2011-12 HANDBOOK FOR FIRST AND SECOND LEVEL MODULES IN THE SCHOOL OF PHYSICS AND ASTRONOMY, UNIVERSITY OF ST ANDREWS

CONTENTS

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2011-12 Pre-Honours Handbook v 1.13, 1.9.11, BDS

INTRODUCTION

This handbook provides information about the first and second level modules to be taught by the School of Physics and Astronomy in the session 2011-12. Students are asked to read this booklet carefully, and are expected to be familiar with the contents. As well as providing useful information for you, this is the "rule book" for these modules.

First Level:	PH1011	Physics 1A
	PH1012	Physics 1B
	PH1501	Gateway – Maths for Physicists 1A
	PH1502	Gateway – Physics Skills 1A
	PH1503	Gateway – Physics Skills 1B
	AS1001	Astronomy & Astrophysics 1
	AS1002	The Physical Universe (daytime)
Second Level:	PH2011	Physics 2A
	PH2012	Physics 2B
	AS2001	Astronomy & Astrophysics 2
	AS2101	Astrophysics 2 (for direct entry astronomers)

Each of these modules lasts for one semester and is assessed during and/or at the end of the semester in which it is taught. First level modules are each worth 20 credits, and the second level modules listed are each worth 30 credits (the exception here is AS2101, which has normally been taken only by accelerated-entry intending-astronomers). Normally six modules are taken at first level and four modules at second level, including modules from other Schools. Accelerated entry students have a different mix, please see later.

The selection of modules depends primarily on the degree in view and on the student's own interests and qualifications. Those with limited prior knowledge in physics and/or mathematics may find the introductory module AS1002 the Physical Universe to be appropriate. Those aiming for a degree involving this School will start with either Physics 1A and 1B or Physics 2A and 2B depending on their entry point. The Gateway modules are available only to those students on the Gateway to Physics and Engineering programme. AS1901 is available only to those on the evening degree programme. AS1002 is intended to be suitable for students from across the University, and may not be taken alongside PH1011, PH1012, or AS1001.

A separate booklet provides full details of the honours degree programmes and modules offered by the School, i.e. those which normally occupy the third, fourth and fifth levels of an honours degree. This is available from the School's Staff and Student web page. Students wishing to take an honours degree involving this School will normally be expected to have good passes in Physics 2A, Physics 2B, and Maths MT2001.

AIMS OF OUR TEACHING PROGRAMMES

- To provide a systematic functional knowledge and understanding of core physical concepts, principles and theories, and some of their applications.
- To provide specialist functional knowledge and understanding relevant to the particular degree programme, for example in astrophysics, theoretical physics, or photonics.
- To provide access to physics at the frontiers, capitalising on the strengths of the research undertaken in the School.
- To develop proficiency in the analysis of complex physical problems and the use of mathematical and other appropriate techniques to solve them.
- To develop the ability of students to organise their knowledge in a way that they can articulate the big ideas from the various modules, and can see the inter-relationship of material from different modules. Students should develop the ability to filter their knowledge in such a way that they can access the information that they need to apply to a particular problem or learning situation.
- To provide the ability to plan, execute under supervision, analyse and report upon the results of an experiment or investigation.
- To provide experience and expertise in experimental investigations for all students at the earlier stages of the programme. At least for students on the *Physics* and *Physics with Photonics* degree programmes to develop these skills further in the honours years. At least for students on the *Astrophysics* degree programmes to develop competence in observational and computational techniques in astronomy. At least for *Physics* and *Physics with Photonics* students to develop skills in the use of computers for control, data acquisition, and data analysis in experimental investigations.
- To develop the professional skills of teamwork, independent learning, information retrieval, critical analysis, and the communication of scientific concepts in writing and orally.
- To develop the ability to be a self-directed learner, including fostering a healthy intellectual curiosity in this and other disciplines, and the ability to determine one's own learning needs and to organise one's own learning.
- To enthuse students about the discipline and its applications, and to develop their confidence in their work using the discipline.
- To provide students in the School with an educational and social environment which encourages them to become informed, responsible, and respected members of society.
- To provide opportunities and support for all students to reach their full potential during their studies.

ENTRY POINTS AND REQUIREMENTS

Students who are aiming for a degree in physics or astrophysics (including joint degrees with mathematics) may consider whether they wish to take the conventional entry route starting with level one physics (and other) modules, or whether they wish to take an accelerated entry route. The former allows a broader education, but the latter allows students to complete their honours degree one year earlier.

Accelerated Entry to Physics and Astronomy Degree Programmes

The accelerated route gives direct entry to level two physics modules. Qualifying students are given 120 "advanced standing credits" on the basis of their school performance, and can then obtain an honours BSc degree in three years or an honours MPhys or MSci degree in four years (note that the University may withdraw these advanced standing credits if the student changes to a programme where they are no longer appropriate).

The qualifications required for direct entry to second level are currently one of

- AAB in Advanced Higher or A-levels including Mathematics and Physics, with A in both Mathematics and Physics, or
- AA in Advanced Higher in Mathematics and Physics, and AA in Highers in two other subjects, or
- qualifications equivalent to the above.

We strongly recommend that those with A-levels taking direct entry to second level should have included at least one mechanics module in their mathematics A-level. For those who take direct entry to second level, the following combinations of modules taken in the entry year can lead into the third level of the degree programme at the end of that year:

	1st Semester	*2nd Semester*
	PH2011 Physics 2A MT1002 Mathematics + another 20-credit first level module	PH2012 Physics 2B MT2001 Mathematics
or		
	PH2011 Physics 2A MT2001 Mathematics	PH2012 Physics 2B MT2003 Applied Mathematics

We normally recommend that accelerated entry students should take the first of these combinations, partly because it involves a more gradual progression through the necessary mathematics, and also because it allows the possibility of including the first level module Astronomy and Astrophysics 1. (This module is essential for students intending to take a degree in Astrophysics. Such students take AS2101 in level three - a different option *may* be available in 2011.) However the second combination may be preferred by those

intending to take the BSc degree in Mathematics and Physics or the MPhys degree in Mathematics and Theoretical Physics.[1]

The degree programmes involving our School which allow the possibility of direct entry to second level (accelerated entry) are:-
(a) all single honours BSc and MPhys degrees,
(b) the joint honours BSc in Mathematics and Physics,
(c) the joint honours MPhys in Mathematics and Theoretical Physics,
(d) in truly exceptional cases, the MSci degree in Physics and Chemistry.

Although direct entry to second level may be offered to suitable applicants as part of the admission process, no final decision is required until incoming students have consulted their Adviser of Studies.

Entry to Gateway to Physics and Engineering Programme

This programme and its dedicated modules are available only to those who have been offered entry to this programme.

Summary of Entry Requirements for Pre-Honours AS/PH Modules

We welcome on to our pre-honours modules those intending to do a degree involving the School and those who are aiming for a degree in a different discipline.

PH1011 Physics 1A and AS1001 Astrophysics 1 assume that students have a familiarity and competence in physics and mathematics (including calculus) equivalent to at least B-grade attainment in Scottish Highers in these subjects. PH1012 Physics 1B builds on the material of Physics 1A, and so Physics 1A is a pre-requisite for Physics 1B.

AS1002 The Physical Universe is available to all students in the University apart from those taking a degree involving physics or astronomy, and has no specific pre-requisites.

PH2011 Physics 2A builds on level one physics and maths material, though is also accessible for those joining us on the accelerated entry route having obtained the equivalent of A-grades in the Scottish Advanced Highers in physics and maths. PH2012 Physics 2B builds on the material of Physics 2A. AS2001 Astrophysics 2 requires the knowledge and skills developed in Astrophysics 1 or in the Gateway Programme.

We welcome students with other relevant qualifications on to these modules. Those from outside the UK may wish to look at past Scottish Higher Exam Papers to see level:-
www.sqa.org.uk/pastpapers/papers/papers/2010/H_Physics_all_2010.pdf for physics
www.sqa.org.uk/pastpapers/papers/papers/2010/H_Mathematics_all_2010.pdf for maths.

[1] For these students, a third possibility is to take the first combination of modules shown above in the first year of study, and to include MT2002 Algebra and Analysis in the programme for their second year of study.

Summary of Pathways for Degree Programmes Within the School

Traditional Entry Route

Level One Sem 1		Level One Sem 2
Physics 1A (20 credits)		Physics 1B (20 credits)
Maths MT1001 or MT1002 (20 credits)		Maths MT1002 or Choice (20 credits)
Astronomy 1 or Choice (20 credits)		Choice (20 credits)

Level Two Sem 1		Level Two Sem 2
Physics 2A (30 credits)		Physics 2B (30 credits)
Astro 2, Choice, or Maths MT2001, (30 credits)		Maths MT2001 or Choice (30 credits)

Accelerated Entry Route

Acc Entry Sem 1		Acc Entry Sem 2
Physics 2A (30 credits)		Physics 2B (30 credits)
Maths MT1002 (20 credits)		Maths MT2001 (30 credits)
Astro 1 or level 1 Choice (20 credits)		

Junior Honours Builds on Physics, Maths, and where appropriate Astronomy modules from second year. Honours BSc programmes need grade 11 in level two Physics modules and Maths MT2001 (and Astronomy as appropriate), MPhys programmes need grade 15. Full details in handbooks.

All, Semester One		Physics Sem 2	Theoretical Ph Sem 2	Astronomy Sem 2
Maths for Physicists		Electromagnetism	Electromagnetism	Electromagnetism
Quantum Mechanics 1		Quantum Mechanics 2	Quantum Mechanics 2	Quantum Mechanics2
Trans skills 1st section		Trans skills 2nd section	Trans skills 2nd section	Trans skills 2ndsection
Vector Calculus		Physics lab 1	Lag & Ham Mechanics	Computational Astro
Thermal & Stat Physics		Solid State Physics	Solid State Physics	Galaxies
Astro 2101 or Choice				Choice

Senior Honours Builds on knowledge and skills developed in JH and before. Full module choices for different programmes are given in the Honours Handbook. Honours BSc students have project this year, then should graduate. MPhys students have one further year of study.

MPhys Year Major project and advanced lecture-based modules. These modules assume knowledge of the core physics and maths covered earlier, and many will have specific pre-requisites in terms of JH and SH modules that may not be taken by all students – please plan ahead.

NB: This is just an overview. Full details are in the relevant School Handbooks and the University's Course Catalogue, including for joint degrees. There are different routes available.

LEVEL-ONE MODULES

1

Co-ordinators:

		Room	Tel	e-mail
Physics (PH1011, PH1012)	Dr Tom Brown Dr Cameron Rae (labs)	216 132c	3129 7314	ctab cfr
Gateway to Physics and Engineering (PH1501-3)	Dr Lucy Hadfield	304	3144	ljh11
Astronomy 1 (AS1001)	Dr Jane Greaves	306	1681	jsg5
The Physical Universe (AS1002)	Dr Jane Greaves	306	1681	jsg5
The Physical Universe (AS1901, evening degree) (Not running 2011-12)				

The Co-ordinator is responsible for the enrolment of students, the keeping of records, and the tutorial and workshop programme.

Level One Physics

The two level-one modules in core physics PH1011 and PH1012 provide a balanced introduction to university physics, assuming a prior knowledge and understanding of mathematics and physics at Higher grade BB (or equivalent) in these subjects. They are not a first course in physics, whereas AS1002 can be so. The modules include appropriate coverage of the traditional disciplines of classical physics, but also exposure to the ideas of modern physics including quantum concepts, and to applications including laser physics and optical communications. The labs give experience in experimental investigations and techniques. It is intended that the two modules should be similar in standard to that of the Advanced Higher in Physics although the syllabi will not match in detail. In particular, students may find a much greater emphasis here on how mathematical and physical relations are determined.

