also including your written work on the quiz sheet. The quizes will be graded both on the multi-choice answer and your clarity of solution.

All quizzes will be graded (11 quizes - quizes start on week 2) and we will take the best 8 scores for the semester to contribute to your overall tutorial grade (15%).

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Video Exposition

Due: **Week 12**
Weighting: **5%**

Special Projects:

The purpose of these is to assist in your understanding of the topics studied by developing a clear focused exposition on a particular topic with associated demontration e.g. see the Veritasium youtube channel.

A list of 10-15 topics for exposition will be given out in week 4. Students work as a combined group (max 4 in a group), on a particular topic. Groups will choose their topics by week 5. By week 6 a schedule of lab sessions will be posted online for groups to use to develop their exposition and plan/execute their demonstration and 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 5mins)[either using their own phone or via a camera in the lab] by week 12 and upload to ilearn. The video will be graded based on the clarity of their exposition and not on their skills at video recording.

On successful completion you will be able to:

- Be able to clearly explain concepts learned and illustrate them to their peers.

Final Examination

Due: **University Examination Period**
Weighting: **45%**

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.

On successful completion you will be able to:

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Mid-Term Exam

Due: **Week 7**
Weighting: **15%**

A short 1 hour mid-term written exam in week 7 will be given covering the topics taught in weeks 1-6. 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.

On successful completion you will be able to:

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Delivery and Resources

Classes

Lectures (attend all):

Lecture 1: Monday 9-10am, E7B 264

Lecture 2: Wednesday 11am-12pm, E7B 264

Lecture 3: Friday 12-1pm, E7B 264

Tutorials (register for one):

Monday 1-2pm, W6B 350

Tuesday 1-2pm, W6B 286

Practical Laboratories (register for one):

Monday 10am-1pm, E7B 114

Monday 2-5pm, E7B 114

Friday 9am-1pm, E7B 114

Friday 2pm-5pm, E7B 114

Video Laboratories

Thursday Afternoons in Weeks 8, 9, 10 : E7B 114

NB: One hour Laboratory introduction sessions will occur in week 1. Full laboratories and tutorials will commence in the week 2 of the semester.

Required and Recommended Texts and/or Materials

Required Text

Matter and Interactions by Ruth Chabay and Bruce Sherwood.

Either Volume 1 (Paperback) or the combined Volume (hardbound). Note that Volume 2 will be the required text for PHYS 106 in semester 2.

Required Resources

A copy of the PHYS107 Laboratory Manual should be purchased from the Coop bookshop before the laboratory sessions begin in the second week of the semester.

Web Resources

More information on the required text as well as additional ressource 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 the 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 PHYS107 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 special exposition activity. We strongly encourage students to attend lectures because they provide a much more interactive and effective learning experience than studying 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 an average of 3 hours per week understanding the material and working on the tutorial problems and the assignments. You may wish to discuss your tutorial and assignment problems with other students, the tutors and the lecturers, but you are required to be able to show your own work (see the note on plagiarism). Tutorials and assignments are provided as one of the 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 halves. The first half is taught by Dr Alex Fuerbach and the second by Prof Jason Twamley.

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 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, frames of reference, scattering in 2--D and 3--D,
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	Gases and engines: mean free path, pressure, temperature, fundamental limits of efficiency

Learning and Teaching Activities

Lectures

There will be three one hour lectures per week. During these the content of the unit will be explained, example problems will be solved and physics principles demonstrated.

Tutorials

There will be one tutorial per week. During this time students will work through problems related to the previous week's lecture content.

Laboratory

Three hour laboratory classes will be held in 8 weeks of the semester. During these students will engage in practical exercises to further their understanding of the physics concepts discussed in lectures and to develop their skills at measurement, analysis and verification of physical models.

Expositions

Groups of students build a 5 minute video demonstration of an interesting physical concept covered within the course. Thie will develop their depth of understanding of the concepts involved and connect them to the physical world.

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.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

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

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

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

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://informatics.mq.edu.au/help/.

When using the University's IT, you must adhere to the Acceptable Use 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

- Use the vector notation to describe physical systems and solve 3-dimensional problems in mechanics.
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particles and systems of particles?.

- Describe and solve problems in rotational motion, including rolling, torque and angular momentum.
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- Have an understanding of the physics concepts of temperature, heat and the thermal properties of matter , including thermal expansion and heat capacities.
- Be able to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved.
- Be able to record experimental results, analysis and conclusions in a clear, concise and systematic manner.
- Be able to clearly explain concepts learned and illustrate them to their peers.

Assessment tasks

- Assignments (2)
- Laboratory Work
- Tutorials
- Video Exposition
- Final Examination
- Mid-Term Exam

Learning and teaching activities

- There will be three one hour lectures per week. During these the content of the unit will be explained, example problems will be solved and physics principles demonstrated.
- There will be one tutorial per week. During this time students will work through problems related to the previous week's lecture content.
- Three hour laboratory classes will be held in 8 weeks of the semester. During these students will engage in practical exercises to further their understanding of the physics concepts discussed in lectures and to develop their skills at measurement, analysis and verification of physical models.
- Groups of students build a 5 minute video demonstration of an interesting physical concept covered within the course. Thie will develop their depth of understanding of the concepts involved and connect them to the physical world.

