PHYS149

Physics for Life Sciences

S1 Day 2014

Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff 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 Unit Convenor Alex Fuerbach alex.fuerbach@mq.edu.au Contact via alex.fuerbach@mq.edu.au E6B 2.608 By appointment Other Staff Levente Horvath levente.horvath@mq.edu.au Contact via levente.horvath@mq.edu.au
Credit points 3
Prerequisites (HSC Mathematics Band 4 or HSC Mathematics Extension 1 Band E3 or HSC Mathematics Extension 2) or corequisite of (MATH132 or MATH133 or MATH135 or MATH136) or MATH130(P)
Corequisites
Co-badged status

Unit description
This unit develops a conceptual and quantitative approach to key physics topics including: waves, light and sound; electricity; forces and motion; and thermodynamics, with illustrations of these topics using biological or technological applications. It teaches students to apply their knowledge of science to solve problems; to think and reason logically and creatively; and to communicate effectively. The key role of modelling in understanding and describing the natural world is supported by a development of the basic techniques of physical measurements, data analysis and verification of models. Written communication skills for laboratory report writing, and problem-solving techniques, are emphasised throughout the unit.

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:

Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).

Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.

Using a range of measurement and data analysis tools to collect data with appropriate precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).

Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/ assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.

To be responsible, critically reflective, self-directed and motivated learners. The nature of the tutorials, tutorial problems, assessment tasks and examination are all designed to develop students as self-learners who know their own learning styles.

Assessment Tasks

Name	Weighting	Due
Tutorial Assignments	20%	Weeks 2 - 12
Lab sessions	15%	Specified weeks
Final lab report	10%	Week 11
Final examination	55%	As timetabled

Tutorial Assignments

Due: **Weeks 2 - 12**
Weighting: **20%**

Tutorials start in week 2. In each tutorial you will work with a tutor on selected problems that cover the lecture material of the previous week.

At some point during each tutorial (starting in week 3 until week 12), you will be asked to solve a slightly modified version of one of the problems from last week's tutorial. You will be asked to hand in your completed work which will be marked and returned to you for feedback. Each mark will contribute 2% to your total mark.

On successful completion you will be able to:

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).
- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/

assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.
- To be responsible, critically reflective, self-directed and motivated learners. The nature of the tutorials, tutorial problems, assessment tasks and examination are all designed to develop students as self-learners who know their own learning styles.

Lab sessions

Due: **Specified weeks**
Weighting: **15%**

You complete 8 weeks of laboratory work (3 hours per week) during the weeks specified in the 'Delivery and Resources' section. During these sessions, you gain an introduction to measurement techniques and equipment, and to data analysis and you also complete four specific experiments chosen from the list.

On successful completion you will be able to:

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).
- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using a range of measurement and data analysis tools to collect data with appropriate precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).
- Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/ assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.

Final lab report

Due: **Week 11**
Weighting: **10%**

Using results from one of your previous laboratory sessions, in this report writing session in the lab (week 11), you write a report for assessment using the writing skills you have learned during the semester.

On successful completion you will be able to:

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).
- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using a range of measurement and data analysis tools to collect data with appropriate precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).
- Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.

Final examination

Due: **As timetabled**
Weighting: **55%**

This will be a 3-hour closed-book exam. You are expected to present yourself for the final examination at the time and place designated in the University examination timetable. The timetable will be available in draft form approximately eight weeks before the commencement of examinations and in final form approximately four weeks before the commencement of examinations.

The only exception to not sitting the examination at the designated time is because of documented illness or unavoidable disruption. In these circumstances you may wish to apply for Special Consideration (see 'Special Consideration' in this Guide).

On successful completion you will be able to:

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).
- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.
- To be responsible, critically reflective, self-directed and motivated learners. The nature of the tutorials, tutorial problems, assessment tasks and examination are all designed to develop students as self-learners who know their own learning styles.

Delivery and Resources

Required Text

Essentials of Physics, JD Cutnell and KW Johnson, John Wiley, 5th edition, 2006, ISBN 0-471-71398-8.