Physics 1A PH1011 (20 Credits)

This module covers the core subjects of mechanics, waves and optics, and the properties of matter. It includes lectures on Newton's laws, gravitation, simple harmonic motion, the different types of wave motion, geometrical and wave optics, the nature and composition of nuclei, atoms, molecules, solids, and gases.

Physics 1B PH1012 (20 credits)

This module covers the mechanics of motion, quantum phenomena, and an introduction to lasers. The module is suitable for those who have already taken Physics 1A. It includes lectures on the origins of quantum theory, and its application to atoms and other small scale systems, dynamics and conservation laws; the principles of lasers, and some aspects of optical communication. The module also includes a set of group based activities associated with the use of physics ideas to solve an interesting problem.

Students who take Physics 1A and/or Physics 1B should acquire

- an understanding of the topics covered in the module,
- an ability to solve problems based on the lecture material,
- an increased interest in exploring and understanding the physical world
- a competence in using some of the standard equipment in physics laboratories,
- an appreciation of uncertainty analysis in experimental work.
- an ability to model a real-world problem using physical concepts.
- experience of working in small groups to solve technical problems

Gateway Maths for Physicists PH1501 (20 credits)

This module provides the necessary semester-one mathematics for students following the Gateway to Physics and Engineering entry route. The module mirrors the content of that presented in the level one course MT1001 and is intended to highlight the application of mathematics within Physics and Engineering contexts. It is designed to give students a solid mathematical background and to introduce them to a range of mathematical techniques required for physics and engineering degrees. It is a core module in the Gateway to Physics and Engineering first year and is taken in conjunction with the semester two module MT1002. The following topics will be covered: basic algebra (inequalities, functions, coordinate systems, algebraic manipulation), geometric sequences and series, techniques of differentiation and integration. This module will also include a small computing component. Students who have a grade B at Advanced Higher Mathematics (including units 1 and 2) or B at A-level Mathematics may bypass PH1501 and take MT1002 in the first semester and MT1003 in the second semester.

Gateway Physics Skills 1A PH1502 (20 credits)

The first of the two Level 1 Gateway to Physics and Engineering modules provides a basic grounding in studying physics at university. The aim is to consolidate basic scientific/numerical skills and equip students with the study skills needed to develop a firm foundation for future learning. The course will also address problem solving in physics with the aim being to develop confident and competent physicists. To this end, emphasis is placed on the understanding of fundamental scientific concepts and the encouragement of independent study. Gateway Physics Skills 1A serves as preparation for Gateway Physics Skills 1B.

Gateway Physics Skills 1B PH1503 (20 credits)

Building upon the skills developed in semester one, the second skills module continues to expand and develop problem solving and communication skills that are essential for progression to more complex challenges. To complement other first year physics lectures, this module also introduces the physics of change and covers mathematical modeling of physical systems. The module also contain an astronomy component sufficient to satisfy the needs of those students wishing to take level two astronomy.

The Gateway Physics Skills 1A and 1B modules will be delivered via a combination of taught material, workshop style tutorials, practical activities and self-study assignment. Students who successfully complete the modules, should

- be able to manage their own learning and understand the requirements of academic integrity
- accept responsibility for developing their potential as a higher education student and critically reflect and evaluate personal progress
- develop a portfolio to highlight the adoption and integration of good study habits
- approach problem solving in a structured way and become confident in applying knowledge to familiar and unfamiliar problems
- foster an appreciation of the interplay between different areas of physics and independently pursue topics that are of particular interest
- be developing skills in learning from and critically evaluating textual material
- be developing skills in science communication including presenting work using written and oral media
- understand how to create a mathematical model to describe a physical situation

Astronomy & Astrophysics 1 - AS1001 (20 credits)

The aim of this module is to provide an elementary understanding of the structure of the observable universe and our position within it. The physical content of the universe, its structures and their mutual interactions, are explored. It is shown how the properties of planets, stars, galaxies, etc may be determined from observations coupled with theoretical models based on physical principles. The module comprises four 11-lecture courses on The Solar System, Stars and Elementary Astrophysics, The Milky Way Galaxy, and Cosmology, thereby providing a complete overview of the subject at this level.

By the end of this module, students will have gained

- an understanding of the structure and evolution of the physical universe from the solar system, through the galaxy, to the large-scale distribution of galaxies and the origin of the universe,

- an ability to calculate astrophysical properties of planets, stars and galaxies from basic physical and mathematical models and simplified data.

The Physical Universe AS1002 and AS1901 (20 credits)

These modules present a descriptive, non-mathematical account of the physical universe, and are designed for those who do not intend to follow a degree programme within the School of Physics and Astronomy. The modules have no prerequisites and are divided into two components: concepts in astronomy, dealing with our understanding of the properties and ages of planets, stars and galaxies, their distributions in space, cosmology and the origin of the universe; and concepts in physics, dealing with our understanding of matter, the nature of light, the structure of atoms and of atomic nuclei, fundamental particles and their link to cosmology, and the applications of physics in everyday life.

The learning objectives of these modules are

- an understanding of the structure of the physical universe on all scales from the sub-atomic level of matter to the large-scale distribution of galaxies,
- an appreciation of physical and astronomical phenomena in everyday life, and the value of that understanding in promoting rational interpretations of such phenomena.

In alternate years, this module is also available in the evening (as AS1901) to part-time students enrolled for the General MA degree programme.

Detailed syllabi for all first level modules are given in Appendix B.

Entry Requirements

The general entry requirements for students entering the university are described in the Undergraduate Prospectus. The following are the specific requirements for each of the first level modules in Physics and Astronomy.

Physics 1A, Physics 1B, Astronomy & Astrophysics 1
Passes are normally required in SQA Higher-grade Physics and Mathematics (minimum grades BB) or GCE A-level Physics and Mathematics (minimum grades BB), or an equivalent set of qualifications. Physics 1A is a pre-requisite for Physics 1B.

Gateway Modules
Only those students who are registered on the Gateway to Physics and Engineering programme may take these modules.

The Physical Universe
There are no specific entry requirements for these modules. However the modules cannot be taken in conjunction with any of the other modules mentioned here, i.e. Physics 1A, Physics 1B and Astronomy and Astrophysics 1.

Recommended Books for Level-One Physics and Astronomy

All students may wish to read *Learn How to Study* (3rd edition), a programmed text by D Rowntree (Macdonald 1998) which provides training in study techniques.

Physics

The core text is Halliday, Resnick, and Walker, Principles of Physics, Extended 9th edition. We request that this book should be purchased by all students on these modules. We strongly recommend making this purchase at Blackwells bookshop in St Andrews, as doing so will give students for no additional charge access to the e-learning resources associated with this text. The ISBN number for the book with the "Wiley Plus" online resource is 9780470576083. This resource contains much useful stuff provided by the publisher, and will contain material tailored by us for use at St Andrews. It is available only from Blackwell's bookshop in St Andrews, and costs £49.99. Given the large amount of online resource that comes with this purchase, this seems to us to be good value compared with buying the book elsewhere without the associated electronic resources.

Alternative texts are:-

- *Physics for Scientists and Engineers: A Strategic Approach with Modern Physics* by R D Knight, Pearson, 2007,
- *Understanding Physics,* 1st Edition by K Cummings, PW Laws, E F Redish, P J Cooney, Wiley, 2004, (New edition due out mid/late 2011)
- *Sears and Zemansky's University Physics* by H D Young and R A Freedman (12^{th} edition, Addison-Wesley 2008 or other edition), and
- *Physics for Scientists and Engineers* by P A Tipler and G P Mosca (6th edition, Freeman 2008).

Additional reading for the lasers course is *Understanding Lasers* by J Hecht, (3^{rd} Edition, IEEE Press 2008), though we do not recommend purchase; there are multiple copies in the library.

Astronomy & Astrophysics 1

The main recommended book for this module is *Astronomy – a Physical Perspective* by M L Kutner (CUP 2003), which is sufficient also for the second level module on Astronomy & Astrophysics. This text can be accessed as an ebook via www.netlibrary.com. An Athens account is required for off-site access.

The Physical Universe

The recommended books are *Astronomy, a Beginner's Guide to the Universe* by E Chaisson and S McMillan (5th edition, Prentice Hall, 2006) covering concepts in astronomy, and *Conceptual Physics* by P Hewitt (10th edition, Addison-Wesley 2005) providing a background to concepts in physics.

Access to ebooks
Some books are available as ebooks to registered students. The links to booklists for AS and PH modules on the School's staff and students page will show you what is available, and will provide links as appropriate.

Tutorials and Workshops

For the modules Physics 1A and Physics 1B each student will attend one tutorial and one workshop (problem-solving class) per week. The tutorials will involve discussions on lecture material and the solution of conceptual and numerical problems based on the course. Students are expected to have attempted all designated tutorial problems in advance of the tutorial and are required to bring their written solutions to the tutorial. They are also required, prior to the tutorial, to hand in a self-reporting form and answers to selected problems for marking.

Students will also take three maths revision classes at the start of the PH1011 class. The purpose of these classes is to re-acquaint students with the mathematics that will be required to undertake this module. Students carry out mathematical exercises (with demonstrator support) on topics which cover part of the syllabus of Higher and A-level Mathematics, and some of this work is handed in for assessment.

In the workshops, students attempt problems on current lecture topics with demonstrator assistance. At the end of each workshop students independently attempt a test question which is marked and returned with feedback.

The Gateway modules involve significant amounts of tutorial and workshop time with input from academic staff. Room 230 will be used for this purpose.

For the other first level modules, there will be one tutorial per week involving small-group discussions on current lecture courses. In addition, the lecturers are always happy to discuss with individual students any issues arising out of course material.

Practical Work

Physics

The aims of first level practical work in physics are

- to allow an exploration of relevant physics,
- to illustrate the subject matter covered in the lectures,
- to introduce students to some of the modern equipment that is used in physics laboratories,
- to teach the principles of experimental techniques and methods of analysis underlying experimental procedures.

For the Physics 1A and 1B modules there will be one afternoon period of 2½ hours per week of practical work. We expect that most of your practical work should be completed within these normal laboratory hours, with just a little more time 'at home'; prior to the start of a practical to familiarise yourself with the upcoming work and attempt the pre-lab questions, between lab session for producing graphs or completing other data analysis and at the end to finalise your analysis and write a short conclusion. In Physics 1A, the first three weeks of practical sessions take the form of mathematics revision workshops, assessed by a short test at the end of each, and some specific lab skills development. A detailed description of the arrangements for practical work is available separately

Astronomy & Astrophysics 1

The aims of practical work are to encourage, through carrying out simple exercises, an appreciation of the physical properties of objects in the universe, e.g. planetary motions, the masses and temperature of stars, distances to stars and galaxies, and the age of the universe. Students learn also by computer simulation the location and movement of the Earth in space. In addition, students may wish to get access to some of the telescopes at the University Observatory through the student society Astrosoc.

Laboratory sessions in practical astronomy are held for 2½ hours per week during afternoons. Students work individually or in small groups at their own pace on four experiments selected from a range which covers planetary motions, radiation laws, properties of the Sun and of the stars, the distribution of stars and galaxies in space, and the expansion of the Universe

Monitoring and Assessment

The progress of students taking each module will be monitored in different ways. For Physics 1A and Physics 1B, the weekly workshops and tutorials entail some written work, some of which is handed in for marking, as well as a class test in the middle of the semester. Correspondingly, those taking Astronomy and Astrophysics 1 will be given a brief test, on two occasions during the semester, intended to focus attention on material covered in recent lectures. The performance of those taking The Physical Universe will also be monitored and assessed through tests. The Gateway skills modules are entirely continuously assessed.

For most lecture courses, students will be issued with one question taken from a recent examination paper, and asked to hand in a written answer by a specified later date.

The examinations consist of one written paper of two hours at the end of the semester. Resit examinations for those who are eligible (roughly, those who get a module grade between 4.0 and 6.9 and have not been given a Grade 10 Academic Alert) are held late in the summer.

