PHYS2913: Astrophysics and Relativity (Advanced)
Semester 2, 2012 | 6 Credit Points | Coordinator: Prof. Iver Cairns (cairns@physics.usyd.edu.au)

1 Introduction

This Unit of Study outline describes PHYS 2913, the second semester Advanced-level 'elective' unit. This unit is designed for students who wish to broaden and complete their study of physics at the advanced Intermediate level, and will generally be taken by students who are also taking PHYS 2912. This unit (or PHYS2012) is a prerequisite for study of Senior Physics.

The unit is split into a number of modules, combining lectures on Cosmology and Special Relativity with sessions on Experimental Physics in the Intermediate Physics Laboratory. Some of these activities are in common with the unit of study PHYS 2013 Astrophysics and Relativity.

1.1 Assumed Knowledge and Prohibitions

Students must have Credit or better average in PHYS (1003 or 1004 or 1902) and PHYS (1001 or 1002 or 1901 or 2011 or 2911). Corequisites are PHYS (2012 or 2912). It is assumed that students have taken MATH (1001/1901 and 1002/1902 and 1003/1903). MATH (1005/1905) would also be useful. PHYS2013 may not be counted with PHYS 2001, PHYS 2901, PHYS 2013, PHYS 2101, PHYS 2103.

2 Course Aims, Learning Objectives and Graduate Attributes

2.1 Course Aims

The unit is designed to help you develop appropriate methods of study that will allow you to become an independent learner, capable of organising new information into a coherent conceptual framework and applying it in both familiar and unfamiliar situations. In addition, you are introduced to basic experimental skills in the measurement of physical quantities and analysis of experimental data.

2.2 Learning Outcomes

After successfully completing this unit, you should be able to demonstrate:

1. an understanding of the key concepts in special relativity and cosmology;
2. the ability to apply these concepts to develop models, and to solve qualitative and quantitative problems in scientific and engineering contexts, using appropriate mathematical and computing techniques as necessary;
3. an understanding of the nature of scientific measurement, and skills in the measurement of physical quantities and the handling of data;
4. the ability to find and analyse information and judge its reliability and significance;
5. the ability to communicate scientific information appropriately, both orally and through written work;
6. the ability to engage in team and group work for scientific investigations and for the process of learning;
7. a sense of responsibility, ethical behaviour and independence as a learner and as a scientist.
2.3 Graduate Attributes

Graduate Attributes are generic attributes that encompass not only technical knowledge but additional qualities that will equip students to be strong contributing members of professional and social communities in their future careers. The overarching graduate attributes identified by the University relate to a graduate’s attitude or stance towards knowledge, towards the world, and towards themselves. These are understood as a combination of five overlapping skills or abilities, the foundations of which are developed as part of specific disciplinary study. For further details please refer to the Science faculty website at: http://www.itl.usyd.edu.au/graduateAttributes/facultyGA.cfm?faculty=Science

<table>
<thead>
<tr>
<th>Graduate Attributes</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A Research and Inquiry</strong></td>
<td></td>
</tr>
<tr>
<td>A1. Apply scientific knowledge and critical thinking to identify, define and analyse problems, create solutions, evaluate opinions, innovate and improve current practices.</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td>A2. Gather, evaluate and deploy information relevant to a scientific problem.</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>A4. Critically examine the truth and validity in scientific argument and discourse, and evaluate the relative importance of ideas.</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td><strong>B Information Literacy</strong></td>
<td></td>
</tr>
<tr>
<td>B1. Use a range of searching tools (such as catalogues and databases) effectively and efficiently to find information.</td>
<td>4</td>
</tr>
<tr>
<td>B2. Access a range of information sources in the science disciplines, for example books, reports, research articles, patents and company standards.</td>
<td>4</td>
</tr>
<tr>
<td>B3. Critically evaluate the reliability and relevance of information in a scientific context.</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>B5. Use information technology to gather, process, and disseminate scientific information.</td>
<td>4, 5</td>
</tr>
<tr>
<td><strong>C Communication</strong></td>
<td></td>
</tr>
<tr>
<td>C2. Write and speak effectively in a range of contexts and for a variety of different audiences and purposes.</td>
<td>2, 5</td>
</tr>
<tr>
<td>C4. Present and interpret data or other scientific information using graphs, tables, figures and symbols.</td>
<td>3, 4, 5</td>
</tr>
<tr>
<td>C5. Work as a member of a team, and take individual responsibility within the group for developing and achieving group goals.</td>
<td>6</td>
</tr>
<tr>
<td>C6. Take a leadership role in successfully influencing the activities of a group towards a common goal.</td>
<td>1, 2, 6, 7</td>
</tr>
<tr>
<td><strong>D Ethical, Social and Professional Understanding</strong></td>
<td></td>
</tr>
</tbody>
</table>
D1. Demonstrate an understanding of the significance and scope of ethical principles, both as a professional scientist and in the broader social context, and a commitment to apply these principles when making decisions. 7