Laboratory Manual for PHYS149. Students must have this manual when completing practical work.

Teaching Strategy

PHYS149 consists of lectures, tutorials, laboratory sessions and assessment including assignments, laboratory reports and a final examination.

You are expected to attend all lectures. Any announcements relating to the course are made during lectures. If there are unavoidable timetable clashes, you can listen to the echo recording of each lecture, accessed from the course site.

Attendance at tutorials is compulsory.

You should spend 9 hours per week (for 18 weeks) studying the unit.

Laboratory (Lab) Sessions

The laboratory will operate in E7B.114, commencing week 1. Access to the laboratory at other times may be possible by arrangement. You must finish one experiment at a time, and each experiment is expected to require one 3-hour laboratory session. Laboratory work is an extremely important part of the unit.

You should have a scientific calculator for use during the laboratory sessions. We expect to mark and return laboratory reports submitted on time within two weeks at most.

Attendance at laboratories is compulsory.

How to Use Lab Notebook

You are required to have a bound notebook for laboratory work (no loose sheets). Experimental work is to be recorded in this notebook during the session. The notes will be signed. You will also be assessed on general performance and conduct in the laboratory. Your lab book must be available for checking each week and at the end of semester.

Lab Safety

Safe practices in the laboratory are to be strictly observed. You must wear enclosed footwear to the laboratory. This is required by State Occupational Health and Safety legislation. Our teaching laboratories can be closed down if we permit any breaches. No one wearing inadequate footwear will gain entry to the lab. Food and drink cannot be taken into the laboratory. Exclusion from a laboratory session for violation of these requirements will be treated as absence without legitimate cause.

Schedule of Lab Work

Week	Lab
1	Introduction to the lab (1 hour only)
2	Unit 1 - Week 1 Computer based graphing
3	Unit 1 - Week 2 Computer based graphing
4	Unit 3 – Digital Oscilloscopes
5	Unit 4 – DC circuits
6	No Lab
Mid semester break	
Mid semester break	
7	Experiments
8	Experiments
9	Experiments

10	Experiments
11	Report Writing Session
12	No Lab
13	No Lab

Lab experiments

• Introduction to Graphs (Linear and non-linear)

• Direct Current, Voltage and resistance

• Cathode Ray Oscilloscope

• Measurement of Acceleration due to Gravity

• Physics of Human Arm

• Energy and Power

• Optical Interference

• Standing Waves

• Ultrasonic Waves

• Radioactivity

• Determination of $\gamma = C_p / C_v$ for Air

Unit Schedule

Detailed Topic Outline

with a list of Chapters and Sections of Textbook covered in the Lectures

Week 1.

Introduction and Mathematical Concepts (Chapter 1)

Section 1.1 The nature of physics

Sections 1.2, 1.3 Units

Kinematics in One Dimension, Graphs (Chapter 2)

Section 2.1 Displacement

Section 2.2 Speed and velocity

Section 2.3 Acceleration

Sections 2.4 - 2.5 Equations of kinematics for constant acceleration and applications

Section 2.6 Freely falling bodies

Section 2.7 Graphical analysis of velocity and acceleration

Week 2.

Vectors (Chapter 1)

Sections 1.5-1.8 Vectors

Forces and Newton’s Laws of Motion (Chapter 4)

Section 4.1 Concepts of force and mass

Section 4.2 Newton' first law of motion

Sections 4.3 - 4.4 Newton's second law of motion

Section 4.5 Newton's third law of motion

Sections 4.6 – 4.9 Types of forces: gravitational force, frictional forces and normal force

Sections 4.11- 4.12 Applications of Newton’s laws of motion

Rotational Motion - Torques (Chapter 9)

Sections 9.1- 9.2 Action of forces and torques on rigid objects, and rigid objects in equilibrium

Week 3.