A student who achieves grade 7.0 or better in both the practical component and in the examination component will be awarded an overall grade for the module according to the formulae:

PH1011	60% examination, 15% class test, 25% labs (Reassessment the same)
PH1012	50% exam, 25% labs, 15% Group Discovery Project, 10% class test, (Re-assessment the same)
PH1501	50% examination, 50% continuous assessment (Reassessment 100% examination)
PH1502	100% continuous assessment, no resit examination. Made up of scientific reporting (35%), exercises & progress tests (25%), astronomy short course (20%), study skills short course (20%)
PH1503	100% continuous assessment, no resit examination. Made up of scientific reporting (30%), practical experiments & computing (25%), Exercises & tests (25%) and the astronomy short course (20%).
AS1001	60% examination, 15% tests, 25% practical (Re-assessment 75% examination, 25% practical)
AS1002	50% examination, 50% tests (Re-assessment 100% examination)
AS1901	50% essays, 50% class tests (Re-assessment 100% examination)

In modules that have examination and practical components, a student who achieves grade 7.0 or better in the practical component but grade 6.9 or less in the examination component will be awarded an overall grade for the module which is determined by the formulae above but subject to a maximum grade 6.9.

Medals and Prizes

In each module a medal is awarded to the student with the best performance overall in the assessment. In addition, the J F Allen Prize in Physics is awarded to the most outstanding student in PH1011 and PH1012 taken together. The Margaret Stewart Prize is awarded to the student in the module AS1001who gains the highest grade.

Academic Alerts

Academic Alerts are a way of helping students who are having trouble coping with their studies; such as missing deadlines for handing in work, or missing compulsory tutorials. The aim of the Alert system is to help students by flagging up problems before they seriously affect students' grades. Academic Alerts will be issued by email from one of the Director of Teaching, Module Co-ordinator or School administrator and will tell

students what is wrong and what they are required to do (eg attend classes in future). The Alerts will also tell students what support the University can offer. If students do not take the action required they will get another Alert, and eventually will automatically get a grade of zero and will fail that module. The system is designed to help and support students in order to remedy any problems or issues before these lead to failing a module. Alerts will never appear on a student's permanent transcript. For more information on Academic Alerts and details on how the categories work, see www.st-andrews.ac.uk/staff/policy/tlac/attendance/academicalerts/.

Note that a "category ten" alert can result in a student receiving grade 0 for the module with no right to a resit examination, ie they will get a fail for the module for that year. This can have serious consequences for their study at the University.

In all pre-honours modules in physics and astronomy, attendance at all classes (lectures, tutorials, workshops, and any specified practical work) is strongly recommended and in some cases is a requirement. In level-one modules in this School, in order to avoid receiving a category ten alert, a student must:

1. Attend a minimum of 75% of the tutorials.

2. Attend a minimum of 75% of any laboratory classes associated with the module, and achieve a grade of at least 7.0 overall for such laboratory work.

3. For Physics (PH) modules, attend a minimum of 75% of the workshops, and in the case of Physics 1B, 75% of the scheduled group-project sessions.

4. For Astronomy AS1001, achieve a grade of at least 4.0 in the combined score for the tests.

5. For Physics 1A and 1B, achieve a grade of at least 4.0 for the class tests.

6. For the Gateway Physics Skills modules to achieve at least grade 7.0 in each of the four continuous assessment components.

7. In module AS1002 (daytime Physical Universe) achieve at least grade 4.0 in the combined score for the class tests.

8. In module AS1901 (evening degree Physical Universe) complete and submit a minimum of 75% of the continuously assessed components of the module.

9. In module AS1901, achieve a grade of at least 4.0 in the combined score for the class tests.

10. For all modules, achieve a grade of at least 4.0 in the final examination. (This includes the case of students who fail to attend the examination without a satisfactory reason.)

Any justifiable reasons for absence from tutorials, workshops, labs, tests and exams should be presented by a self-certificate of absence. In such cases students should also contact the member of staff concerned in order to arrange how and when the missed work should be undertaken. Late justifications of missing work will be accepted only in exceptional circumstances.

Progression

Those on the traditional degree programmes are normally expected to gain at least grade 7 in all level one modules for progression to level two.

In order to progress to level two in St Andrews those on the Gateway to Physics and Engineering Programme will normally need to gain at least grade 7 in all their level-one modules and gain a mean grade of at least 11 across these modules. In order to progress to physics or engineering in level-two at Heriot-Watt University they will normally need to gain at least grade 7 in all their modules.

Level-One Module Combinations

Entering at level one, six modules are usually taken. This allows a wide range of combinations of modules that are consistent with a particular honours degree. A student may therefore branch out into subjects unrelated to their honours degree, out of interest.

Students wishing to take an honours degree in the School of Physics and Astronomy and starting at first level on the traditional route must take the modules

PH1011	Physics 1A
PH1012	Physics 1B
MT1001	Introductory Mathematics[2]
MT1002	Mathematics

For the degree in Astrophysics however, an additional requirement is to attend the module AS1001 Astronomy & Astrophysics 1. Also, those interested in taking a joint honours degree must attend the module(s) associated with the other subject involved.

The other modules making up the total of six may be selected according to personal interests. The choice is made at the start of the session after the student has met their Adviser of Studies and discussed all the options. Relevant factors to be considered at that time are the timetable and particular interests in second level subjects.

Students who enter the Gateway to Physics and Engineering programme normally take in their year of entry PH1011, PH1501, PH1502, PH1012, MT1002, and PH1503.

[2] The requirement to attend Introductory Mathematics is relaxed for students with a pass at grade B or better in Advanced Higher Mathematics or GCE A-level Mathematics or with an equivalent qualification.

LEVEL-TWO MODULES

2

Co-ordinators:

		Room	Tel	e-mail
Physics (PH2011, PH2012)	Dr Antje Kohnle Dr Cameron Rae (laboratory)	314 132c	3195 7314	ak81 cfr
Astronomy 2 (AS2001, AS2101)	Dr Hongsheng Zhao	316a	3135	hz4

The duties of the co-ordinator are to enrol students at the start of the academic session and to organise tutorials, workshops and assessment. The organisation and planning of the physics teaching laboratory is the responsibility of Dr Rae.

Second Level Physics

The two modules in physics at second level are intended to be equally suitable for two categories of students: (a) those who have entered the university at first level and who have taken appropriate first level modules in physics and mathematics, and (b) those who have taken direct entry from school into second level on the basis of good Advanced Higher or A-Level passes including physics and mathematics. Full details are provided in the sections following. Physical topics are covered in greater depth than in the first level modules, but a high priority is given to continuity of treatment between topics at school and university levels.

Physics 2A and Physics 2B are given in the first and second semester respectively. Both are taken by students aiming for any of the degrees taught within the School. Students taking them should acquire

- an understanding of the basic concepts in classical mechanics and Newtonian gravity including kinematics and dynamics of a single particle and rigid bodies, and the ability to use these concepts to analyse modern mechanical systems such as bungee jumping and describe their behaviour.
- an understanding of simple harmonic motion, damped, forced and coupled oscillations, including examples of coupled oscillatory and rotational modes and resonance catastrophes.
- an understanding of classical mechanical waves including interference, energy transport and the behaviour at boundaries, electromagnetic waves and wave optics.
- an understanding of the fundamental laws of thermodynamics and the ability to apply them to simple thermodynamic systems, including heat engines and the Carnot cycle and to consider environmental issues using thermodynamical reasoning.

- an understanding of the distinction between reversible and irreversible processes and their relation to entropy.
- a knowledge of the historical developments that led to the special theory of relativity, and the dramatic consequences of Einstein's postulates.
- a conceptual and mathematical understanding of kinematics and dynamics in relativistic mechanics and their application to elementary particles.
- a knowledge of the historical development and philosophical implications of quantum physics and an intuitive understanding of basic concepts in quantum physics.
- an ability to apply the Schroedinger equation to some one-dimensional situations and to discuss the solutions and their implications and compare their behaviour with the corresponding classical systems.
- an understanding of concepts in electrostatics, magnetostatics, basic DC circuit theory and induction and the ability to apply them to a range of charge and current distributions.
- a knowledge of how concepts in electricity and magnetism can lead to applications in particle accelerators, fusion tokamaks, atom traps, optical tweezers, modern electronics, and electrical engineering.
- laboratory skills, including the planning of experimental investigations, the use of modern test equipment, and the construction of electronic circuits.
- the ability to reason through scientific concepts, to relate different concepts to one another and to solve qualitative and quantitative problems in the areas covered in the courses with a toolkit of problem-solving techniques.

Physics 2A PH2011 (30 credits)

This module covers (i) *mechanics* – revision of Newton's laws, force, energy, work and power, central forces, conservative forces, conservation laws, gravitational theory, rigid body dynamics, statics, and fluids in motion; (ii) *oscillations in physics* - simple harmonic motion, damped and forced and coupled harmonic oscillations; (iii) *thermal physics* – including elementary thermodynamics and the notion of entropy, (iv) *the special theory of relativity* – Einstein's theory which unifies mechanics and electromagnetism and fundamentally modifies our notions of space and time, and (v) *laboratory work.*

Physics 2B PH2012 (30 credits)

This module comprises lectures on (i) *quantum physics* – the Schrodinger wave equation, and the solution of the energy eigenvalue equation for simple potentials in one dimension; (ii) *electricity and magnetism* – an elementary introduction to the electromagnetic field comprising electrostatics, magnetostatics, electromagnetic induction and DC circuit theory; (iii) *waves in physics* –waves on strings, energy flow, interference and beats, sound waves, Doppler effect, phase and group velocities, wave properties of light, including polarisation, interference and diffraction, and (v) *laboratory work.*

Astronomy & Astrophysics 2 AS2001 (30 credits)

This module is designed to complement and extend the knowledge gained in the first level module in Astronomy and Astrophysics, and to prepare the way for the more advanced topics encountered in a study of the subject at honours level. All lectures are based on the principles of physics together with mathematical techniques acquired earlier. It is intended that students should gain

- a strengthening of the skills learned in AS1001 and level 1 physics and mathematics modules,
- a deeper understanding of the structure and evolution of stars, the design of telescopes and instruments for astronomical observations over the entire electromagnetic spectrum, the dynamical interactions of stars in the Galaxy, and nucleosynthesis and the chemical evolution of the universe,
- a greater ability to analyse astronomical data, including the use of spreadsheet packages on computers.

Astrophysics 2 AS2101 (15 credits)

This is as AS2001, but without the observational techniques lectures and the labs. This is normally taken only by accelerated entry students who are aiming for an astronomy degree.

Entry Requirements

For entry to either of the second-level modules in Physics, it is normally necessary to have one of the following sets of qualifications:

(a) Traditional first level route. Passes in the first level modules

PH1011	Physics 1A
PH1012	Physics 1B
MT1001	Introductory Mathematics[3]
MT1002	Mathematics

(b) Gateway to Physics and Engineering Route. Students need to get at least grade 7 in all level one modules and a mean grade of at least 11.0 over these modules.

(c) School qualifications. Passes in Advanced Higher or A-Level Physics and Mathematics, both normally at grade A.

Note: these grade requirements are naturally consistent with those required for accelerated (direct) entry to second level – as discussed earlier. However, they may also be satisfied by a student who is not entering directly into second level, but wishes to take one or both of the level two physics modules in the first year of study. This possibility may be of

[3] Unless bypassed

particular interest to students taking certain joint-honours degrees for which the possibility of direct entry to second level does not arise.

For entry to the second level module in Astronomy & Astrophysics, an additional requirement is normally to have attended and passed the assessment in the first-level module AS1001 Astronomy & Astrophysics 1.