D2. Appreciate the importance of sustainability and the impact of science within the broader economic, environmental and socio-cultural context. 7

E Personal and Intellectual Autonomy

E1. Evaluate personal performance and development, recognise gaps in knowledge and acquire new knowledge independently. 7

For further details on course learning outcomes related to specific topics see the eLearning site.

3 Study Commitment

Below is a breakdown of our expectations for PHYS 2913. It should be noted that ‘Independent Study’ is based on what we believe to be the amount of time a typical student should spend to achieve to pass an item of assessment. Times are a guide only.

The current standard work load for a 6 credit point unit of study is 6 hours per week of face-to-face teaching contact hours and up to an additional 6 hours per week of independent study.

<table>
<thead>
<tr>
<th>In class activities</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures (22 @ 1 hr each)</td>
<td>22</td>
</tr>
<tr>
<td>Experimental Physics lab sessions (12 @ 3 hrs each)</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent Study</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading of text for lectures (22 @ 0.5 hr each)</td>
<td>11</td>
</tr>
<tr>
<td>Reading of lecture notes after lectures (22 @ 0.5 hr each)</td>
<td>11</td>
</tr>
<tr>
<td>Revision and self assessment (13 @ 1 hr each)</td>
<td>13</td>
</tr>
<tr>
<td>Assignments (4 @ 5 hr each)</td>
<td>20</td>
</tr>
<tr>
<td>Preparation for experimental lab (12 @ 0.5 hr each)</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
</tr>
</tbody>
</table>

Study Tips

You are now in control of your own study strategy, and as an adult learner it is up to you to devise a study plan that best suits you. If you attend classes regularly and involve yourself in all of these learning experiences, you will gain a good understanding of the course work. This will have a considerable impact on your exam preparation and performance.

Good study habits are also very important - we offer some suggestions on our Learning Physics web page (http://sydney.edu.au/science/physics/current/learningphysics.shtml).

4 Learning and Teaching Activities
Class timetabling

All lectures are held in the Physics Building. Lectures on **Cosmology** will be held in common with PHYS2013, and will take place in the Slade Lecture Theatre. Lectures on **Special Relativity** will be separate and also held in Slade Lecture Theatre.

<table>
<thead>
<tr>
<th>Lecture Theatre</th>
<th>Wednesday 1pm and Friday 11am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slade Lecture Theatre</td>
<td>1 August to Fri 19 October</td>
</tr>
</tbody>
</table>

**Note:** there will be no classes over mid-semester break and Labour Day holiday (Monday 24 September to Monday 1 October)

