

FIRST AND SECOND LEVEL MODULES IN THE SCHOOL OF PHYSICS AND ASTRONOMY 2009-10

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Head of School: Professor Thomas Krauss
 School of Physics and Astronomy
 University of St Andrews
 North Haugh, St Andrews, Fife KY16 9SS
 Tel: (01334) 463103, Fax: (01334) 463104
physics@st-andrews.ac.uk
<http://www.st-andrews.ac.uk/physics/>

School Office opening hours
 weekdays 08.45 – 11.00, 11.30 – 13.00, 14.00-17.00

INTRODUCTION

This booklet provides information about the first and second level modules to be taught by the School of Physics and Astronomy in the session 2009-10. These modules are as follows:

First Level:	PH1011	Physics 1A
	PH1012	Physics 1B
	AS1001	Astronomy & Astrophysics 1
	AS1002	The Physical Universe*
Second Level:	PH2011	Physics 2A
	PH2012	Physics 2B
	AS2001	Astronomy & Astrophysics 2
	AS2002	Astronomy & Astrophysics 2 (for JH astro)

Each module lasts for one semester (one half of the academic session) and is assessed 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 AS2002, and as this is a module available only to students in Junior Honours Astronomy, it will not be considered further in this booklet). Normally six modules are taken at first level and four modules at second level. At both levels the selection of modules depends primarily on the degree in view and on the student's own interests. Guidance on the former, and full details of all the modules listed above, are provided in later sections of this booklet.

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. A brief summary of the honours degrees available is set out in Appendix E.

The School of Physics and Astronomy is one of the 18 Schools (i.e. major teaching units) in the University of St Andrews. Its academic staff (listed in Appendix A) and much larger number of contract research staff and research students are actively engaged in research activities over a wide spectrum in physics and astronomy, with particular interests in Laser Physics, Optoelectronics, Millimetre Waves, Semiconductors, Magnetism, Superconductivity, Theoretical Physics, and Observational and Theoretical Astronomy. In addition to the current choice of undergraduate Bachelor's and Master's degrees, the School offers at postgraduate level a taught MSc degree in Photonics and Optoelectronic Devices, and a PhD or MPhil may be taken by research.

*This module will not be taught in session 2009-10. It is likely that it will be available in 2010-11..

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 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.

LEVEL-ONE MODULES**Co-ordinators:**

		Room	Tel	e-mail
Physics (PH1011, PH1012)	Dr Tom Brown	216	3129	ctab
	Dr Cameron Rae (laboratory)	132c	7314	cfr
Astronomy 1 (AS1001)	Prof Simon Driver	308	1680	spd3
The Physical Universe (AS1002)	Not due to be taught in 2009-10			

The Co-ordinator is responsible for the enrolment of students, the keeping of records, and the tutorial and workshop programme. The organisation and planning of the physics teaching laboratory is the responsibility of Dr Rae.

Level One Physics

The two level-one modules in physics provide a balanced introduction to university physics, assuming a prior knowledge of mathematics and physics that corresponds to Higher grade passes at BB in these subjects. 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. 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 every detail. In particular, students may find a greater emphasis here on how mathematical and physical relations are determined.

**Physics 1A
(20 Credits)**

This module covers the core subjects of mechanics, waves and optics, and also provides an introduction to quantum phenomena. It is suitable for those who have studied physics to the level of Higher Physics or equivalent. It includes lectures on Newton's laws, gravitation, simple harmonic motion, the different types of wave motion, geometrical and wave optics, the origins of quantum theory, its application to atoms and other small scale systems..

Physics 1B

(20 credits)

This module covers the properties of matter, the mechanics of motion and an introduction to lasers. The module is suitable for those who have studied physics to the level of Higher Physics or equivalent. It includes lectures on the nature and composition of nuclei, atoms, molecules and solids; 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 will acquire

- an understanding of the topics covered in the module,
- an ability to solve problems based on the lecture material,
- 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

Astronomy & Astrophysics 1

(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 (not available in 2009-10)

(20 credits)

This module presents a descriptive, non-mathematical account of the physical universe, and is designed for those who do not intend to follow a degree programme within the School of Physics and Astronomy. The module has no prerequisites and is 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 this module 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, and a timetable is displayed in Appendix D.