Recommended Books

Physics

The core text for Physics 2A, and 2B is Halliday, Resnick, and Walker, Principles of Physics, Extended 9th edition. We request that this book should be purchased by all students on these modules. We strongly recommend making this purchase at Blackwells bookshop in St Andrews, as doing so will give students for no additional charge access to the e-learning resources associated with this text. The ISBN number for the book with the "Wiley Plus" online resource is 9780470576083. This resource contains much useful stuff provided by the publisher, and will contain material tailored by us for use here. It is available only from Blackwell's bookshop in St Andrews, and is priced at £49.99. Given the large amount of online resource that comes with this purchase, this seems to us to be good value compared with buying the book elsewhere without the associated electronic resources. There are additional books that are recommended for consultation on all these modules, and details of these can be accessed via the School's Staff and Students web page.

Alternative texts are:-

- *Physics for Scientists and Engineers: A Strategic Approach with Modern Physics* by R D Knight, Pearson, 2007,
- *Understanding Physics*, 1st Edition by K Cummings, PW Laws, E F Redish, P J Cooney, Wiley, 2004, (New edition due out mid/late 2011)
- *Sears and Zemansky's University Physics* by H D Young and R A Freedman (12th edition, Addison-Wesley 2008 or other edition), and
- *Physics for Scientists and Engineers* by P A Tipler and G P Mosca (6th edition, Freeman 2008).

These all provide wide coverage of the lecture courses, examples of how physics is applied in realistic situations, and many problems together with hints for solving them.

However, neither these nor Halliday, Resnick and Walker go as deep into the topics as do some of the courses within our modules. We recommend the following additional books, but do not expect students to purchase them. There are multiple copies in the library.

Physics 2A

Mechanics - *Analytical Mechanics*, Grant R Fowles and George Cassiday (Brooks/Cole, 7th edition, 2004).

Oscillations and Special Relativity- *Classical Mechanics,* John R Taylor (University Science Books 2005).
Special Relativity - *Nonclassical Physics;. Beyond Newton's View,* Randy Harris (Addison Wesley Longman, CA, 1999); *Relativity Visualised*, Lewis Carroll Epstein (Insight Press, CA, 1985)
Thermal Physics - *An introduction to Thermal Physics,* D V Schroeder (Pearson, 2004)

Physics 2B
Quantum Mechanics - *Quantum Mechanics,* A. I. M. Rae (fifth edition, 2007, Chapman and Hall) - also available as an e-book.

Astronomy and Astrophysics 2
The recommended book for Astronomy & Astrophysics 2 is *Astronomy – A Physical Perspective* byM L Kutner (CUP 2003). This text can be accessed as an ebook.
An alternative text is *Introductory Astronomy and Astrophysics* (4th edition) by M Zeilik and S A Gregory (Saunders College 1998).

Access to ebooks
Some books are available as ebooks to registered students. The links to booklists for AS and PH modules on the School's staff and students web page will show you what is available, and will provide links as appropriate.

Tutorials and Workshops

Tutorials form a valuable part of the learning process, help to develop communications skills and provide a forum in which to explore the "But what if ...?" questions. Groups of about four students meet weekly, normally with a member of staff. These tutorials will provide an opportunity to discuss queries which arise on topics covered in the lectures. Students are expected to have attempted all designated tutorial problems in advance of the tutorial, and are required to bring their written solutions to the tutorial. They are also required, prior to the tutorial, to hand in a self-reporting form and answers to selected problems for marking. In addition, all students taking Physics 2A or Physics 2B will attend one workshop (problem solving class) each week, usually directly preceding their afternoon laboratory session.

Practical Work

The aims of the second level practical work in physics are to build on previously acquired experimental skills while at the same time provide the opportunity for students to:

- work toward desired experimental outcomes but with greater freedom to explore the relevant topic,
- broaden competences in the use of various forms of experimental and diagnostic instrumentation,
- explore subject matter both covered in lectures and, particularly in electronics, extended beyond,
- develop skills in scientific writing.

For the Physics 2A and 2B modules there will be one afternoon period of 2½ hours per week of practical work (groups will be arranged for Tuesday, Thursday and Friday at the start of the semester). We expect that most of the practical work should be completed within these normal laboratory hours, with just a little more time 'at home'; prior to the start of a practical to familiarise yourself with the upcoming work and attempt the set pre-lab questions, between lab afternoons for producing graphs or completing other data analysis, and at the end to finalise your analysis and write a short conclusion. At the start of 1st Semester (Physics 2A), the programme is slightly different for returning students and direct entry students, as direct entry students quickly cover some of the lab work that has already been explored by our returning student, to gain a similar skill set and understanding of our expectations. In 2nd Semester (Physics 2B) all students will attempt the same programme of work, including a visit to our research laboratories and the opportunity to see how the skills being developed in the teaching laboratory are relevant to the experimental physics practitioner

Astronomy & Astrophysics laboratory sessions are held from 3.00 - 5.30 pm on Tuesdays or Thursdays. There are additional evening meetings at the Observatory so that students may gain experience of observational work. The aims of practical work in Astronomy & Astrophysics 2 are:

- to give confidence in working with and interpreting astronomical data,
- to instil an appreciation of the practicalities and excitement of making observations using research-grade telescopes,
- to enhance students' awareness of the ever-changing nature of the night sky.

In all second level modules where practical assignments are to be handed in for marking according to a specified timetable, penalties will be applied for lateness up to and including the loss of all marks in particularly serious cases. For late submission of lab books, formal reports, and other continually assessed material in the physics lab there is a penalty of up to 10% of the awarded mark per day late. For astrophysics labs the penalty for late submission of lab books is two marks for the first working day overdue, and one mark per day late thereafter.

Mathematics revision

A good grasp of mathematics and its application to physics is essential for all students of physics and astrophysics. During the first few weeks of the Physics 2A module, some morning and afternoon sessions will be provided in which students will be given an

opportunity systematically to revise and practise mathematical techniques which they have learned previously. In order to demonstrate a minimum level of competence in these vital skills, students will be expected to pass a brief test covering all topics which have been covered. Those who initially fail the test (a mark of less than 70%) will be given further opportunities to pass it later in the semester. Failure to pass this test will result in a Category 10 Academic Alert.

Monitoring and Assessment

The progress of students taking each module will be monitored in different ways. For Physics 2A and Physics 2B, the weekly workshops and tutorials will entail some written work, to be handed in for marking and feedback, and there will be a class test at about half way through the semester. Correspondingly, those taking Astronomy and Astrophysics 2 will be given a brief test, on two occasions during the semester, intended to focus attention on material covered in recent lectures.

The examination for each module consists of one written paper of 3 hours at the end of the semester. Re-assessment (resit) examinations are held at the end of the summer. Please note that resits are possible only for those who gain less than grade 7.0 but more than 4.0 in the module, and who have not been given a Category 10 Academic Alert.

A student who achieves grade 7.0 or better in both the practical component and in the examination will be awarded an overall grade for the module according to the formulae:

PH2011 & PH2012	60% examination, 10% class test, 5% workshops, 25% labs (Re-assessment same as above)
AS2001	60% examination, 15% tests, 25% practical (Re-assessment 75% examination, 25% practical)
AS2101	80% exam, 20% continuous assessment (tests) (Re-assessment 100% exam)

A student who achieves grade 7.0 or better in the practical component but grade 6.9 or less in the examination will be awarded an overall grade for the module which is determined by the formulae above but subject to a maximum award of grade 6.9.

For the physics modules the 5% workshops contribution comes from the assessed workshop questions that are taken at the end of most workshop sessions.

Prizes and Medals

A medal is awarded in each module to a student who gains the highest grade. The J F Allen Prize is awarded to the most outstanding student (ie the highest module grade) in PH2011 and PH2012 taken together.

Academic Alerts

Academic Alerts are a way of helping students who are having trouble coping with their studies; such as missing deadlines for handing in work, or missing compulsory tutorials. The aim of the Alert system is to help students by flagging up problems before they seriously affect students' grades. Academic Alerts will be issued by email from one of the Director of Teaching, Module Co-ordinator or School administrator and will tell students what is wrong and what they are required to do (eg attend classes in future). The Alerts will also tell students what support the University can offer. If students do not take the action required they will get another Alert, and eventually will automatically get a grade of zero and will fail that module.

The system is designed to help and support students in order to remedy any problems or issues before these lead to failing a module. Alerts will never appear on a student's permanent transcript. For more information on Academic Alerts and details on how the categories work, see www.st-andrews.ac.uk/staff/policy/tlac/attendance/academicalerts/.

In all pre-honours modules in physics and astronomy, attendance at all classes (lectures, tutorials, workshops, and any specified practical work) is strongly recommended and in some cases is a requirement. In level two modules in this School, in order to avoid receiving a category ten alert, a student must:

1. Attend a minimum of 75% of the tutorials.

2. Attend a minimum of 75% of any laboratory classes associated with the module, and achieve a grade of at least 7.0 for such laboratory work.

3. For Physics (PH) modules, attend a minimum of 75% of the workshops

4. For Astronomy AS2001 and AS2101 modules, achieve a grade of at least 4.0 in the combined score for the tests.

5. For Physics 2A and 2B, achieve a grade of at least 4.0 for the class tests.

6. In Physics 2A, achieve a pass (70%) in the maths test by the end of the teaching part of the semester.

7. For all modules, achieve a grade of at least 4.0 in the final examination. (This includes the case of students who fail to attend the examination without a satisfactory reason.)

Any justifiable reasons for absence from tutorials, workshops, labs, tests and exams should be presented by a self-certificate of absence. In such cases students should also contact the member of staff concerned in order to arrange how and when the missed work should be undertaken. Late justifications of missing work will be accepted only in exceptional circumstances.

STUDENT WORK

All

Physics and Astronomy, in common with most other worthwhile learning, needs study, practice, reflection, and further work in order for a student to come to terms with the material and gain the ability to use it (and to pass exams). In the same way that merely buying a text book does not result in the owner being competent in using the material contained within it, merely turning up to lectures is not enough to understand and learn how to use ideas in physics and astronomy. There is a good deal of support available for learning here in terms of staff time, fellow students, online and paper-based resources, libraries and IT suites, teaching laboratories and lecture rooms, but it is up to every student to organise themselves to do what is necessary for their own learning.

We are aware that our students have all achieved great things in their previous studies. We are keen that such high achievement carries on here. Some students join us having not had to study particularly hard to pass their school exams; some of them may be at particular risk of not putting in the thought and effort needed in their university studies.

Keeping Up

Most lecture courses build concepts on top of understanding of previously described concepts. The most important thing in your study therefore may be to ensure that you keep up with the work covered. Lectures should be about listening, understanding, asking questions if necessary, and jotting down notes on what is happening. They should not deteriorate into a mere copying exercise! For that to be the case, you will need to be comfortable with the topics in one lecture before the next one occurs. At the end of each day of lectures, it is important to read over your notes, add additional comments where necessary when the ideas are still fresh in your mind, and sort out any difficulties you may have. Reading a textbook, discussing with a friend, or asking your tutor or lecturer can all help. As well as preparing you for the next lecture, this is likely to have the added benefit of aiding your memory of the topic for the end-of-module exams.

Please bear in mind that just because you have seen some topics before in previous study, you may not be as familiar with the ins and outs of the material as we would wish you to be. Here we are as much interested in where physical and mathematical relationships come from as in being able to use them. By understanding the ideas (and limitations) on which a relationship is built, we are better placed to know how and when to use it.

Practice

In a subject such as ours, learning facts is not enough (though it is still important). We aim to develop an understanding of the subject, and how it can be applied. To help in this, we encourage you to try appropriate questions and problems that relate to the course. The questions in the tutorial sheets should help you practise your physics in the same way that any other skill has to be practised to improve it. Where you find difficulties, look again at the lecture notes, text books, or discuss with friends and tutors. Bring questions and queries to tutorials for discussion - that is what tutorials are provided for! Please make

good use of your tutors. If there are not enough questions on the tutorial sheets, then there are many more relevant questions in your course textbook.