Week by week timetable

<table>
<thead>
<tr>
<th>Teaching Week Monday date</th>
<th>Lecture Wednesday 1 pm</th>
<th>Lecture Friday 11 am</th>
<th>Experimental Physics Lab Wed or Thu 2-5 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1 – 30 Jul</td>
<td>C1</td>
<td>C2</td>
<td>Lab registration</td>
</tr>
<tr>
<td>Week 2 – 6 Aug</td>
<td>C3</td>
<td>C4</td>
<td>Lab 1</td>
</tr>
<tr>
<td>Week 3 – 13 Aug</td>
<td>C5</td>
<td>C6</td>
<td>Lab 2</td>
</tr>
<tr>
<td>Week 4 – 20 Aug</td>
<td>C7</td>
<td>C8</td>
<td>Lab 3</td>
</tr>
<tr>
<td>Week 5 – 27 Aug</td>
<td>C9</td>
<td>C10</td>
<td>Lab 4</td>
</tr>
<tr>
<td>Week 6 – 3 Sep</td>
<td>C11</td>
<td>C12</td>
<td>Lab 5</td>
</tr>
<tr>
<td>Week 7 – 10 Sep</td>
<td>SR1</td>
<td>SR2</td>
<td>Lab 6</td>
</tr>
<tr>
<td>Week 8 – 17 Sep</td>
<td>SR3</td>
<td>SR4</td>
<td>Lab 7</td>
</tr>
<tr>
<td>Mid-semester break</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 9 - 1 Oct</td>
<td>SR5</td>
<td>SR6</td>
<td>Lab 8</td>
</tr>
<tr>
<td>Week 10 – 8 Oct</td>
<td>SR7</td>
<td>SR8</td>
<td>Lab 9</td>
</tr>
<tr>
<td>Week 11 – 15 Oct</td>
<td>SR9</td>
<td>SR10</td>
<td>Lab 10</td>
</tr>
<tr>
<td>Week 12 – 22 Oct</td>
<td>No lecture</td>
<td>No lecture</td>
<td>Lab 11</td>
</tr>
<tr>
<td>Week 13 – 29 Oct</td>
<td>No lecture</td>
<td>No lecture</td>
<td>Talks</td>
</tr>
</tbody>
</table>

*SR Special Relativity; C Cosmology*

Lectures

22 one-hour **Lectures** divided into 2 lecture modules:

<table>
<thead>
<tr>
<th>Cosmology 12 Lectures</th>
<th>Historical and philosophical basis for cosmological models, the cosmological principle, the Friedmann equations, the Friedmann-Robertson-Walker metric, cosmological redshift, the cosmic microwave background radiation, big-bang nucleosynthesis, the thermal history of the Universe, inflation, dark matter and dark energy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Relativity 10 Lectures</td>
<td>Concepts of classical relativity, special relativity, Einstein's two postulates, relative motion, twin paradox, Doppler shift, Lorentz transformations, spacetime and causality, relativistic momentum, relativistic kinetic energy, mass as a measure of energy.</td>
</tr>
</tbody>
</table>
Please consult your personal timetable on myUni for more details.

**Experimental Physics Laboratory Work**

12 three-hour **Experimental Physics Laboratory sessions**. You will be timetabled into one, 3-hour Experimental Physics Laboratory session per week in the Intermediate Physics Laboratory, Rms 419-423. You work in a partnership with all work recorded in individual logbooks, to be issued in the lab. Lab registration will be during the **first** week of semester and will be held in the Intermediate Physics Laboratory.

**Experimental Physics Laboratory Times**

- Wednesday 2pm - 5pm
- Thursday 2pm - 5pm

**N.B.** No experimental lab over mid-semester break and Labour Day holiday (Monday 24 September to Monday 1 October).

5 **Teaching Staff and Contact Details**

<table>
<thead>
<tr>
<th>Unit Coordinator</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Iver Cairns</td>
<td><a href="mailto:cairns@physics.usyd.edu.au">cairns@physics.usyd.edu.au</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching Staff</th>
<th>Email</th>
<th>Room</th>
<th>Phone</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Tim Bedding</td>
<td><a href="mailto:tim.bedding@sydney.edu.au">tim.bedding@sydney.edu.au</a></td>
<td>Physics, Room 214</td>
<td>9351 2680</td>
<td>Special Relativity</td>
</tr>
<tr>
<td>A/Prof. Scott Croom</td>
<td><a href="mailto:s.croom@physics.usyd.edu.au">s.croom@physics.usyd.edu.au</a></td>
<td>Rosehill St Building, Room 211</td>
<td>9036 5311</td>
<td>Cosmology</td>
</tr>
</tbody>
</table>

6 **Learning Resources**

**Cosmology**

There is no required textbook for this module. However, the first reference below (*An Introduction to Modern Cosmology*, by Liddle) is highly recommended and contains the vast majority of material covered in this course. Lecture notes will be available via eLearning. The following reference books may also be useful. They are available on closed reserve from the Library.