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

Passes are normally required in SQA Higher-grade Physics and Mathematics (minimum grades BB) or GCE A-level Physics and Mathematics (minimum grades BC), or an equivalent set of qualifications. The School has put in a request to the University that, for the benefit of students, these entry requirements be raised.

Astronomy & Astrophysics 1

Passes are normally required in SQA Higher-grade Physics and Mathematics or in GCE AS-level Physics and Mathematics or an equivalent set of qualifications.

The Physical Universe

There are no specific entry requirements for this module. However the module 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 text book recommended for purchase for Physics 1A and Physics 1B, and a book that is also very useful for level-two physics, is Halliday, Resnick, and Walker, *Fundamentals of Physics*, 8th Edition (extended), Wiley, 2007. Earlier editions of the extended version are usually fine, though you may need to “translate” chapter numbers and the like. If you plan to buy the book new, then we recommend that you consider waiting until you are in St Andrews, and go to the bookshop in the Students Union Building and get it there, using ISBN number 0470136863. This version, for no extra charge, gives you online access to the electronic materials associated with the book, and which we tailor for our classes here. For those who choose not to purchase the book we will provide, at no cost to the student, electronic access to the same online materials. This book is also recommended for the second level modules Physics 2A and Physics 2B.

Alternative texts are:-

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

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

The library currently purchases ebooks from two different providers, www.netlibrary.com and <http://lib.mylibrary.com/home.asp> .

All ebooks can be accessed via the St Andrews University Library Catalog (SAULCAT), <http://138.251.116.3/> . Click on the “Electronic” Tab, enter author or title of the book into the search box, and then click on “connect to ebook”.

The MyLibrary ebooks have distinct URL’s, which are noted in the above lists. To see a list of all ebooks available in the MyLibrary reader, go to <http://lib.mylibrary.com/home.asp> and browse ebooks by subject.

The NetLibrary ebooks do not have distinct URL’s, and are most easily accessed through SAULCAT, or via <http://www.netlibrary.com/Search/BasicSearch.aspx> and then entering title/author into the search box.

Off-site access to ebooks:

You need an Athens account to access ebooks off-site. If you do not have an Athens username and password, please go to

<http://www.st-andrews.ac.uk/library/ElectronicResources/athens/> .

The instructions and Athens Registration Form are available from this link. Print out and complete the Athens Registration Form, and bring both the completed registration form and your University ID card to the library office counter. After having been given a username and password, follow the instructions for Athens Self-registration at <http://www.st-andrews.ac.uk/library/ElectronicResources/athens/> .

To access MyLibrary titles through Athens, go to the URL of the ebook as usual. A window titled "Authentication" comes up with boxes to enter a MyLibrary User ID and password. Do NOT put your Athens username into these boxes. Instead, further down the page, you should see

Click to access the Athens Authentication Point >>

You need to click on this. The Athens login then comes up, and you enter username (andphy...) and password into these boxes.

If you have any difficulties accessing ebooks, please contact the School’s Library Representative, Dr Antje Kohnle, ak81@st-andrews.ac.uk.

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.

In the workshops, students attempt problems on current lecture topics with demonstrator assistance, and some of their work is handed in for assessment.

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.

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 Mathematics, and some of this work is handed in for assessment.

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 each physics module there will be one afternoon period of 2½ hours per week of practical work. The laboratory programme is closely linked to the lecture courses and makes extensive use of computers for data collection and processing and for simulations. Further details about the arrangements for practical work are published separately.

In Physics 1A, the first three weeks of practical work take the form of mathematics revision sessions, as described above.

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. Voluntary evening sessions introduce students to the night sky and help to develop an appreciation of its natural beauty.

Laboratory sessions in practical astronomy are held for 2½ hours per week during afternoons. Students work individually or in pairs 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. In addition, voluntary observing sessions are arranged on clear Tuesday and Thursday evenings at the University Observatory, so that the night sky can be studied and experience gained in the operation of telescopes.

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, to be 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. Those taking The Physical Universe will also be monitored through tests. For each lecture course, 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 examination for each module consists of one written paper of 2 hours at the end of the semester. Re-assessment examinations are held in September.