We aim to teach our students to understand physics and astronomy, not just to pass exams. However, we realise that examination results are important, and it is useful to practice past exam questions. Past exam questions and some solutions are available via the School's website – Staff and Students page – Past Papers.

Responsibility

We hope you are here because you have an interest in physics and astronomy. There are many attractions to life as a student, but a sensible balance between study and recreation has to be found. To be a decent physicist or astronomer (even for those doing only one module) you will need to think about the science and get practice in applying it to different situations. The same comments apply to other subjects too.

Do you

- like to be told exactly what to learn parrot-fashion
- read around the subject only in order to complete a particular assignment
- have more interest in getting a degree than in understanding the subject
- attend tutorials because you get marked down if you don't
- skip lectures if you've had a hard night?

or are you

- trying to understand the material presented in your courses
- questioning what you are told and read
- enjoying having your understanding of the material challenged
- following up interesting topics
- preparing for tutorials, discussing and questioning what is being covered
- regularly attending lectures, asking questions when you feel appropriate?

We hope by this stage in your education you are moving strongly towards the latter.

Time Allocation

In addition to their attendance at lectures, tutorials and (where applicable) laboratories during normal class hours, students are expected, through independent study, to work at augmenting their knowledge and understanding of the topics currently being taught in lectures. The QAA recommends that each unit of credit should correspond to 10 hours of study time in total, for the average student at that level. This corresponds to a time commitment of around 40 hours per week for students taking the normal 120 credits per year. This means, for example, that the average student in the 20-credit level-one modules in the School should be allocating 13 hours a week to each module, and in the 30-credit level two modules 20 hours a week.

Self-directed Study

As one of the aims of our teaching programme is

- *To develop the ability to be a self-directed learner, including fostering a healthy intellectual curiosity in this and other disciplines, and the ability to determine one's own learning needs and to organise one's own learning.*

students are expected and encouraged to use information in the library and online to help their studies, as well as discussing physics with other students and with staff.

The School encourages students to form groups that can meet on a regular basis to discuss the work being covered in the teaching programme. The Group Study Area in the School is one place that may be used for such meetings.

If you encounter difficulties in understanding the lecture material which cannot easily be resolved, eg by reference to text books or discussion with a classmate or your tutor, you are encouraged to approach the lecturer concerned who will be pleased to deal with queries of this type.

GENERAL INFORMATION

Absence from Classes or Examinations

If, for any reason, you are absent from a module, you should complete as soon as possible a Self Certificate for Absence. These are available electronically from the University web site. There is no need to self-certify for missing a lecture, but any illness that affects assessed work (eg tutorial submission, class test, lab work) or compulsory activities (eg tutorials and labs) must be noted. If you are absent from a small-group teaching session it is polite also to inform the tutor or demonstrator directly.

Absence from an examination should be reported *immediately* to the Examination Office [examoff@st-andrews.ac.uk, tel (01334 46)2528] and backed up by a completed Self Certificate for Absence report. It would be helpful if the School was also directly notified, please.

Special Circumstances Affecting Assessment

Unfortunately some students will suffer unavoidable circumstances that impede their academic performance. These may include illness or bereavement of a close family member. If you find yourself in this position, you should alert your year coordinator as soon as possible. You can do this directly, or through Student Services. Depending on the circumstances it may be possible for the School to defer the piece of assessment (including exams) to a later date.

Use of Calculators in Examinations

Students should note that the Senate has prohibited the use of certain calculators in examinations, ie those with programming, text, symbolic or graphical capabilities.

The 0-20 Grading Scale – Pre-Honours Physics and Astronomy

The University has adopted a common grading scale for the purpose of reporting assessment results for modules. Grades are quoted to one decimal place, and the maximum grade which can be awarded is 20.0. The minimum grade for which credits for the modules are awarded (i.e. the bare pass mark) is 7.0. Please note that a grade of 7.0 is not regarded as a "good" grade, and this grade would not permit a level two student to progress into honours, and a set of grade sevens at honours level would not result in a student being awarded an honours degree. More details are provided by the University on its website.

Each School is allowed to adopt its own procedures for determining the grades awarded to students, subject to agreement by the External Examiner. In the School of Physics and Astronomy, normal practice is to assess submitted work such as answers to examination questions initially in terms of percentage marks, and then convert these to grades by a mapping procedure.

The correspondence between percentage marks and grades, for all first and second level modules offered by the School of Physics and Astronomy, is as follows, though in principle this may be changed by the Examination Board if necessary (please note that a different mapping is in place for honours modules).

Grade 5.0 corresponds to 40%. Between 0% and 40%, the grade is the percentage mark divided by 8, meaning that grade 7.0 (bare pass) corresponds to 45%.

Grade 17.0 corresponds to 70%. Between 40% and 70% there is a linear mapping of percentage marks onto grades. For example grade 11.0 corresponds to 55% and grade 15.0 to 65%.

Grade 20.0 corresponds to 100%. Between 70% and 100% there is a linear mapping of percentage marks onto grades. For example grade 18.0 corresponds to 80%, and 19.0 to 90%.

This percentage to grade mapping for level one and two physics and astronomy is shown in a different format on the following page.

%	Grade	Comment
10	*1.3*	
15	*1.9*	
16	*2.0*	
17	*2.1*	
18	*2.3*	
19	*2.4*	
20	*2.5*	
21	*2.6*	
22	*2.8*	
23	*2.9*	
24	*3.0*	
25	*3.1*	
26	*3.3*	
27	*3.4*	
28	*3.5*	
29	*3.6*	
30	*3.8*	
31	*3.9*	
32	*4.0*	Minimum for resit
33	*4.1*	
34	*4.3*	
35	*4.4*	
36	*4.5*	
37	*4.6*	
38	*4.8*	
39	*4.9*	
40	*5.0*	
41	*5.4*	
42	*5.8*	
43	*6.2*	
44	*6.6*	
45	**7.0**	Minimum for credit
46	7.4	
47	7.8	
48	8.2	
49	8.6	
50	9.0	
51	9.4	
52	9.8	
53	10.2	
54	10.6	
55	**11.0**	Level 2 grades needed for BSc Honours entry
56	11.4	
57	11.8	
58	12.2	
59	12.6	
60	13.0	
61	13.4	
62	13.8	
63	14.2	
64	14.6	
65	**15.0**	Level 2 grades needed for MPhys Honours entry
66	15.4	
67	15.8	
68	16.2	
69	**16.6**	Qualify for Deans' List
70	17.0	
71	17.1	
72	17.2	
73	17.3	
74	17.4	
75	17.5	
76	17.6	
77	17.7	
78	17.8	
79	17.9	
80	18.0	
81	18.1	
82	18.2	
83	18.3	
84	18.4	
85	18.5	
86	18.6	
87	18.7	
88	18.8	
89	18.9	
90	19.0	
91	19.1	
92	19.2	
93	19.3	
94	19.4	
95	19.5	
96	19.6	
100	20.0	

Relevance of module grades

Although it is only honours module grades that contribute to the final degree classification, every module grade from level one onwards appears on a student's transcript (the academic record sheet that potential employers or research supervisors will wish to see). It is thus clear to such people what level of attainment was achieved by an applicant in each year of their studies. Fortunately, almost all students in this School work hard and aim for as high a grade as possible, and can show this to people in the future with satisfaction. Beware, however, that such good intentions are not uniformly present in students across the University.

For progression from level one to level two students on the traditional programme need to gain at least grade 7.0 in all their modules. Those on the Gateway programme in level one need passes in all modules and a mean grade of 11 over all the modules in order to enter level two in St Andrews. Progression to honours is covered in a following paragraph.

Progression to Honours Physics and Astronomy

Entry to the physics honours degree programme requires good passes in level two physics and maths; for the astrophysics programme a good pass in level two astronomy is an additional requirement (direct entrants need instead a good pass in level one astronomy). It should be noted that resists are no longer normally permitted to be used in the progression decision. More details are given in appendix E of this handbook, but in general terms, **those wishing to join the physics or astronomy honours programmes need to obtain level two grades in physics and maths modules of 11 or better for entry to BSc honours and 15 or better for entry to MPhys honours**. Those who need resits to reach the necessary grades or who *narrowly* miss the entry requirements might be permitted to "shadow" the honours modules in junior honours, and if they achieve sufficiently highly in those modules they may be permitted to transfer then to the honours cohort.

Deans' List

The University has an annual award for academic excellence, promoted by the four Deans of the University. Undergraduate students who achieve an outstanding overall result in the course of an academic year have their names inscribed on the Deans' List, an honour which will also appear on their University transcript.

A student who meets all the criteria and who obtains a credit-weighted mean grade of 16.5 or above for the year will be recorded on the Deans' List. The rules will be adapted for part-time students. Full details of all the criteria and conditions for the Deans' List are available at: http://www.st-andrews.ac.uk/administration/deans/deanslist/

Academic Misconduct

Academic integrity is fundamental to the values promoted by the University. It is important that all students are judged on their ability and performance, and no student will be allowed unfairly to take an advantage over others, to affect the security and integrity of the assessment process, or to diminish the reliability and quality of a University of St Andrews degree.

Academic misconduct includes the presentation of material as one's own when it is not one's own; the presentation of material whose provenance is academically inappropriate; and academically inappropriate behaviour in an examination or class test. Any work that is submitted for feedback and evaluation is liable for consideration under the University's Academic Misconduct policy irrespective of whether it carries credit towards your degree. All work submitted by students is expected to represent good academic practice. "Not knowing" the regulations is not regarded as an acceptable excuse for academic misconduct.

You should be aware that the University takes academic misconduct offences extremely seriously, and penalties for first offences can be severe. Any student found guilty of a repeat offence may be expelled from the University either temporarily or on a permanent basis.

All students should familiarise themselves with the University's Guide to students called "Avoiding Academic Misconduct" which may be accessed from:
http://www.st-andrews.ac.uk/students/policy/academicmisconduct
Students who are unsure about the correct presentation of academic material should approach their tutors or lecturers, and may also contact CAPOD
(June.Knowles@st-andrews.ac.uk) for advice and training.

Within the School, the most obvious example of academic misconduct at first and second level would be the copying of part of another student's laboratory report or essay and passing it off as one's own work, copying material off the web without full acknowledgement, or copying someone else's tutorial work and submitting it as your own.

The University's procedure will be applied whenever instances of this or similar practices are detected, and the available penalties include the possibility of being given a grade 0 for the module or even termination of studies at the University in serious or repeat cases. The Turnitin software tool may be used to check for plagiarism. However, students should carefully distinguish plagiarism from the assistance that they derive by discussing their work with others and, in some approved cases, carrying out that work in collaboration with others. The latter has genuine and legitimate value to the student and is encouraged, whereas intentional plagiarism is essentially dishonest.

Penalties for Late Submission

In those cases where written work requires to be handed in for marking, a deadline will be defined well in advance and the penalties for late submission will be given. Often this will be expressed as a percentage reduction in the mark to be awarded for each day late.

Feedback, and Access to Examination Scripts

You should be able to receive feedback on any piece of work that you are asked to submit. Part of the learning process is reflecting on this feedback, and making note of what aspects of your work process you wish to repeat in future assignments, and what improvements you should strive for in the future. If you are not clear from any written or oral comments what are the issues involved, please discuss this with the person who marked the work, or if this is not possible then with the relevant year coordinator. Work that is handed in for tutorials may be discussed in the relevant tutorial. Generic feedback to students after an exam is normally posted on Moodle.

The policy of the University is that students may see their examination scripts after the assessment process has been completed, but only in the presence of a member of staff. The School aims to ensure that a staff member is present who can provide some feedback to student queries about the exam script. Students wishing to do this should contact their year coordinator in the first instance. Some groups within the School may have scheduled sessions for this to take place, and this will be announced to the classes concerned. Students are not allowed to take away an examination script, but may have a photocopy on payment of a fee to the University. Requests for this should be made to the School Office.