The following is an incomplete list of recommended books for further reading and reference:

- Padmanabhan, T., 2006, *An Invitation to Astrophysics*
- Maoz, D., 2007, *Astrophysics in a Nutshell*
- Rees M., 2001, *Just Six Numbers*

**Special Relativity**
Reference
Young and Freedman, University Physics (Addison Wesley)

Experimental Physics
The module is defined in terms of the Intermediate Physics Experimental Physics Notes, available at the Co-op Bookshop and on the web at (http://www.physics.usyd.edu.au/current/2yr_lab.shtml). These notes contain descriptions of the experiments for both first and second semesters, so there is no need to buy a new copy if you already have one from first semester.

Module syllabus guidelines
There are syllabus guidelines for each of the lecture modules listing specific objectives that define what you should learn and understand about the detailed content of each chapter of the textbook (see Section 4). Understanding a term or concept means that you should be able to:

- explain its meaning in writing and give examples;
- interpret it correctly when you read or hear it;
- use it correctly in your own writing; and
- apply it correctly to examples and problems.

Module Descriptions
COSMOLOGY
The 12 lectures will be given by A/Prof. Scott Croom.

In cosmology we attempt to understand the physics that governs the evolution of the Universe as a whole. Research over the last century has completely overturned how humans view the Universe, with the hot big bang model now providing us with a coherent picture of how the Universe evolves. However, major uncertainties remain, not least the physics behind the discovery of the accelerated expansion (driven by so-called “dark energy”). In this course we will take a largely Newtonian approach, although discuss some issues related to general relativity and the limitations of Newtonian approximations. We will examine experimental evidence that supports the big-bang cosmological model.

Specific Objectives
After studying this module, you should be able to:

- Describe and understand the philosophical and historical background of our current cosmological model and how this has changed over time.
- Describe and understand the cosmological principle and its importance in cosmology.
- Understand the concept of a metric to define the distance between two points in a space.
- Understand how the Friedmann–Lemaître–Robertson–Walker metric that describes the geometry of the Universe can be derived from the assumptions of homogeneity and isotropy in the cosmological principle.
- Derive the relationship between cosmological redshift and cosmic expansion.
- Derive the Friedmann equations using a Newtonian approach.
- Explain the limitations of Newtonian approximations, how the physical meaning of the terms differ when using General Relativity.
- Use the Friedmann equations to find solutions for simple cosmological models.
- Understand the concept of density parameters and be able to re-write the Friedmann equations in terms of density parameters.
- Understand, describe and use the different cosmological distances that can be measured,
- Apply the physics of black body radiation to the cosmic microwave background.
- Explain the thermal history of the Universe and understand what the dominant physics is at each stage.
- Understand the concept of nucleosynthesis and its observational consequences, including being able to make an estimate of the primordial hydrogen and helium abundance.
- Describe and understand the concepts of dark matter and dark energy.
- Explain the basic components of the current cosmological model and the highlight outstanding problems.
- Know the basic components of a galaxy and the differences between galaxies now and in the early Universe.
SPECIAL RELATIVITY

The 10 lectures will be given by Prof. Tim Bedding.

This lecture module introduces Special Relativity, one of the most important and influential theories of modern physics. Special Relativity is an extension of Newtonian mechanics to objects moving at very high speeds, and is based on the fundamental postulate that the speed of light is the same for all observers. The remarkable and often counterintuitive consequences of the theory include length contraction, time dilation and rest energy ($E=mc^2$). This module covers the theory of Special Relativity, its predictions and applications. It also introduces the main concepts of General Relativity, the theory that describes gravity as resulting from the fact that space-time is curved by the presence of matter. This module lays the foundations for a full course on General Relativity, and is also important for future courses in electromagnetism and quantum mechanics.

Specific Objectives

After studying this module, you should be able to:

- appreciate that special relativity involves extending and modifying Newton's laws, not replacing them.
- describe and discuss Einstein's two postulates.
- recall that Maxwell's equations explain light as a travelling wave of electric and magnetic fields (Sec. 33-3), and appreciate that this leads to Einstein's second postulate.
- define and use the following concepts: inertial reference frames, events, simultaneity.
- understand the following terms and differentiate between them: constant, conserved and invariant.
- appreciate that the time interval between events depend on the reference frame and, in particular, that two events may be simultaneous in one frame but not in others.
- define and use the concept of proper time.
- describe the so-called twin paradox and explain its resolution.
- appreciate that lengths measured in two frames of reference are different in the direction parallel to the relative motion, but not in the perpendicular direction.
- solve problems involving time dilation and length contraction.
- explain and use the Lorentz transformations for coordinates and for velocities.
- derive, explain and use the relativistic Doppler effect.
- understand and use spacetime diagrams.
- define the concepts of relativistic momentum and relativistic kinetic energy and use them to solve dynamical problems.
- appreciate that the total energy of a particle includes both the kinetic energy and the rest energy, and use this to solve problems involving motions and collisions of particles.
- understand and use four-vectors for displacement, velocity and energy-momentum.
- understand and describe the basic principles of General Relativity as a theory of gravity, including the Equivalence Principle.