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, 7.5% class test, 7.5% workshops, 25% labs (Re-assessment same as above)
PH1012	50% examination, 25% labs, 15% Group Discovery Project, 5% class test, 5% workshops (Re-assessment same as above)
AS1001	60% examination, 15% tests, 25% practical (Re-assessment 75% examination, 25% practical)
AS1002	50% examination, 50% tests (Re-assessment 100% examination)

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 award of grade 6.9.

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 the two modules in physics taken together. The Margaret Stewart Prize is awarded to the student in the module in Astronomy & Astrophysics who gains the highest grade.

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 must take the modules

PH1011	Physics 1A
PH1012	Physics 1B
MT1001	Introductory Mathematics ¹
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 the 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.

In addition to the modules already mentioned, the modules that are likely to be of most interest to students taking a degree in Physics and Astronomy are as follows:

MT1003	Pure & Applied Mathematics
MT1008	Mathematical Information Technology
CS1002	Computer Science
CS1004	Internet Programming
CH1401	Introductory Inorganic and Physical Chemistry
CH1402	Inorganic and Physical Chemistry I

Note that AS1002 The Physical Universe is not included in this list, since it cannot be taken along with any of the modules PH1011, PH1012 and AS1001.

¹ 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

Co-ordinators:

		Room	Tel	e-mail
Physics (PH2011, PH2012)	Dr Antje Kohnle	314	3195	ak81
	Dr Cameron Rae (laboratory)	132c	7314	cfr
Astronomy 2 (AS2001)	Professor Keith Horne	315A	3322	kdh1

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 (see Entry Requirements and Direct Entry to Second Level). 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 will 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 Schrodinger 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 (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 (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

(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.

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) First level route. Passes in the first level modules

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

(b) 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 direct entry to second level – see below. However, they may also be satisfied by a student who is not entering directly into second level, but wishes to take one or both modules in the first year of study. This possibility may be of 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 to have attended and passed the assessment in the first-level module AS1001 Astronomy & Astrophysics 1.

² Unless bypassed

Direct Entry to Second Level

In the present context, “direct entry” refers to accelerated progression for students who wish to take one of a range of degree courses in physics or astrophysics. Qualifying students are given 120 “advanced standing credits” on the basis of their school performance, and can then obtain an honours BSc degree in 3 years or an honours MPhys or MSci degree in 4 years.

The school 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.

It is our strong recommendation that those with A-levels considering direct entry to second level should have included mechanics as one of their mathematics A-level modules.

For those who take direct entry to second level, the following combinations of modules taken in the first year of study can lead into the third level of the degree programme at the end of that year:

1st Semester

PH2011 Physics 2A
MT1002 Mathematics
+ another 20-credit first level module

2nd Semester

PH2012 Physics 2B
MT2001 Mathematics

or

PH2011 Physics 2A
MT2001 Mathematics

PH2012 Physics 2B
MT2003 Applied Mathematics

We normally recommend that 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 all students intending to take a degree in Astrophysics. Such students take AS2002 in level 3.) 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.³

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.

³ 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.

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.

Recommended Books

Physics

A recommended text book for Physics 2A and Physics 2B is Halliday, Resnick, and Walker, *Fundamentals of Physics*, 8th Edition (extended), Wiley, 2007. Earlier editions of the extended version are usually fine, though you may need to “translate” chapter numbers and the like. If you plan to buy the book new, then we recommend that you consider waiting until you are in St Andrews, and go to the bookshop in the Students Union Building and get it there, using ISBN number 0470136863. This version, for no extra charge, gives you online access to the electronic materials associated with the book, and which we tailor for our classes here. For those who choose not to purchase the book we will provide, at no cost to the student, electronic access to the same online materials.

Alternative texts are:-

- *Physics for Scientists and Engineers. A Strategic Approach with Modern Physics* by R D Knight, Addison Wesley, 2004,
- *Understanding Physics*, 1st Edition by K Cummings, PW Laws, E F Redish, P J Cooney, Wiley, 2004,
- *Sears and Zemansky's University Physics* by H D Young and R A Freedman (12th edition, Addison-Wesley 2008), 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 (though not always up to the level that the course gets to), examples of how physics is applied in realistic situations, and many problems together with hints for solving them.