Work and Energy (Chapter 6)

Section 6.1 Work done by constant force

Section 6.2 Work-energy theorem and kinetic energy

Section 6.3 Gravitational potential energy

Section 6.4 Conservative and non-conservative forces

Section 6.5 Conservation of mechanical energy

Section 6.6 Non-conservative forces and the work-energy theorem

Section 6.7 Power

Section 6.8 Other forms of energy and the conservation of energy

Section 6.9 Work done by a variable force

Week 4.

Electricity. (Chapter 18)

Section 18.1 and 18.2 Introduction and charged objects

Section 18.6 Electric field

Electric potential. (Chapter 19)

Section 19.1. Potential energy

Section 19.2 Electric potential difference

Electric circuits. (Chapter 20)

Section 20.1 Electromotive force and current

Section 20.2 Ohm’s law

Section 20.3 Resistance and resistivity

Section 20.4 Electric power

Section 20.5 Alternating current

Week 5.

Electric circuits. (Chapter 20)

Section 20.6 Series wiring

Section 20.7 Parallel wiring

Section 20.8 Circuits partially in series and partially in parallel

Section 20.11 Measurement of current and voltage

Section 20.14 Safety and the physiological effects of current

Week 6.

Fluids. (Chapter 11)

Section 11.1 Mass density

Section 11.2 Pressure

Section 11.3 Pressure and depth in a static fluid

Section 11.4 Pressure gauges

Section 11.5 Pascal’s principle

Section 11.6 Archimedes’ Principle

Section 11.7 Fluids in motion

Section 11.8 Equation of continuity

Section 11.9 –11.10 Bernoulli's equation and applications

Week 7.

Heat. (Chapter 12)

Section 12.1- 12.2 Temperature scales

Section 12.3 Thermometers

Section 12.6 Heat and internal energy

Section 12.7 Heat and temperature change

Section 12.8 Heat and phase change

Heat transfer. (Chapter 13)

Section 13.1 Convection

Section 13.2 Conduction

Section 13.3 Radiation

Section 13.4 Applications

Week 8.

Thermodynamics. (Chapter 15)

Section 15.1 Thermodynamic systems and surroundings

Section 15.2 Zeroth law of thermodynamics

Section 15.3 First law of thermodynamics

Section 15.7 Second law of thermodynamics

Section 15.8 Heat engines

Section 15.10 Refrigerators

Section 15.11- 15.12 Entropy and third law of thermodynamics

Waves and Sound. (Chapter 16)

Section 16.1 Nature of waves

Section 16.2 Periodic waves

Section 16.3 Speed of a wave on a string

Section 16.4 Mathematical description of a wave

Section 16.5 Nature of sound

Section 16.6 Speed of sound

Sections 16.7 – 16.8 Sound intensity and dB

Section 16.9 Doppler effect

Section 16.10 Applications of sound in medicine

Week 9.

Superposition and Interference. (Chapter 17)

Section 17.1 Principle of linear superposition

Section 17.2 Constructive and destructive interference of sound waves

Section 17.3 Diffraction

Section 17.4 Beats

Section 17.5 Transverse standing waves

Section 17.6 Longitudinal standing waves

Electromagnetic waves. (Chapter 24)

Section 24.1 Nature of electromagnetic waves

Section 24.2 Electromagnetic spectrum

Section 24.3 Speed of light

Section 24.5 Energy carried by electromagnetic waves

Section 24.6 Doppler effect and electromagnetic waves

Section 24.6 Polarization

Week 10.

Reflection of Light. Mirrors. (Chapter 25)

Section 25.1 Wave fronts and rays

Section 25.2 Reflection of light

Section 25.3 Formation of images by a plane mirror

Section 25.4 Spherical mirrors

Section 25.5 Formation of images by spherical mirrors

Section 25.6 Mirror equation and magnification equation

Refraction of Light: Lenses and Optical Instruments. (Chapter 26)

Section 26.1 Index of refraction

Section 26.2 Snell’s law and refraction of light

Section 26.3 Total internal reflection

Section 26.4 Polarization and reflection and refraction of light

Section 26.5 Dispersion of light

Week 11.