EXPERIMENTAL PHYSICS

Introduction

The coordinator of the laboratory is A/Prof. Kevin Varvell (Room 344) email: kevin.varvell@sydney.edu.au; phone: 9351 2539

Experimental Physics is a laboratory course based on a set of individual experiments, which cover many different aspects of experimental physics. In this semester each student must complete one experiment from each group (A, B and C). After that, experiments may be chosen from any group, subject to availability. Experiments already done in first semester may not be repeated. Towards the end of the semester, students may work on an (optional) project, usually in a group of four.

Students work in a partnership; usually one pair of students works together. However, all work must be
recorded in individual logbooks to be issued in the laboratory.

Laboratory tutors will check your work. Unless one of the partners is away for that particular session, both students in a partnership must present their books to the tutor at the same time. If your work is unsatisfactory you will be asked to bring it up to the required standard and demonstrate that you have mastered the material, repeating parts of the experiment if necessary.

Each team will have to write a report on one of the experiments performed during the semester, and the team is also expected to make an oral presentation of the report work during the last session of the semester.

Session Arrangements and Registration

The Intermediate Physics Laboratory, (Rooms 419-423) is located at the western end (the end nearest to No.1 Oval) of the Physics Building on Level 4 (two floors above ground level). The laboratory sessions are from 2:00 pm to 5:00 pm on each of Wednesday and Thursday afternoons. Students will be assigned to one of these sessions by their timetable.

You must attend your first scheduled laboratory session, during the first week of the first semester, which is used for registration and for an introduction to the unit of study. The sessions start at 2:00 pm and will be held in the Intermediate Physics Laboratory. If you have not been assigned a time for laboratory work, attend the earliest session you can.

Missed Sessions

Experimental Physics forms an important element of the Intermediate Physics course. Students who miss sessions or arrive late or leave early may be severely penalised. If you are unable to attend because of illness, misadventure or other difficulties you should refer to the “Consideration of Factors Affecting Your Study” section of this outline.

Assessment

A satisfactorily completed experiment is worth a maximum of 13 marks. Other components of the assessment are the written report and oral presentation, and the project proposal and performance (if applicable). For details of the assessment of laboratory work see the ‘General Information’ section of the Experimental Physics Notes book.

Specific Objectives

- After studying this module, you should be able to:
  - Perform physics experiments, analyse and interpret data and draw conclusions from your results
  - Solve experimental problems in physics and link these to appropriate theories
  - Work independently and in groups
  - Present the results of physics experiments orally and in the form of a written report
  - Appreciate the role of computers and other equipment in experimental physics
  - Make effective records in a logbook, and calculate uncertainties when appropriate

Web Resources

The University eLearning system elearning.sydney.edu.au provides resources to help you with your studies, please spend time getting acquainted with this site. MyUni sydney.edu.au/myuni is the student portal providing University information and services. Access to MyUni and eLearning requires a Unikey username and password that is issued with your confirmation of enrolment. The University provides computer facilities described on the Student IT pages at http://sydney.edu.au/ict/student/. The ‘Current Student’ link on the School of Physics web page sydney.edu.au/science/physics also provides resources to help you with your studies.
Email
The University provides you with email access based on your username. We may use this email address to provide you with important information regarding this unit of study. **We expect you to periodically read your email account or to forward mail from it to an account you do read (eg. a gmail account).**

Where to go for help
If you need help, you can:

- as a first step, always check your unit eLearning pages for information, documents and links
- go to the Physics Student Services Office, Room 210 in the Physics building, or phone 9351 3037
- ask your lecturer or tutor
- ask a Duty Tutor - available Mon 12-1pm and Thur 1-2pm in the Computational Science Lab 177 in the Carslaw Building to help with problems with physics course material. The duty tutor will be available from **Week 3** of semester.
- email the relevant coordinator – Intermediate Physics Coordinator: A/Prof. Mike Wheatland
  (michael.wheatland@sydney.edu.au); Experimental Physics Coordinator: A/Prof. Kevin Varvell
  (kevin.varvell@sydney.edu.au); Computational Physics Coordinator: Dr Pulin Gong
  (pulin.gong@sydney.edu.au).