For Physics 2A, a useful textbook for the mechanics part of the module is *Analytical Mechanics* by Grant R Fowles and George Cassiday (Brooks/Cole, 7th edition, 2004). Another useful textbook for Physics 2A is *Classical Mechanics* by John R Taylor (University Science Books 2005). This is good for the oscillations and special relativity parts of this module.

Not particularly recommended for purchase, but useful reading in the library for the special relativity course within Physics 2A is *Nonclassical Physics; Beyond Newton's*

View by Randy Harris (Addison Wesley Longman, CA, 1999). *Relativity Visualised* is a popular text by Lewis Carroll Epstein (insight Press, CA, 1985) and is also well worth a read.

Although not recommended for purchase *An introduction to Thermal Physics* by D V Schroeder (Pearson, 2004) gives a very nice introduction to many of the concepts taught in Thermodynamics in level two.

For Physics 2B, a useful additional book is *Quantum Mechanics* by A. I. M. Rae (fifth edition, 2007, published by Chapman and Hall, and costing about £23. This is an affordable introductory textbook for undergraduate-level quantum mechanics, and would also be useful for study in level three. This text can be accessed as an ebook via www.netlibrary.com. An Athens account is required for off-site access.

Astronomy and Astrophysics 2

The recommended book for Astronomy & Astrophysics 2 is *Astronomy – A Physical Perspective* by M L Kutner (CUP 2003). This text can be accessed as an ebook via www.netlibrary.com. An Athens account is required for off-site access.

An alternative text is *Introductory Astronomy and Astrophysics* (4th edition) by M Zeilik and S A Gregory (Saunders College 1998).

Access to ebooks

Please see the information in the level one section of this handbook

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.

Practical Work

For students taking the Physics modules, practical work is intended to provide training in experimental techniques and to develop competence in using some of the standard equipment in physics laboratories, the analysis of experimental uncertainties and the presentation of experimental data in scientific reports. It is taught mainly in the laboratory, assisted by some lectures. Laboratory sessions are held from 3.00 to 5.30 pm on Mondays, Wednesdays or Thursdays. There are a number of units providing experience in measurement techniques, familiarity with instrumentation and computer programming. Data processing using computers will be an important part of some units, and a visit to research laboratories will give an opportunity to see techniques being used outside the teaching laboratory.

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.

Astronomy & Astrophysics laboratory sessions are held from 3.00 - 5.30 pm on Tuesdays. There are additional evening meetings at the Observatory so that students may gain experience of observational work.

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.

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 will be given further opportunities to pass it later in the semester.

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. 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. For each lecture course students will be issued via the tutorial system with one question normally taken from a past examination paper, and asked to hand in a written answer on a specified later date.

The examination for each module consists of one written paper of 3 hours at the end of the semester. Re-assessment examinations are held in September.

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, 15% workshops/tutorials, 25% labs (Re-assessment same as above)
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AS2001	60% examination, 15% tests, 25% practical (Re-assessment 75% examination, 25% practical)
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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 15% contribution from workshops and tutorials comes from the assessed workshop questions and the exam-style tutorial questions; each question has equal weight in this component.

A medal is awarded in each module to a student who shows outstanding achievement in the assessment. The J F Allen Prize is awarded to the most outstanding student in the two modules in physics taken together.

FURTHER INFORMATION

All

STUDENT WORK

In addition to their attendance at lectures, workshops, 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. Although it is difficult to quantify this, a reasonable target would be at least one hour of independent study for each lecture attended, in addition to whatever time is required to carry out tutorial exercises. The QAA recommends that each unit of credit should correspond to 10 hours of study time in total, for the average student. If difficulties are encountered in understanding the lecture material which cannot easily be resolved, e.g. by reference to text books or discussion with a fellow classmate, students are encouraged to approach the lecturer concerned who will be pleased to deal with queries of this type.

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) 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 Academic Registrar's Office (tel 462005 or 462596) and backed up by a completed Self Certificate for Absence report. It would also 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 the services of Student Support Services. Depending on the circumstances it may be possible for the School to defer the piece of assessment to a later date.