Appeals and Complaints

The University web site gives full information on how students should pursue a complaint or appeal, whether this be on an academic or non-academic issue. One guiding principle is that students should attempt first to resolve the issue by an informal approach to the member of staff most directly concerned. If that fails, there are available further stages by which the matter may be pursued.

Within the School of Physics and Astronomy, any complaint or appeal should be addressed (after the informal approach has been tried) to the Director of Teaching or, if the Director of Teaching has already been involved, to the Head of School. Academic issues which could be the subject of an appeal or complaint include the marks awarded to assessed work, module grades, degree classification, or any allegation of harassment or bullying. It should be noted that the final outcome of any appeal concerning grades includes the possibility that the marks or grades awarded could go down as well as up.

Physics / Mathematics Library

The JF Allen Library is a new and modern Library situated in the Physics and Astronomy building. It has a large number of comfortable, bright and quiet spaces for individual study, six PCs and two bookable rooms for group work.

There is a wide variety of up-to-date books available in both print and electronic format. Most books can either be borrowed for 7 or 28 days. It should be noted that the 28-day loan books are subject to a 7-day recall in the case of someone else wanting to borrow them. There is a self-issue and return machine which allows users to take out books themselves. If you have suggestions for additional physics and astronomy books that you think should be in the Library, please contact Dr Antje Kohnle (ak81@st-andrews.ac.uk) or email morebooks@st-andrews.ac.uk.

The Library also subscribes to a large number of journals, most of which are available electronically. There is a photocopier in the Library which is operated by prepaid cards which can be purchased from the Library helpdesk.

Online resources and information about books available can be searched for through the Library's Physics & Astronomy page: http://libguides.st-andrews.ac.uk/panda. Past examination questions for the last few years are available via iSaint, and tutorial sheets and solutions for some modules are available on Moodle or MMS.

Library staff are present to deal with enquiries, Monday to Friday, between the hours of 10am and 3pm, thought the library space is open during normal working hours, and potentially beyond. There is also an online enquiry service available from the web pages as well as an evening phone service. Vicki Cormie (vhc1@st-andrews.ac.uk) is the Academic Liaison Librarian for Physics & Astronomy and is happy to be contacted for any help in using Library resources.

Work Spaces

The library is one obvious space in the building in which students may study, though it is intended to be a reasonably quiet area. The main concourse has group-study tables behind the cafeteria. These are equipped with large screen computer monitors, and it is hoped that groups of students may find this space useful for collaborative working and/or as a noisy self-study space. The main part of the concourse may be used as a study and/or social area. If seminar/tutorial rooms in the building are not booked out for teaching or meetings, it is normally possible to use these for work. The School office staff can provide information on availability.

Computing Facilities

The PC classroom next to the main entrance contains 34 PCs, data projection facilities, scanners and printers. All entrant students are encouraged to attend a familiarisation session on these facilities during the first week of the teaching year. Computers with large screens are available particularly for group-based work in the group study area behind the new cafeteria serving area. IT services operate many other clusters of computers and provide training in the use of hardware and software as well as the username and password required to log on the computers and for email.

Student-Staff Council, and School President

The Student-Staff Council has representatives for students in each level of study, postgraduate representatives, and members of staff. Its primary purpose is to serve as a forum for the discussion of academic issues, but it also oversees some of the social facilities available in the building and some student activities. The Council normally meets twice per semester. It has its own web pages that may be accessed from the School's web pages. It is chaired by the School Student President, who is elected by students at the end of the previous session.

Student representatives are elected from first and second level modules, and normally hold office for the whole academic year. Representatives discuss teaching matters with the Co-ordinator, and report to meetings of the Council on the issues raised and the action taken.

There are five sub-committees on which both students and staff are represented. The Fund Raising Committee is concerned with raising funds for vacation projects and social events. The Vacation Awards Committee disburses grants to students who wish to pursue worthwhile scientific or recreational projects during the Easter and Summer vacations. The Art Committee promotes art and photographic exhibitions.. The Website Committee looks after the Council's website. The Social Committee is responsible for the organisation of the Student/Staff Christmas dinner and for other social events which take place during the year.

Information for students

The University's "Current Students" page linked to the Home page of the University's web site contains in a single convenient package information on a wide variety of issues of interest to students. It includes for example details on academic regulations, codes of practice, employment, financial information, health, Library and Information Services, student organisations, student services, student support and guidance, and access to the pre-advising system, previous examination papers and examination timetables. The University also publishes on its website a "Student Handbook", which contains a digest of some of the most relevant material.

Our School's "Staff and Students" web page contains a range of useful information, including a page on academic issues that are influenced by both School and University policy. The online managed learning environments supported by the University are now MMS and Moodle.

Disabilities

If for disability reasons you require support, for example particular teaching and exam arrangements, please contact the Disability Team via the link below. Student Services provides support for a wide range of disabilities such as learning difficulties, visual and hearing impairments, mobility difficulties, Aspergers, mental health, long standing medical conditions, and much more.
www.st-andrews.ac.uk/studenthandbook/diversity/disabilities/

The School's disabilities coordinator (Dr Bruce Sinclair) will liaise with any user of the building who has a disability. All those with a disability are requested to register with the University's Student Services. Our aim is to try to make the same or equivalent facilities and experiences available to all. The School should be notified by Student Services of any recommended actions. However, this cannot always be immediate, and students are welcome to contact Dr Sinclair directly to advise him of their situation.

Most of the School is accessible to wheelchair users via the main entrance and the lift. If a person who is unable to use the stairs is on level three when there is a fire or other emergency, they should know that there is an evacuation chair in the stairwell outside room 301.

English Language Support

The In-sessional English Language Support Service offers free language support to matriculated students who are non-native speakers of English. Support is offered in a number of forms, ranging from one-to-one tutorials to weekly workshops on writing, conversational speaking and grammar, and independent study resources. Further information is available on the Support Service website:
http://www.st-andrews.ac.uk/elt/support

If you would like further information, please contact Janie Brooks, In-sessional English Language Support Co-ordinator, ajb31@st-andrews.ac.uk

Health and Safety

The Head of the School of Physics and Astronomy, as part of his responsibilities for safety within the School and its buildings, requires all persons who enter the buildings for any purpose to take reasonable care of the health and safety of themselves and of others. The

School's safety policy is available via the "Staff and Students" page of the School website. The School Safety Officer is Mr Reg Gavine, ext 3180, rcg2.

Anyone requiring First Aid during normal hours should contact Mr Les Kirk (Room 324, Level 3, Tel 3148), Dr Graham Turnbull, Mr Steve King, or Mr Steve Balfour, or ask any member of staff to do this for them.

First aid boxes are located at the main entrance, outside room 301, and at the lift entrances. An emergency evacuation chair for those with mobility difficulties is located in the corridor outside room 301.

Fees

There are no additional fees for labs and similar in the School. In line with University policy, the School expects its students to purchase a number of textbooks as part of their study.

Finding Referees

Students are likely to wish to use members of academic staff as referees in applications for summer work experience, etc. To this end, they are advised to cultivate a professional relationship with appropriate staff members. The more a member of staff knows about a student, the more useful a reference they can write. It is thus most likely that a student's tutor would be in a good position to write a reference. Students should seek the permission of staff members to use them as referees before naming them. As staff members are not permitted to disclose information about students without explicit permission, potential referees may ask for written statements from students authorizing disclosure. It may be worth noting that student attitude and attainment through their time at St Andrews can be relevant, which may be another reason for working hard throughout the degree programme.

Advice and Support

If you need advice, then you should feel free to contact any member of academic or secretarial staff in the School; they may be able to help you directly or should be able to tell you who to contact for particular advice. Please feel free to ask questions of your lecturers, tutors, lab demonstrators, or advisers of studies. For general academic and other queries your Adviser of Studies and the School's Director of Teaching may both be good people to start with.

If you wish to speak with your Adviser of Studies and they are not available, the School's Director of Teaching would be an appropriate alternative.

If you wish to speak with someone with no direct connection to the School, then the professional staff in the Advice and Support Centre may be accessed via the reception desk at the ASC in North Street or by email at theasc@st-andrews.ac.uk. They are particularly well placed to help with problems affecting your studies or personal life, including problems with your course work, money, accommodation, health and disability, relationships, stress or anxiety. They also offer special help for international students. The majority of students seek advice from this service during their time in St Andrews. For more information see
www.st-andrews.ac.uk/studentservices/Adviceandsupport/

The School also provides advice on "Who can advise or help me?" on particular issues. This is on the main academic notice board and online via the student section of the School's Staff and Students web page.

Academic Dates 2011-12

Martinmas (first) Semester:	26 September to 20 January
Christmas Vacation:	17 December to 3 January
Candlemas (second) Semester:	6 February to 25 May
Spring Vacation:	24 March to 8 April

Orientation Week and Reading Week are integral parts of the University semester, and students are expected to devote these periods to their studies. Students are also expected to be available for the entire examination period

APPENDIX A – SELECTED STAFF MEMBERS

Lecturing Staff	*Room*	*ext*	*email*
Baumberger Dr F	208	1682	fb40
Bonnell Prof I A	312	3140	iab1
Brown Dr C T A	216	3129	ctab
Cameron Prof A C	315	3147	acc4
Cassettari Dr D	218	3109/3186	dc43
Cornwell Prof J F	340	1676	jfc
Cruickshank Dr P	244	3196	pasc
Dholakia Prof K	217	3184	kd1
Di Falco Dr A	342	3165	adf10
Dominik Dr M	329A	3068	md35
Dunn Prof M H	221	3119	mhd
Gillies Dr A D	241	3179	adg1
Greaves Dr J	306	1681	jsg5
Hadfield Dr L J	304	3144	ljh11
Helling Dr Ch	318	1666	ch80
Horne Prof K D	315A	3322	kdh1
Hooley Dr C A	304	3171	cah19
Jardine Prof M M	318	3146	mmj
Keeling Dr J	213	3121	jmjk
Kemp Dr J	Music		jk50
Koenig Dr F	204	3128	fewk
Kohnle Dr A S	314	3195	ak81
Korolkova Dr N	311	3139	nvk
Krauss Prof T F	215	3107	hospanda
Kruger Dr F	244	3196	fk20
Lee Prof S L	318A	3143	sl10
Lesurf Dr J C G	340	1676/3154	
Leonhardt Prof U	317	3127/3115	ulf
Mackenzie Prf A P	207B	3108	apm9
Mazilu Dr M	252	3124	mm17
Philbin Dr T G	231	3127	tgp3
Rae Dr C F	132C3	7314	cfr
Samuel Prf I D W	207A	3114	idws
Sibbett Prof W	209	3100	ws
Sinclair Dr B D	221	3118	b.d.sinclair
Smith Dr G M	219	2669	gms
Turnbull Dr G A	205	7330	gat
Wan Dr K K	242	3210	kw
Wild Dr V			
Woitke, Dr P			pw31
Wood Dr K	316	3116	kw25
Zhao Dr H	316A	3135	hz4

Office Staff	*Room*	*ext*	*email*
Aitken Mrs L M,	211	3100	lma1
Anderson Miss V	211	3111	va3
Fitchet Mr G	211	3103	gf10
Staniforth Mrs L	211	3103	ls42

Planning and Resources Manager

Edwards Dr T J	207	3145	tje1

Teaching Laboratory Technicians

Kirk Mr L J	235A	3132/3148	ljk2
Donaldson Mr P T	235A	3132/3148	ptd

Head Janitor

McQuade Mr A		3136	jan-phys

Safety Officer

Gavine Mr R C	172	3180	rcg2

First Aiders

Kirk Mr L J	235A	3132/3148	ljk2
King Mr S	132c2	7309	sk18
Balfour Mr S	133	3178	stb3
Turnbull Dr G A	205	7330	gat

Generic School Contact Details

School Office	211	3111	physics

School Office opening hours Monday-Friday 08.45-11.00, 11.20-17.00

Photos of most staff members are available on the School's web pages.