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:

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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.

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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.

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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.

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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.

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- Groups of students build a 5 minute video demonstration of an interesting physical concept covered within the course. Thie will develop their depth of understanding of the concepts involved and connect them to the physical world.

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.

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- Video Exposition
- Final Examination

Learning and teaching activities

- There will be three one hour lectures per week. During these the content of the unit will be explained, example problems will be solved and physics principles demonstrated.
- There will be one tutorial per week. During this time students will work through problems related to the previous week's lecture content.
- Three hour laboratory classes will be held in 8 weeks of the semester. During these students will engage in practical exercises to further their understanding of the physics concepts discussed in lectures and to develop their skills at measurement, analysis and verification of physical models.
- Groups of students build a 5 minute video demonstration of an interesting physical concept covered within the course. Thie will develop their depth of understanding of the concepts involved and connect them to the physical world.

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 outcome

- Be able to clearly explain concepts learned and illustrate them to their peers.

General Reminders

Student Liaison Committee

The Physics and Astronomy Department values feedback from its students. Once a semester a meeting of the Student Liaison Committee is called and representatives from each of the PHYS/PHTN/ASTR units have an opportunity to voice their opinions about the structure of the unit and how it is taught. Further information and a call for representatives will be made in lectures closer to the meeting date.

Email Communication

The unit web page and your student email account are the primary ways that the unit lecturers can communicate with you outside of lectures. Please check your students email accounts once a day for messages concerning the unit.

Laboratory details

Laboratory Requirements

The laboratory component is considered an essential component of your studies and so counts for an appreciable fraction of your final assessment.

The laboratory work is designed to introduce you to some of the basic skills and techniques that are used in experimental physical science. Some of the activities in the laboratory may not relate directly to the material in the lecture course. This is because the laboratory activities are intended not only to illustrate physical concepts but also to introduce you to some techniques of measurement.

This work is designed to be carried out independently of the lectures, although some of these topics will be discussed in lectures. By providing you with instructional material in the form of the Laboratory Notes manual, together with help from the laboratory demonstrators, the laboratory work has been designed to be tackled independently of the lecture material. Indeed there is some advantage in becoming familiar with a topic in an experimental situation before you meet it in lectures. That is often the case in real life! All the information you need for each experiment is contained in the Laboratory Manual. There is no need to spend a long time outside the laboratory hours in preparation, however a quick read through the lab notes beforehand will allow you to make better use of your time in the laboratory

Location of the 100-level Physics Laboratory

The laboratory is located on the ground floor of building E7B, at the NE corner (room 114). Entry is from the courtyard at the opposite end to the main staircase.

What to Bring

You will need to bring a copy of the PHYS107 Laboratory Notes, which are available from the Coop Bookshop.

You are also required to buy and use a standard science notebook (with ruled and graph pages, not spiral bound). ALL YOUR WORK MUST BE RECORDED DIRECTLY INTO YOUR LABORATORY NOTEBOOK. Loose sheets of paper must not be used. If you feel that your notes are incomprehensible or untidy you may rewrite a more legible report in the same book and simply cross out the original notes.

Both these items should be brought with you to the first lab session.

Laboratory Attendance Requirements

You are required to attend all rostered laboratory sessions. If you miss more than one session without a written explanation then you will not be considered to have satisfactorily completed the laboratory component of the unit. Each time you attend the laboratory you must sign in and out (legibly) in the attendance book.

If you miss a laboratory session you should contact the Unit Convenor, Prof Jason Twamley, with written explanation and/or a medical certificate.

How to use your Laboratory Notebook

More details are on page ii of the Laboratory Notes manual.

Your notebook should show your collected data and the calculations and graphs resulting from the data. At the end of each section summarise your findings and answer any questions posed in the guiding notes.

At the completion of each laboratory session you must show your book to the laboratory supervisor who will check it and collect for marking. The marker (one of the laboratory demonstrators) will be checking your book to see whether you have kept a satisfactory record of what you have done and what you have concluded. Your marked notebook will be available at the start of your next scheduled laboratory. Be sure to check you book for comments from the marker as this will help you refine you laboratory technique (and increase your laboratory mark). Your notebook will be kept in the laboratory, and must not be removed from the laboratory at any time; this includes any previously filled notebook.

Laboratory Assessment

Details of the laboratory assessment will be outlined in the first session.

Laboratory Safety

You are required to follow all safety guidelines given in the lab manual, and as outlined by your lab supervisor. Food and drink cannot be taken into the laboratory and students without suitable covered footwear will be refused admission.

Laboratory Schedule

Introduction laboratories start in the first week of semester. The schedule of labs is posted in the lab. Please attend your nominated laboratory session. If you cannot attend your nominated session due to illness etc then you need to bring a doctor certificate to Prof Jason Twamley.