USE OF CALCULATORS IN EXAMINATIONS

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

THE 0-20 GRADING SCALE – SUB-HONOURS

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 passmark) 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 7s 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 principal 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 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	
11	1.4	
12	1.5	
13	1.6	
14	1.8	
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	
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	

%	Grade	Comment
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	

DEANS' LIST

In 2007/8 the University established a new 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.

The criteria for the award are strict. Only students taking no fewer than 120 credits counting towards an approved degree programme over the course of an academic year will be eligible and all credits have to be taken within the four Faculties of the University of St Andrews.

Study abroad is excluded from the scheme, although incoming students from other Universities will be eligible provided they meet all other criteria.

Any 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, who must achieve the minimum credit-weighted mean of 16.5 in 120 credits taken part-time over no more than three academic sessions.

Full details of all the criteria and conditions for the Deans List are available at:
<http://www.st-andrews.ac.uk/administration/deans/deanslist/>

PERMISSION TO PROCEED

The principle of Permission to Proceed (PP) is that students are permitted to progress in a module unless PP is withdrawn due to the non-fulfilment of a requirement of the module. Any student who forfeits PP will take no further part in the module and will not receive the credits for the module.

In all first and second level modules in physics and astronomy, attendance at all classes (lectures, tutorials, workshops and any specified practical work) is strongly recommended, *and in many cases is a requirement*. PP is liable to be withdrawn *without warning* from any student who is persistently absent from compulsory components of the module, as set out below.

Note that PP is quite separate from the issues which are involved in determining a student's overall grade for the module. It is not intended to penalise those who, despite doing their best, fail to achieve good marks in assessments; rather it is a mechanism to deter those who may be tempted to be idle and consequently to under-perform.

In order to retain Permission to Proceed, you 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, and in the case of Physics 1B, 75% of the scheduled group-project sessions.**
- 4. For Astronomy (AS) modules, achieve a grade of at least 2.0 in the combined score for the tests.**
- 5. In Physics 2A, achieve a pass in the maths test by the end of the teaching part of the semester.**
- 6. For Physics 1A and 1B, to achieve a grade of at least 3.0 in the class tests.**
- 7. For all modules, achieve a grade of at least 3.0 in the final examination. (This includes the case of students who fail to attend the examination without a satisfactory reason.)**
- 8. In module AS1901 to complete and submit a minimum of 75% of the continuously assessed components of the module.**

Any justifiable reasons for absence from tutorials, workshops, tests and examinations should be presented in writing following the procedure set out above. Late justifications will be accepted only in exceptional circumstances.

Any student who loses PP other than through their performance in an examination will be informed by the module coordinator via e-mail. Such students may appeal, stating the grounds, to the Director of Teaching. Any appeal must be lodged within the time allowed.

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>

or from the Students Association's publication "Don't Get it Wrong":

(http://yourunion.net/files/dont_get_it_wrong.pdf).

The full University policy and procedure is also available 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 SALTIRE

(June.Knowles@st-andrews.ac.uk) for advice and training.

Within the School, the most obvious example of plagiarism 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. The University's procedure will be applied whenever instances of this or similar practices are detected, and the available penalties include the possibility of forfeiting Permission to Proceed in the module. 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 plagiarism is essentially dishonest.

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 the University no longer normally permits resit examination grades 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 of 11 or better for entry to BSc honours and 15 or better for entry to MPhys honours.

PHYSICS / MATHEMATICS LIBRARY

The Library on the third floor contains the University's main collection of textbooks and research journals on Astronomy, Physics, Computing and Mathematics.

The library has benefitted from a complete structural renewal in the summer of 2009. In the last three years hundreds of new books and ebooks have been purchased for our library. We hope that our students find this investment to have been worthwhile. The building work is due to finish a few weeks into first semester. Until then, there will be a library access point in the main concourse.

Books may be borrowed but are generally subject to recall after seven days. Journals may not be borrowed, but are often available online. Texts recommended for a lecture course will normally be available from the librarian on short loan and may be borrowed from the library overnight or for the weekend. Other recommended texts may sometimes be available on 7-day loan. Some texts are available as ebooks, see www.myilibrary.com/Search/my_content.asp for a complete listing. The reference works occupy a separate section and must not be removed from the library. Solutions to some tutorial problem sheets and some lecture notes are kept on reserve in the library office and may be borrowed for use within the library. Some solutions are available via the modules's WebCT site.