Providing us with feedback
We welcome comments on all aspects of this unit. You should feel free to contact your lecturers, tutors or the coordinators (listed under "Where to go for help" above) at any time. There is also a formal opportunity for feedback at the Staff-Student Liaison meeting, held one lunch time towards the end of semester with staff and student representatives from the various units of study, including this one. Your feedback helps us improve this unit.

Changes this year
As a result of student feedback and other initiatives there will be a number of changes this year:

- A full review of the Physics syllabus is underway, so your feedback is especially timely.
- The 2nd year Cosmology module is newly introduced this year, and any feedback provided will be used directly to improve the course.
- Assessment policies are changing so progressively, but behind the scenes, there will be changes in the way your assessment marks are used to produce your final grade.
- We have a new building project underway - see [http://www.physics.usyd.edu.au/about/building.shtml](http://www.physics.usyd.edu.au/about/building.shtml)

7 Assessment Tasks
You are responsible for understanding the University policy regarding assessment and examination, which can be found at [http://www.sydney.edu.au/ab/policies/Assess_Exam_Coursework.pdf](http://www.sydney.edu.au/ab/policies/Assess_Exam_Coursework.pdf)

Assessment
This unit is assessed through an examination, assignments taken throughout the semester, participation at computational physics sessions and a computational test at the end of semester, and marking of laboratory logbooks in experimental physics sessions as well as a talk and report late in the semester. Proof of identification is required at all examinations.

Assessment of this unit of study is based on achievement of specific learning objectives (listed in the module outlines) demonstrated in a combination of assignments, examinations and laboratory work. Satisfactory performance in both the theory and experimental segments of the unit of study is necessary for a pass.

In addition, students in physics must be able to express themselves accurately by clear, efficient use of
the English language in their written work. Spelling, grammar, punctuation and correct use of language will be taken into account when written reports and examination work are assessed. Students should refer to the University’s WriteSite (http://writesite.elearn.usyd.edu.au) if they are looking for guidance on grammar and other aspects of academic and professional writing.

You should be familiar with the new University Assessment policy, which can be found at http://sydney.edu.au/ab/policies/Assessment_Policy_2011.pdf

Assignment Information
There will be two assignments from each of the two lecture modules. Assignment questions will be handed out in lectures or made available via MasteringPhysics. Students will submit individual assignments. Even though students may work in groups on solving the problems, the individually submitted answers must include explanations of how each individual has understood the problem and its solution. Each handed in assignment must have a cover sheet, which is available from the eLearning site. In signing the cover sheet, each student is confirming awareness of the University’s policy on plagiarism and academic honesty, and agreement to comply with that policy. Assignments will be handed in at Physics Student Services, Room 210, no later than 5pm on the due date.

Late Assignments
Assignments and other assessed project work submitted late without permission will incur an immediate 20% late penalty, with a further 20% penalty accumulating each week until the assignment/project is submitted. This policy applies by default, unless your lecturer advises you differently.

7.1 Summative Assessments

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Percentage Mark</th>
<th>Due Date</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cosmology Assignment 1</td>
<td>1.875</td>
<td>Week 3 Friday, 17 August 2012</td>
<td>1, 2, 4, 5, 6, 7</td>
</tr>
<tr>
<td>Cosmology Assignment 2</td>
<td>1.875</td>
<td>Week 8 Friday, 21 September 2012</td>
<td>1, 2, 4, 5, 6, 7</td>
</tr>
<tr>
<td>SR Assignment 1</td>
<td>1.875</td>
<td>Week 10 Friday, 12 October 2012</td>
<td>1, 2, 4, 5, 6, 7</td>
</tr>
<tr>
<td>SR Assignment 2</td>
<td>1.875</td>
<td>Week 13 Friday, 02 November 2012</td>
<td>1, 2, 4, 5, 6, 7</td>
</tr>
<tr>
<td>Experimental Physics</td>
<td>45</td>
<td>Weekly (weeks: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12)</td>
<td>3, 4, 5, 6, 7</td>
</tr>
<tr>
<td>Final Examination (2-hour paper)</td>
<td>47.5</td>
<td>Exam Period</td>
<td>1, 2, 4, 5</td>
</tr>
</tbody>
</table>