Lenses and Optical Instruments. (Chapter 26)

Section 26.6 –26.7 Lenses and formation of images by lenses

Section 26.8 Thin lens equation and magnification equation

Section 26.9 Lenses in combination

Section 26.10 Human eye

Section 26.11 Angular magnification and magnifying glass

Section 26.12 Compound microscope

Section 26.14 Lens aberrations

Interference and Wave Nature of Light. (Chapter 27)

Section 27.1 Principle of linear superposition

Section 27.2 Young's double slit experiment

Section 27.3 Thin film interference

Section 27.5 Diffraction

Section 27.6 Resolving power

Section 27.7 Diffraction grating

Week 12.

Nature of the Atom. (Chapter 30)

Section 30.2 Line spectra

Section 30.3 Bohr model of the hydrogen atom

Section 30.6 Pauli exclusion principle and the periodic table of the elements

Section 30.7 X-rays

Nuclear Physics and Radioactivity. (Chapter 31)

Section 31.1 Nuclear structure

Section 31.2 Strong nuclear force and stability of the nucleus

Section 31.3 Mass defect of the nucleus and nuclear binding energy

Sections 31.4 and 31.6 Radioactivity and radioactive decay

Ionizing Radiation. Elementary Particles(Chapter 32)

Section 32.1 Biological effects of ionizing radiation

Section 32.6 Elementary Particles – positron emission tomography

Week 13.

Revision and Review.

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/

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

Capable of Professional and Personal Judgement and Initiative

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

This graduate capability is supported by:

Learning outcomes

- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- To be responsible, critically reflective, self-directed and motivated learners. The nature of the tutorials, tutorial problems, assessment tasks and examination are all designed to develop students as self-learners who know their own learning styles.

Commitment to Continuous Learning

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

This graduate capability is supported by:

Learning outcomes

- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- To be responsible, critically reflective, self-directed and motivated learners. The nature of the tutorials, tutorial problems, assessment tasks and examination are all designed to develop students as self-learners who know their own learning styles.

Discipline Specific Knowledge and Skills

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

This graduate capability is supported by:

Learning outcomes

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).
- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using a range of measurement and data analysis tools to collect data with appropriate

precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).
- Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/ assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.

Critical, Analytical and Integrative Thinking

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

This graduate capability is supported by:

Learning outcomes

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).
- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using a range of measurement and data analysis tools to collect data with appropriate precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).
- Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/

assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.

Problem Solving and Research Capability

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

This graduate capability is supported by:

Learning outcomes

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).
- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using a range of measurement and data analysis tools to collect data with appropriate precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).

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

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).

- Applying of physics principles to understand the causes of problems, devise strategies to solve them and test possible solutions. Students are counselled that developing problem-solving strategies is the hallmark of a physicist. They take the first steps in building these skills. The structure of the problems from the text - being categorised by topic - is a stepping stone to being able to determine the concepts relevant to solving problems without this support.
- Using a range of measurement and data analysis tools to collect data with appropriate precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).

Effective Communication

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

This graduate capability is supported by:

Learning outcomes

- Using a range of measurement and data analysis tools to collect data with appropriate precision and carry out subsequent analysis with due regard to the uncertainties. The unit includes a comprehensive laboratory component to build these capabilities, in which students perform physics experiments. This involves understanding the physics of the problem, performing the measurements (with due regard to uncertainties), and analysing their results (including computer-based processing and presentation).
- Using the tools, methodologies, language, conventions of physics to test and communicate ideas and explanations. Topic content, laboratories and tutorial/assignment problems all provide opportunities to build an understanding of how to test and communicate physics ideas and explanations.
- To be responsible, critically reflective, self-directed and motivated learners. The nature of the tutorials, tutorial problems, assessment tasks and examination are all designed to develop students as self-learners who know their own learning styles.

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

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).

Socially and Environmentally Active and Responsible

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

This graduate capability is supported by:

Learning outcome

- Knowledge of fundamental physics concepts, principles and theories. Students learn concepts and show their understanding by predicting outcomes of 'thought experiments' (conceptual answers) and calculating outcomes in specific physical situations (numerical answers).