Key Contacts

School Level

		Room	Email
Head of School	Prof Thomas Krauss	211	hospanda
Deputy Head of School	Prof Andy Mackenzie	207b	apm9
Director of Teaching	Dr Bruce Sinclair	214	b.d.sinclair
Director of Research	Prof Andy Mackenzie	207b	apm9
Director of Postgrad Study	Dr Graham Turnbull	205	gat
School Senior Secretary 01334 463100	Mrs Lesley Aitken	211	physics

Advisers of Study

Pre-honours	Dr Donatella Cassettari	218	dc43
	Dr Friedrich Koenig	210	fewk
	Dr Graham Smith	219	gms
Junior Honours	Dr Natalia Korolkova	311	nvk

Module and programme coordinators – shown in main text

Physics 1A and 1B	Dr Tom Brown	216	ctab
Gateway modules	Dr Lucy Hadfield	304	lh11
Astronomy AS1001	Dr Jane Greaves	306	jsg5
Physical Universe AS1002	Dr Jane Greaves	306	jsg5
Physics 2A and 2B	Dr Antje Kohnle	314	ak81
Astronomy AS2001 & 2101	Dr Hongsheng Zhao	316a	hz4

Other

Examination Officer	Prof Steve Lee	318a	sl10
Disabilities Coordinator	Dr Bruce Sinclair	221	b.d.sinclair
Health and Safety Officer	Mr Reg Gavine	172	rcg2
First Aid	Mr Les Kirk	235	ljk2
S-coding etc requests	Dr Bruce Sinclair	221	b.d.sinclair
Library rep	Dr Antje Kohnle	314	ak81
School Student President	Mr Chris Carroll	physicspresident	

APPENDIX B: SYLLABI OF FIRST LEVEL MODULES 1

PH1011 Physics 1A

Mechanics 1 (10 lectures) **Dr Lucy Hadfield**

Kinematics: Vectors and scalars. Motion with constant acceleration. Motion under gravity. Calculation of trajectories, maximum height, range etc. Motion with non-constant acceleration.

Rigid bodies: Centre of mass, centre of gravity. Torque of a force about an axis. Angular momentum. Condition for a rigid body to be in static equilibrium.

Newton's Laws: An introduction to Newton's Laws of motion illustrated by a range of examples of their applications.

Waves and Optics (16 lectures) **Dr Bruce Sinclair**

What is Light? Ideas of waves and particles, and how light is generated.

Ray Optics: Snell's law, and the use of a lens for imaging. Thin lens formula.

Oscillations: SHM of spring. Velocity, acceleration and phase, for mechanical oscillations. Extension to a pendulum. Relation between SHM and circular motion. Energy in SHM. Tuning fork and other resonators, and damping.

Travelling Waves: Transverse and longitudinal travelling waves, and connection with oscillations. Sound waves, waves on strings, Electromagnetic waves. Transverse velocity and acceleration. Energy carried by a wave. Doppler effect for sound, extended to light and the red shift. Superposition, beats, phase change on reflection.

Standing Waves: Standing waves on strings. Nodes and antinodes. Resonant wavelengths and frequencies in strings and pipes. The laser resonator.
Wave Optics: Young's slits and two beam interference. Temporal and spatial coherence and its relevance to interference patterns. Michelson interferometer and its use in precision length measurements. Anti-reflection coatings and thin-film interference. Multiple-beam interference. Wavelength separation by diffraction grating.

Properties of Matter (18 lectures) **Dr Tom Brown**

Atomic basis of matter: Atoms and molecules, Dalton's and Avogadro's hypotheses, atomic weight, the mole, Avogadro's number.

Thermal physics and kinetic theory: Temperature scales and the gas laws. Evidence for and assumptions of simple kinetic theory. Derivation of pressure formula. Molecular speeds and kinetic energy. Mean free path. Thermal conductivity, convection and radiation.

The condensed state: Estimates of atomic size and spacing. Interatomic forces. Elasticity: stress, strain, Hooke's law, Young's modulus, stored energy.

Nature of atoms: charge quantisation, measurement of e and e/m for electrons. Behaviour of charged particles in electric and magnetic fields. Electrical conduction in solids. Drift velocity, Hall effect.

The nucleus: radioactivity, α, β and γ rays, exponential decay, half life, nuclear size. Isotopes, radioactive series. Protons and neutrons.
Particle physics: Accelerators and detectors. Classification of particles. Quarks, baryons, mesons and leptons.

Laboratory work and maths workshops **Dr Cameron Rae**

PH1012 Physics 1B

Mechanics II (9 lectures) **Dr Lucy Hadfield**

Dynamics: Force, mass, Newton's laws of motion, inertial reference frames. Friction. Velocity of light as maximum achievable velocity. Momentum, conservation of momentum in absence of external forces. Impulse. Work, energy and power. Potential and kinetic energy. Conservation of energy.

Circular motion: Definition of angular velocity. Angular acceleration. Centripetal acceleration for particle moving in circle at constant speed. Problems involving motion in a circle.

Newton's law of gravitation: Analysis for circular orbits, time for one orbit, calculations involving satellites etc., g in terms of G and mass and radius of earth. Gravitational field and potential. Derivation of gravitational potential energy for spherical source. Escape velocity. Photons, black holes.

Quantum Phenomena (16 lectures) **Dr Donatella Cassettari**

Early quantum ideas: Photoelectric effect and Compton effect. Rutherford's and Bohr's models of the atom. Spectral lines, Rydberg constant. Fine structure.

de-Broglie's matter waves: Diffraction of electrons, neutrons, etc. Wave function, probability and uncertainty. Heisenberg's uncertainty principle. Conceptual problems in quantum theory.

Electron spin: Pauli's exclusion principle, fermions and bosons.

Large scale quantum phenomena: superconductivity and Bose-Einstein condensates.
Energy levels: Atomic spectra. The ordering of the elements. The periodic table.

Lasers and Optoelectronics (10 lectures) **Dr Tom Brown**

Lasers: Introductory overview on lasers and optoelectronics. Basic energy level structures for laser-related media. Einstein A, B coefficients, gain coefficient, laser threshold conditions. Laser oscillator and amplifiers. Properties of laser radiation and important types of laser gain media. Pulsed laser systems. Some applications of lasers in science, engineering and medicine.

Optoelectronic devices: transmitter and receiver system for optical communications.

Group Discovery Project (7 lectures equivalent) **Drs Antje Kohnle & Tom Brown**

In groups of typically four, students will explore a real-world problem applying and extending their knowledge of physics. Students will work self-guided in groups with introductory whole-class sessions and individual group facilitator sessions to review and aid their progress. At the end of the project, each group will give a brief presentation of their results to a panel and submit a written report.

Laboratory work **Dr Cameron Rae**

PH1501 Gateway - Maths for Physicists **Dr Lucy Hadfield**

This module aims to provide an introduction to a range of mathematical techniques required for physics and engineering degrees. practise in the use of these techniques, and to demonstrate the application of these techniques to problems in physics and astronomy

The topics covered include basic algebra (inequalities, functions, coordinate systems, algebraic manipulation, partial fractions), geometric sequences and series, techniques of differentiation and integration. This module will also include a small computing component.

PH1502 & 1503 Gateway – Physics Skills 1A & 1B **Dr Lucy Hadfield**

Study Skills:

An Introductory overview of general study skills including time management, study and note taking, literature retrieval and evaluation, critical reading, effective revision skills, personal development and reflective feedback.

Physics/Engineering skills:

Including unit conversion, estimating and order of magnitude calculations, dimensional analysis, scientific writing, planning and execution of practical work.

Physics in context:

General problem-solving in physics, numerical and analytical reasoning,

Astronomy Short Course:

Solar System: structure, evolution and origin.

Planets and life: Detection and properties of extrasolar planets: bias introduced by detection methods, introduction to astrobiology.

Galaxies: Structure of the Milky Way galaxy; galaxy classification; galaxy formation and evolution.

Stellar evolution: Stars and the Hertzsprung-Russell diagram; mass-luminosity relation; stellar evolution for high and low mass stars; stellar nucleosynthesis

AS1001 Astronomy & Astrophysics 1

The Solar System (11 lectures) **Dr Antje Kohnle**

Brief historical introduction including basic observations and the calendar, leading to Kepler's laws of planetary motion and Newton's law of gravitation. Modern exploration of the Solar System and the study of the physical properties of the planets and their satellites - interior structure, atmosphere and climate, magnetospheres and interactions with the solar wind; physical properties of comets, meteors. The atmosphere of the Sun -photosphere, chromosphere, corona and the solar wind. Origin of the Solar System.

Stars and Elementary Astrophysics (11 lectures) **Dr Jane Greaves**

Telescopes: optical, radio, space. Stellar brightness, apparent and absolute magnitudes, distances, inverse square law. Colours of the stars, black body radiation laws and temperature. Spectra from astronomical sources; Kirchhoff's laws for continuous, emission and absorption spectra. Spectral classification; excitation and ionisation; determination of stellar compositions. Distribution of stellar parameters; the Hertzsprung-Russell diagram. Stellar motions: Doppler effect, radial velocity, redshifts; proper motion.

The Galaxy (11 lectures) **Dr Kenny Wood**

Binary stars for masses, radii, luminosities; the main-sequence mass-luminosity relationship. Star clusters, their colour-magnitude diagrams, and distances via main-sequence fitting. Effects of interstellar extinction. Spatial distribution of star clusters, differences in chemical composition. Outline of stellar evolution from formation through to end states of white dwarfs, neutron stars and black holes. Variable stars as distance indicators. Mass loss from stars, supernovae, pulsars, binary stars with compact components. The interstellar medium - cold molecular clouds, HII regions, 'coronal' component; dust. Structure of the Galaxy - population groups, spiral structure, rotation curve.

Cosmology (11 lectures) **Prof Keith Horne**

A preview of the universe. The extragalactic nebulae (galaxies). The determination of extragalactic distances. Types of galaxies. The Hubble classification. Properties of galaxies - sizes, masses, spectra and luminosities. The distribution of galaxies in space - clusters and superclusters. The red-shift - distance relation. Hubble's law. The expansion of the universe. The age of the universe. The Big Bang origin of the universe. A critical density for expansion and contraction. The evolution of the universe.

Practical Work

AS1002: The Physical Universe

Concepts in Astronomy (20 lectures) **Drs Jane Greaves and Hongsheng Zhao**

The development of astronomy - the day and night sky, seasons, time and the calendar. The Copernican revolution. An inventory of the Solar System (planets, moons, comets, meteors, aurorae).

The stars as distant sources of light. The development of astrophysics - the properties of stars; stellar evolution and ages - red giants, white dwarfs, supernovae and black holes. The formation of stars, and planetary systems; modern searches for extra-solar planets.

An inventory of the Milky Way Galaxy - stars, gas and dust clouds; the size and age of the Galaxy. Other galaxies, their distances and distributions in space - clusters and voids. Peculiar galaxies and quasars. Nonluminous matter.

Cosmology. Olber's paradox. The redshifts of galaxies and Hubble's Law. The origin and evolution of the Universe, the formation of galaxies - big bang cosmology and problems. The formation and evolution of the chemical elements. Links between cosmology and particle physics.

Concepts in Physics (20 lectures) **Dr Paul Cruickshank**

The evolution of the scientist's view of the physical universe from a classical (19th century) to a quantum (20th century) perspective. The physics and philosophy of particle-wave duality, the limitations of the Uncertainty Principle and the role of Relativity.

The nature of light and matter. Concepts in laser physics. Understanding materials from metals to polymers. Exploring the internal structure of liquids, glasses and solids. Inside the atom.

The interplay of electronic and structural properties of materials. From semi-conductors to superconductors, and magnetism.

Concepts of nuclear physics. Fission and fusion and their peaceful and non-peaceful uses.

Particle physics and its links to cosmology. The fundamental particles and the "glue" that holds them together.