Descriptions of Summative Assessments

**Experimental Physics**
Assessment in the laboratory is based on successful completion of laboratory work and performance in the laboratory skills test. For each laboratory session, you are awarded a mark for successfully completing each checkpoint. Satisfactory performance in Laboratory work is necessary for a pass in the unit, but if you work well in the laboratory you will learn a lot and be well on the way to passing this unit.

**Final Examination (2-hour paper)**
The final examination for the unit is a two hours long and closed book. It consists of two parts: Section A is on Cosmology and is worth 50 marks; and Section B is on Special Relativity and is worth 45 marks. Lists of Physical constants and Formulas needed are provided in the paper. Past papers are available for
7.2 Assessment Grading

Final grades in this unit are awarded at levels of **HD** (High Distinction), **D** (Distinction), **CR** (Credit), **P** (Pass) and **F** (Fail) as defined by the Academic Board Assessment Policy. These achievement levels are described below. Details of the policy are available on the University’s 'Policy Online' website at http://www.sydney.edu.au/ab/policies/Assessment_Policy_2011.pdf.

The assessments for this unit are described in this unit of study outline. This description includes the purpose, timing and weighting of each assessment item and an explanation of how task relate to the learning outcomes of the unit. Students are responsible for actively engaging with these assessments, including carefully reading the guidance provided, spending sufficient time on the task, ensuring their work is authentic and their own (whether individual or group work), completing work on time and acting on feedback provided.

Assessment tasks are moderated to ensure their appropriateness, their consistency with the achievement level descriptors below and equity of grade distributions across the units offered by the Faculty of Science. In Intermediate Physics, our aim is to give everyone a chance of a high grade, irrespective of their unit of study. To achieve this, we compare student marks with student AAMs, and compare Normal and Advanced units by having some assessment tasks in common. We use this comparison to ensure one class isn't being disadvantaged by, say, a difficult assessment task. The result of this moderation process is a higher percentage of HDs and Ds in the Advanced unit (as you might expect), however the process also ensures there are HDs and Ds awarded in the other units of study to students who excel.

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**Grades:**

**High Distinction (HD)**
At HD level, a student demonstrates a flair for the subject and comprehensive knowledge and understanding of the unit material. A ‘High Distinction’ reflects exceptional achievement and is awarded to a student who demonstrates the ability to apply subject knowledge to novel situations.

**Distinction (D)**
At D level, a student demonstrates an aptitude for the subject and a solid knowledge and understanding of the unit material. A ‘Distinction’ reflects excellent achievement and is awarded to a student who demonstrates an ability to apply the key ideas of the subject.

**Credit (CR)**
At CR level, a student demonstrates a good command and knowledge of the unit material. A ‘Credit’ reflects solid achievement and is awarded to a student who has a broad understanding of the unit material but has not fully developed the ability to apply the key ideas of the subject.

**Pass (P)**
At P level, a student demonstrates proficiency in the unit material. A ‘Pass’ reflects satisfactory achievement and is awarded to a student who has threshold knowledge of the subject.

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Assessed exercises may not be revised and resubmitted for re-marking. If you wish to appeal an academic decision, you should refer to the University Policy at: http://www.sydney.edu.au/ab/policies/HESA_Grievance_Procedures.pdf and http://www.sydney.edu.au/senate/policies/Ac_Appeals_Rule.pdf

8 Learning and Teaching Policies

**ACADEMIC DISHONESTY/PLAGIARISM**
We will NOT accept assessments that are simply copied. Copying the work of another person without

**Academic Dishonesty** means seeking to obtain or obtaining academic advantage (for example, in assessments) by dishonest or unfair means or knowingly assisting another student to do so. Academic Dishonesty includes, but is not limited to:

(a) recycling – that is, the resubmission for assessment of work that is the same, or substantially the same, as Work previously submitted for assessment in the same or in a different unit of study (except in the case of legitimate resubmission with the approval of the examiner for purposes of improvement);
(b) fabrication of data;
(c) the engagement of another person to complete or contribute to an assessment or examination in place of the student, whether for payment or otherwise or accepting such an engagement from another student;
(d) communication, whether by speaking or some other means, to other candidates during an examination;
(e) bringing into an examination forbidden material such as textbooks, notes, calculators or computers;
(f) attempting to read other student’s work during an examination;
(g) writing an examination or test paper, or consulting with another person about the examination or test, outside the confines of the examination room without permission;
(h) copying from other students during examinations;
(i) inappropriate use of electronic devices to access information during examinations.

