PHYS106

Thermodynamics, Relativity and Fields

S2 Day 2014

Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff

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Credit points
3

Prerequisites
PHYS107

Corequisites
MATH132 or MATH133 or MATH135 or MATH136

Co-badged status

Unit description

This unit, together with PHYS107, 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:

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- An overview of the links between the different aspects of electromagnetism, and how they relate to the physics learnt in prior units
- Ability to analyse and solve complex problems relating the lecture material.
- Ability to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved. Ability to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

General Assessment Information

Satisfactory performance in all of the assessment types is required to pass the unit.

Assessment Tasks

Name	Weighting	Due
Assignments	15%	Spread through the session
Lab work	20%	Throughout the session
Midsemester Exam	15%	Monday 8th Week
Final exam	40%	Exam period
In-tutorial tests	10%	Week 3 - Week 13

Assignments

Due: **Spread through the session**
Weighting: **15%**

We will set four assignments spread through the session (due approximately at the end of weeks 3, 6, 9, and 12)

On successful completion you will be able to:

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- An overview of the links between the different aspects of electromagnetism, and how they relate to the physics learnt in prior units
- Ability to analyse and solve complex problems relating the lecture material.

Lab work

Due: **Throughout the session**
Weighting: **20%**

Labs will take place throughout the term. You will learn practical experimental skills, and discover how to design, carry out, and analyse practical investigations.

On successful completion you will be able to:

- An overview of the links between the different aspects of electromagnetism, and how they relate to the physics learnt in prior units
- Ability to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved. Ability to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

Midsemester Exam

Due: **Monday 8th Week**
Weighting: **15%**

There will be a mid-semester exam. This 50-minute exam will be at 11am, Monday, Week 8, 8th October in E6A 102. The exam will include content from lectures in weeks 1 to 6 only.

On successful completion you will be able to:

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Ability to analyse and solve complex problems relating the lecture material.

Final exam

Due: **Exam period**
Weighting: **40%**

The final exam will be in the normal exam period, and will cover material from the entire course, with a slight emphasis on material from weeks 7 - 13.

On successful completion you will be able to:

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- Ability to analyse and solve complex problems relating the lecture material.

In-tutorial tests

Due: **Week 3 - Week 13**
Weighting: **10%**

There will be a ten-minute test during each tutorial from week 3 to week 13. The tests will comprise a single question, based on those questions covered in the tutorial of the previous week. The results of your best nine tests from the total of eleven will contribute 10% of your final mark.

On successful completion you will be able to:

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- Ability to analyse and solve complex problems relating the lecture material.

Delivery and Resources

Required and Recommended Texts and/or Materials

Required Text

Matter and Interactions by Ruth Chabay and Bruce Sherwood.

Either Volume 2 (Paperback) or the combined Volume (hardbound). Note that Volume 1 is the required text for PHYS107 in semester 1.

Required Resources

A copy of the PHYS106 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

Lecture notes, tutorial questions and answers, assignments, and other resources will be posted on the PHYS106 iLearn site.

Teaching and Learning Strategy

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

Lectures:

There are three lectures per week, as timetabled. Lectures follow the chapters from Volume II of the textbook Matter and Interactions.

Week 1: The electric field

Week 2: Electric fields in matter

Week 3: Electric fields of distributed charges

Week 4: Electric potential

Week 5: Electric field and circuits

Week 6: Circuit elements

(The midsemester exam will cover content up to this point)

Week 7: Magnetic field

Week 8: Magnetic force

Week 9: Patterns of field in space

Week 10: Faraday's law

Week 11: Electromagnetic radiation

Week 12: Waves and particles

Week 13: Revision

Tutorials

You should attend one tutorial per week.

Laboratory work

There is a lab introduction in the week 1 laboratory session. Lab experiments start in week 2, and take place each subsequent week apart from week 8 and 11. See the section on Laboratory Practicals.

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, and complete a short test on the previous week's tutorial content.

Laboratory practicals

Three hour laboratory classes will be held in 11 weeks during 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.

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

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- Ability to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved. Ability to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

Assessment tasks

- Assignments
- Lab work
- Midsemester Exam
- Final exam
- In-tutorial tests

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 outcome

- Ability to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved. Ability to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

Assessment task

- Lab work

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

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
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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.

This graduate capability is supported by:

Learning outcomes

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- An overview of the links between the different aspects of electromagnetism, and how they relate to the physics learnt in prior units
- Ability to analyse and solve complex problems relating the lecture material.
- Ability to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved. Ability to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

Assessment tasks

- Assignments
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- Final exam
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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.

This graduate capability is supported by:

Learning outcomes

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
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Assessment tasks

- Assignments
- Lab work
- Midsemester Exam
- Final exam
- In-tutorial tests

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

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- Ability to perform physical measurements with an understanding of the statistical nature

of measurement uncertainties involved. Ability to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

Assessment tasks

- Assignments
- Lab work
- Midsemester Exam
- Final exam
- In-tutorial tests

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

- Familiarity and use of Coulomb's law, and the concepts of electric field and electric potential, and their application to circuit theory.
- Understanding of magnetic fields and magnetic forces, and how magnetic fields are generated by moving charges.
- Understanding the links between magnetic fields and electric fields, and electromagnetic waves.
- Familiarity with the properties of waves and understanding of wave-particle duality.
- Ability to perform physical measurements with an understanding of the statistical nature of measurement uncertainties involved. Ability to record experimental results, analysis and conclusions in a clear, concise and systematic manner.

Assessment tasks

- Assignments
- Lab work
- Midsemester Exam
- Final exam
- In-tutorial tests

Changes from Previous Offering

We have introduced in-tutorial tests this semester, in line with a similar change in the sister unit PHYS107. These tests give you continuous feedback on your progress, and encourage engagement in tutorials.

Laboratory Practicals

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 PHYS106 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, <u>not</u> 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 and you will fail the course. 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, David Spence, with written explanation and/or a medical certificate. If you miss a session without a valid reason, you must make up that session at an alternate time arranged with the Lab Manager Danny.

How to use your Laboratory Notebook

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

The schedule of labs is posted in the lab. There are labs on every week apart from week 8 and 11. 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 David Spence.