The photocopier in the library is for use by students. Prepaid cards are required to operate the machine and may be obtained from the librarian or from the card dispenser. Further information on the use of the Physics/Mathematics library is contained in an information leaflet obtainable at the service desk.

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 new concourse now has group-study tables behind the new 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

The Student-Staff Council has representatives for students in each level of study, and also a postgraduate representative and ten 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.

Two student representatives are elected from each of the first and second level modules in the first semester, and normally hold office for the whole academic year. The representatives discuss teaching matters with the Co-ordinator, who reports to each meeting 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 and the acquisition of works of art to decorate the public areas in the building.

The Website Committee oversees the arrangements for keeping students informed of current news and developments. The Social Committee is responsible for the organisation of the Student/Staff Christmas dinner and for any other social events which take place during the year.

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 a range of penalties will be applied for late submission. Often this will be expressed as a percentage reduction in the mark to be awarded for each day late.

INFORMATION FOR STUDENTS

The “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.

ACCESS TO EXAMINATION SCRIPTS

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 will usually try 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. Students are not allowed to take away the 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.

DISABILITIES COORDINATOR

The 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 Support Services. Our aim is to try to make the same or equivalent facilities and experiences available to all.

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 safety policy of the School is published on our web pages.

Anyone requiring First Aid during normal hours should contact Les Kirk (Room 235, Level 2, Tel 3132). There are first aid boxes on each level, including by the lift doors.

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 throughout their time at St Andrews can be relevant, which may be another reason for working hard throughout the degree programme.

ACADEMIC DATES 2009-10

Martinmas Semester:	28 September to 22 January
Christmas Vacation:	19 December to 4 January
Candlemas Semester:	8 February to 28 May
Spring Vacation:	27 March to 11 April

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 someone with no direct connection to the School, then Student Support Services in the Students Union Building can provide professional support. They are also 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 Student Support Services during their time in St Andrews. For more information see www.st-andrews.ac.uk/ss/

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.

APPENDIX A – SELECTED STAFF MEMBERS

	<i>Room</i>	<i>ext</i>	<i>email</i>		<i>Room</i>	<i>ext</i>	<i>email</i>
Lecturing Staff				Secretarial Staff			
André Dr P	284	3036	pa11	Aitken Mrs L M	211	3100	lma1
Baumberger Dr F	208	1682	fb40	Rodger Mrs M	211	3111	mr9
Bonnell Prof I A	312	3140	iab1	Staniforth Mrs L	211	3103	ls42
Brown Dr C T A	216	3129	ctab				
Cameron Prof A C	315	3147	acc4	Administrator			
Cassettari Dr D	218	3109/3186	dc43	Edwards Dr T J	207	3145	tje1
Cornwell Prof J F	340	1676	jfc				
Delorme Dr P	335	1672	pd10	Teaching Laboratory Technicians			
Dholakia Prof K	217	3184	kd1	Kirk Mr L J	235A	3132/3148	ljk2
Dominik Dr M	329A	3068	md35	Donaldson Mr P T	235A	3132/3148	ptd
Douglass Mrs M	305	3296	md90				
Driver Prof S P	308	1680	spd3				
Dunn Prof M H	221	3119	mhd	Head Janitor			
Gillies Dr A D	241	3179	adg1	Jardine Mr J		3136	jan-phys
Greaves Dr J	306	1681	jsg5				
Green Dr A G	213	3112	ag71	Safety Officer			
Helling Dr Ch	318	1666	ch80	Gavine Mr R C	172	3180	rcg2
Horne Prof K D	315A	3322	kdh1				
Hooley Dr C A	304	3171	cah19	First Aider			
Jardine Dr M M	313	3146	mmj	Kirk Mr L J	235A	3132/3148	ljk2
Koenig Dr F	204	3128	fewk				
Kohnle Dr A S	314	3195	ak81	Generic School Contact Details			
Korolkova Dr N	311	3139	nvk	School Office	211	3103	physics
Krauss Prof T F	215	3107	hospanda				
Leburn Dr C G	255	3053/3054	cgl				
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				
Rae Dr C F	132C3	7314	cfr				
Samuel Prf I D W	207A	3114	idws				
Scholz Dr A	318	1666	as110				
Sibbett Prof W	209	3100	ws				
Sinclair Dr B D	221	3118	b.d.sinclair				
Smith Dr G M	210	2669	gms				
Turnbull Dr G A	205	7330	gat				
Wan Dr K K	242	3210	kw				
Weidner Dr C	336	1673	cw60				
Wood Dr K	316	3116	kw25				
Zhao Dr H	316A	3135	hz4				