Physics in everyday life. The applications of physics from medicine to archaeology and from information technology to transport.

AS1901: The Physical Universe (Evening Degree)

Not running in 2011-12. Same syllabus as AS1002.

APPENDIX C: SYLLABI OF SECOND LEVEL MODULES 2

PH2011 Physics 2A

Mechanics (18 lectures) **Prof Steve Lee**

Dynamics of a single particle: Newton's laws of motion, inertial reference frames. Momentum, conservation of momentum in absence of external forces. Central force problems: velocity and acceleration of particles in plane polar coordinates. Work, energy and power. Conservative forces, relation between force and potential energy. Friction. Torque. Conservation of angular momentum.

Gravitation: Newton's gravitational force law, potential energy for point source. Kepler's laws for planetary motion.

Dynamics of a system of particles: Centre of mass. Internal and external forces. Translational equation of motion. Torque. Angular momentum and kinetic energy of a rotating system. Rotational equation of motion. Rigid Bodies. Moments of inertia. Parallel and perpendicular axis theorems.

Statics: conditions for equilibrium. Indeterminate structures. Elasticity – Young's modulus, shear modulus, bulk modulus.

Fluids in motion: Types of flow, viscosity, Bernoulli's theorem.

Oscillations in Physics (7 lectures) **Dr Antje Kohnle**

Introduction to oscillations. Mathematical description of oscillations. Circular motion and simple harmonic motion (SHM). Energy in SHM. Examples of SHM: spring-mass systems, pendulums, other oscillating systems. Damped oscillations. Types of damping, Q factor. Forced oscillations. Resonance. Examples of resonant systems. Coupled oscillations.

Thermal Physics (12 lectures) **Dr Graham Smith**

The notion of thermal equilibrium, reversible and irreversible processes. Temperature. The zero'th law. Ideal gases. Types of thermometer.

Thermal expansion (linear, area and volume) and equations of state.

Work and the first law of thermodynamics. Phase changes and latent heat. Adiabatic processes, free expansion of a gas.

Entropy and the second law of thermodynamics. Heat engines, heat pumps, refrigerators, efficiency. The thermodynamic temperature scale. Entropy from a statistical viewpoint.
Heat transport, conduction, convection and radiation.

Special Relativity (9 lectures) **Dr Frank Kruger**

Kinematics: Inertial frames. The Galilean transformation equations. Velocity of light as an invariant. Einstein's postulates. Derivation of the Lorentz transformation equations. Relativity of simultaneity.

Length contraction and time dilation. The invariant interval and proper time. The twin paradox. Transformation of velocity and acceleration. Formulae for the Doppler effect and aberration of light. Spacetime diagrams.

Dynamics: Relativistic conservation of momentum and mass/energy. Concept of rest mass and rest energy. Relation between energy and momentum. Newton's second law. Photons. Relativistic collisions. The physics of accelerators, and the importance of the centre of mass frame.

Laboratory work **Dr Cameron Rae**

PH2012 Physics 2B

Quantum Physics (15 lectures) **Dr Chris Hooley**

Old quantum theories of radiation and matter: light quanta and Bohr's model of the atom, de Broglie's matter wave hypothesis, wave-particle duality.

The wave function: probabilistic behaviour of QM systems and probabilistic interpretation of the wave function, calculation of average vales from wave function, Heisenberg uncertainty principle.

Schrödinger's equation: the time-dependent version, and derivation of the time-independent version. Eigenvalues and eigenfunctions. Qualitative features of eigenfunctions. Determination of eigenvalues and eigenfunctions for the free particle, step potential, and potential barriers and wells. Quantum tunnelling. Wave packets.

Electricity and Magnetism (21 lectures) **Dr Bruce Sinclair**

Basic electrostatics: Coulomb's Law, electric field E, electric field from discrete and continuous distributions. Electric potential V, relation between E and V, examples.

DC circuit theory: electric current and drift velocity of charge-carriers. Electric potential and Kirchoff's laws. Input and output impedance of circuits, equivalent circuits.

Gauss' law and capacitors: electric flux, Gauss' law, use to solve fields around high-symmetry charge distributions, electrostatic shielding, capacitors, role of dielectric materials in capacitors.

Magnetic effects of currents: forces on charges moving in a magnetic field, Biot-Savart law and application to long straight wire and coil, force between two current carrying wires and the definition of the units of current, Ampere's law and examples.

Electromagnetic Induction: Faraday's law, Lenz's law, induced electric fields, self and mutual inductance.

Electricity and magnetism unified via relativity.

Classical Waves (12 lectures) **Dr Antje Kohnle**

Waves: Waves on stretched strings: the wave equation, wave velocity. Transmission of energy. Distinction between travelling waves and standing waves. Nodes. Introduction to sound waves and to

light waves. The Doppler effect in sound, with extension to light. Superposition of waves – standing waves, interference and beats. Examples from music and lasers. Dispersion. Phase and group velocity. Reflection and transmission of waves at an interface or boundary.

Wave properties of light: Nature of electromagnetic radiation, the e-m spectrum, velocity of light. Huygens' principle. Polarisation, birefringence. Laws of reflection and refraction. Refractive index of materials. Dispersion. Phase difference and coherence. Two slit interference pattern. Diffraction pattern for a single slit.

Laboratory work including practical electronics **Dr Cameron Rae**

AS2001 Astronomy & Astrophysics 2

Chemical Evolution of the Universe (12 lectures) **Prof Keith Horne**

Formation of the elements during the Big Bang. Nucleosynthesis and the primordial abundance. Galaxy formation and evolutionary mechanisms. Global star-formation processes and star-formation rates. Evolution of the primordial abundance and the formation of metals. Galaxy metallicities and age estimation. Star formation histories of local galaxies.

Observational Techniques (12 lectures) **Dr Jane Greaves**

Optical systems – images, aberrations, telescope designs. Atmospheric seeing; active and adaptive optics. Optical detectors – photomultipliers and CCDs.

Photometry, spectrophotometry, spectroscopy. Optical instruments – photometers, diffraction gratings and spectrometers, polarimeters. Extinction through the Earth's atmosphere.

Multiwavelength astronomy – infrared techniques, radio aperture synthesis, ultraviolet techniques. X-ray and gamma-ray detectors, instruments and telescopes.

Stellar Structure and Evolution (12 lectures) **Dr Kenny Wood**

The determination and distribution of stellar masses, radii and luminosities; the Hertzsprung-Russell diagram, mass-luminosity law and Vogt-Russell theorem. Sources of stellar energy, nucleosynthesis of hydrogen, helium and carbon. Star formation and evolution; the ages of star clusters; supernova events and the synthesis of heavy elements. Final states - white dwarfs, neutron stars (pulsars) and black holes. The evolution of binary stars - Roche lobe overflow, accretion discs and novae.

Galactic Astronomy (12 lectures) **Prof Moira Jardine**

This course will investigate the distribution and motions of stars, gas and dust within our own galaxy in order to determine its dimensions and overall properties. Properties of other galaxies will be discussed. Topics include: galactic coordinate systems; the solar motion and distribution of stellar velocities; differential galactic rotation, the rotation velocity at the Sun and the distance to the Galactic Centre; rotation curves of the Milky Way and other galaxies; galaxy masses and "dark" matter.

Laboratory work

AS2101 Astronomy & Astrophysics 2 (condensed)

As AS2001, but without the laboratory work and the Observational techniques lectures

APPENDIX D: TIMETABLE

Lectures are given at the times shown in the following table. All modules involve at least some additional activities such as laboratories, tutorials and workshops, the times of which will be announced.

Martinmas (first) Semester

First level		
AS1001	Astronomy and Astrophysics 1	11-12
PH1011	Physics 1A	12-1
PH1501, 1502	Gateway Modules	9-12, some afternoons
Second level		
PH2011	Physics 2A	10-11
AS2001	Astronomy and Astrophysics 2	11-12

Candlemas (second) Semester

First level		
PH1012	Physics 1B	12-1
PH1503	Gateway Skills 1B	10-12,some afternoons
AS1002	The Physical Universe	11-1
AS1901	The Physical Universe (evening)	Evening (not 2011-12)
Second level		
PH2012	Physics 2B	10-11

APPENDIX E: HONOURS DEGREE PROGRAMMES

The honours degrees currently available are set out below. Several of these are taught wholly within the School of Physics and Astronomy, the others being given jointly with the other Schools concerned. Full details of the content and structure of these honours programmes are contained in the separate booklet for Honours students.

BSc degrees	
Single Honours	Astrophysics
	Physics
Joint Honours	Physics and *one* of
	Computer Science
	Internet Computer Science
	Logic & Philosophy of Science
	Mathematics
MSci degree	
Joint Honours	Physics and Chemistry
MPhys degrees	
Single Honours	Astrophysics
	Physics
	Physics with Photonics
	Theoretical Physics
Joint Honours	Theoretical Physics and Mathematics

To obtain any one of these degrees it is necessary to include at second level PH2011 Physics 2A, PH2012 Physics 2B, MT2001 Mathematics and (for those wishing to do the Astrophysics degree) AS2001 Astronomy and Astrophysics 2[4]. Those proceeding to a joint honours degree must also satisfy the requirements of the other subject.

The grades required in these modules for admission to each degree programme are set out in the Honours booklet and in the section below. Resit grades are no longer permitted to be used in progression to honours. Those wishing to join the physics or astronomy honours programmes need to be aware throughout level two of the need to obtain level two grades of 11 or better for each of PH2011, PH2012, and MT2001 for entry to BSc honours and 15 or better in each for entry to MPhys or MSci honours.

At the end of the Candlemas (second) semester, an offer of a place in one or more of the honours programmes will normally be made to those who have achieved the required grades in the relevant second level subjects. In most cases, a final decision by a student regarding choice of honours degree need not be made until the start of the third level or even later.

[4] For those who take direct entry to second level, AS2101 is taken in junior honours instead

Entry Requirements to the Honours Physics and Astronomy Programmes

BSc Programmes Grade 11 or better in each of PH2011, PH2012 and MT2001.

For the BSc in Astrophysics, grade 11 or better in AS2001 is an additional requirement. For those aiming for an astrophysics degree who have taken accelerated entry, AS2101 is taken in JH instead of AS2001 in the year of entry. These students have as an additional requirement for honours entry a grade of 11 in AS1001 rather than in AS2001.

MPhys/MSci Programmes Grade 15 or better in each of PH2011, PH2012, and MT2001.

For the MPhys in Astrophysics, grade 15 or better in AS2001 is an additional requirement. For those aiming for an astrophysics degree who have taken accelerated entry, AS2101 is taken in JH instead of AS2001 in the year of entry. These students have as an additional requirement for honours entry a grade of 15 in AS1001 rather than in AS2001.

For degree programmes involving other Schools there may be additional requirements from those Schools.

Resit grades are no longer normally used to satisfy the above requirements. Students entering the honours class will also normally have the appropriate number of credits at pre-honours levels. Those who fall short of the required grades shown above *may* be admitted at the discretion of the Head of the School of Physics and Astronomy.

Students who *narrowly* miss the requirements for entry to the Bachelors programmes, and those who need to use resit results to get sufficient grades (13 in any necessary resit module), may be permitted to “shadow” the Junior Honours programme while being registered on the General BSc Degree programme. In this case a good performance in Junior Honours would normally result in the School permitting the students to transfer to the relevant Honours programme. “Good” in this context would be gaining credit for all modules, and obtaining a mean grade over the year of at least 12. To keep in the shadowing cohort a mean grade of at least 11 is needed at the end of first semester.

It is unlikely that a student with a mean grade of less than 10.0 at level two, or a grade of less than 8.0 in any of the required level-two modules would be permitted to "shadow" the Honours programme.

DISCLAIMER

Some of the above arrangements detailed in this booklet may have to be changed, and there may be errors. The School will endeavour to notify registered students of any updates to this document.