**Plagiarism** means presenting another person’s work as one’s own work by presenting, copying or reproducing it without acknowledgement of the source. Plagiarism is a form of Academic Dishonesty, but is treated separately. Plagiarism includes presenting work for assessment, publication, or otherwise, that includes:

(a) phrases, clauses, sentences, paragraphs or longer extracts from published or unpublished work (including from the Internet) without acknowledgement of the source; or
(b) the work of another person, without acknowledgement of the source and presented in a way that exceeds the boundaries of legitimate cooperation.

**CONSIDERATION OF FACTORS AFFECTING YOUR STUDY**

If your academic performance in a Science Faculty unit of study is adversely affected by **illness or some other serious event**, such as an accident, you should notify the **Faculty of Science Office** (level 2 of the Carslaw building) within 7 days after the period for which consideration is sought, by completing an **Application for Special Consideration** with accompanying documentation. This is especially important if you miss an examination.

If you have another reason for the Science Faculty to take account of your circumstances - religious commitments, legal commitments (e.g. Jury duty), elite sporting or cultural commitments (representing the University, state or country), or Australian Defence Force commitments (e.g. Army Reserve) - you should notify the **Faculty of Science Office** (level 2 of the Carslaw building) at least 7 days BEFORE the period for which consideration is sought, by completing an **Application for Special Arrangements** with accompanying documentation.

These two forms of Consideration should cover most allowable circumstances. However, if you have another reason for requiring the School of Physics to take account of your circumstances, you should notify the **School of Physics Student Services Office** immediately.

You should not submit an application of any type if

- there is no assessment associated with a missed class, or
- you have a reasonable opportunity to make up any work you missed.

If, for example, you miss an assignment, an application for appropriate Consideration is required to allow late submission, but we do expect the assignment to be submitted. Sometimes catching up may be impossible, in which case we will consider a pro-rata adjustment of your marks on the basis of an
application for Consideration.

**Special Consideration or Special Arrangements**
To submit an application for **Special Consideration** or **Special Arrangements** you should:

1. Obtain the appropriate Application pack from the Student Information Office of the Faculty of Science, the Faculty website at [http://sydney.edu.au/science/cstudent/ug/forms.shtml](http://sydney.edu.au/science/cstudent/ug/forms.shtml), or the Physics Student Services Office.

2. Complete the forms and obtain whatever original documentary evidence is appropriate. Note especially that the Professional Practitioner's Certificate is essential for Special Consideration on grounds of serious illness - Medical Certificates will NOT be accepted.

3. Take the original copy of all forms and documents, plus sufficient copies for each unit of study affected and yourself, to the Faculty of Science Student Information Office (NOT any other Faculty Office if you are seeking Consideration in a unit taught by Physics). They will sign/stamp both the original application form and the copies. In the case of Physics units, one copy of the documentation must then be submitted to the Physics Student Services Office. Keep one copy yourself. A formal decision on your application will be sent to your university email address within 14 days.

Students unsure what type of Consideration is appropriate, or unhappy with a Consideration decision, should consult the Physics Student Services Office.

Further details on University policy regarding Considerations can be found in the Academic Board Assessment Policy at [http://sydney.edu.au/ab/policies/Assessment_Policy_2011.pdf](http://sydney.edu.au/ab/policies/Assessment_Policy_2011.pdf). This document also contains details on other aspects such as Student Appeals against academic decisions.

For full details of applicable university policies and procedures, see the Policy web site at [sydney.edu.au/policy](http://sydney.edu.au/policy).

Relevant forms are available on the Faculty Forms and Procedures web site at [sydney.edu.au/science/cstudent/ug/forms.shtml](http://sydney.edu.au/science/cstudent/ug/forms.shtml)