Key Contacts/Coordinators

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
School Senior Secretary	Mrs Mary Rodger	211	mr9

Coordinators/advisers

Sub-honours Advisers	Prof Ian Bonnell,	312	iabl
	Dr Frieder Koenig,	204	fewk
	Dr Graham Smith	210	gms
Junior Honours	Dr Natalia Korolkova	311	nvk

Module and programme coordinators – shown in main text

Other

Examination Officer	Dr Andrew Green	213	ag71
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

APPENDIX B: SYLLABI OF FIRST LEVEL MODULES

1

PH1011 Physics 1A

Mechanics 1 (10 lectures)

Dr Kong Wan

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.

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.

PH1012 Physics 1B

Lasers and Optoelectronics (10 lectures)

Dr Michael Mazilu

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. Basic aspects of holography. Some applications of lasers in science, engineering and medicine.

Optoelectronic devices: transmitter and receiver system for optical communications. Coherent and digital optics.

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.

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.

Mechanics II (9 lectures)

Dr Kong Wan

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.

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 Phillippe Delorme

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)

Professor Simon Driver

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.

AS1002: The Physical Universe (not available in 2009-10)

Concepts in Astronomy (20 lectures)

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)

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.

PH2011 Physics 2A

Mechanics (18 lectures)

Professor Ian Bonnell

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 Andrew Green

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.

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 values 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.

AS2001 Astronomy & Astrophysics 2

Chemical Evolution of the Universe (12 lectures)

Professor 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)

Professor Andrew Cameron

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 Christianne Helling

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)

Professor Ian Bonnell

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.

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
Second level		
PH2011	Physics 2A	10-11
AS2001	Astronomy and Astrophysics 2	11-12

Candlemas (second) Semester

First level		
PH1012	Physics 1B	12-1
AS1002	The Physical Universe	not 2009-10
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

Major/Minor Honours

Physics with French⁴
Physics with Spanish⁵

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 in one's second level programme PH2011 Physics 2A, PH2012 Physics 2B, MT2001 Mathematics and (for those wishing to do the Astrophysics degree) AS2001 Astronomy and Astrophysics 2⁶. 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. The University no longer normally permits resit grades 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 entry to BSc honours and 15 or better for entry to MPhys honours.

⁴ Also available "with integrated year abroad"

⁵ Also available "with integrated year abroad"

⁶ For those who take direct entry to second level, AS2002 is postponed until level 3

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.

Entry Requirements to the Honours Physics and Astronomy Programmes

BSc Programmes

Grade 11 or better in 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 entry directly into level two physics, AS2002 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 and MSci Programmes

Grade 15 or better in PH2011 and 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 entry directly into level two physics, AS2002 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 the specified grade in AS2001.

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

The University no longer normally allow resit grades to be used to satisfy the above requirements. Students entering the honours class will also normally have the appropriate number of credits at sub-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 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 first semester of 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 of 13.0 or above.

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.

THE MPhys AND MSci DEGREES

The Master in Physics (or Master in Science) degree is designed to cater for those students who wish to take physics to a more advanced level than the BSc honours degree. It is especially suitable for those who wish to proceed to research or to become professional physicists or astronomers.

The MPhys and MSci degrees in St Andrews are normally of 5 years duration, and differ from the BSc by

- (a) requiring 600 credits rather than 480, the difference corresponding to the extra year's study,
- (b) requiring modules worth 120 credits to be taken at 5000 level (equivalent to the standard of modules forming part of a postgraduate MSc course) and
- (c) involving a more demanding project.

However, it is possible for well qualified entrant students to enter directly to level 2 physics (see earlier in this handbook), and for those students an honours BSc degree may be taken in 3 years and an MPhys in 4 years.