AS1001 Astronomy and Astrophysics 1

SCOTCAT Credits:	20	SCQF level 7	**Semester**	1
Academic year:	2021-2022			
Planned timetable:				

This module surveys our present state of knowledge of the orbits, surfaces and atmospheres of the planets in our solar system; the structure and evolution of the Sun and other stars, including extra-solar planetary systems; the bizarre menagerie of star-forming regions, violent stellar objects and supermassive black holes found within our own Milky Way Galaxy and in other galaxies; and the large-scale structure and ultimate fate of the expanding Universe. Throughout the module, fundamental observations are interpreted using mathematical models to show how distances and other properties of astronomical objects throughout the Universe have been measured, from the time of Copernicus to the era of the Hubble Telescope and beyond.

Pre-requisite(s):	The student must have Higher or A-Level (or equivalent) physics and mathematics at grade B or better	
Anti-requisite(s)	You cannot take this module if you take AS1002 or take AS1101	
Learning and teaching methods of delivery:	**Weekly contact**: 4 x 1hr lectures x 10 weeks, 1hr tutorial x 8 weeks, 2.5 hr lab x 6 weeks, 1hr workshop x 9 weeks	
	Scheduled learning: 72 hours	**Guided independent study:** 128 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 60%, Practical Examinations = 0%, Coursework = 40%	
	As used by St Andrews: 2-hour Written Examination = 60%, Class Tests = 15%, Laboratory work = 25%	
Re-assessment pattern:	2-hour Written Examination = 75%, Existing Laboratory work = 25%	
Module coordinator:	Dr A Scholz	

Additional information from Schools:

AS1001 - Astronomy and Astrophysics 1
Aims & Objectives
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 10-lecture courses on The Solar System, Stars and Elementary Astrophysics, The Galaxy, and Cosmology, thereby providing a complete overview of the subject at this level.
Learning Outcomes
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.

	Synopsis (1) The Solar System 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. (2) Stars and Elementary Astrophysics Astronomical observations. 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. Binary stars for masses, radii, luminosities. (3) The Galaxy 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. (4) Cosmology 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. **Additional information on continuous assessment etc** **Recommended Books** Please view University online record: http://resourcelists.st-andrews.ac.uk/modules/as1001.html **General Information** Please also read the general information in the School's 1st and 2nd level handbook that is available via st-andrews.ac.uk/physics/staff_students/timetables.php

AS1101 Astrophysics (Direct Entry)

SCOTCAT Credits:	5	SCQF level 7	**Semester**	1
Academic year:	2021-2022			
Availability restrictions:	Available only to Direct Second level Entry students in Physics or Astrophysics			
Planned timetable:				

This module provides a streamlined introduction to the science of astrophysics for students who have taken direct entry to Second level and who are planning to take level two astrophysics later in the same academic session. It covers the essential items of observational astrophysics and how the radiation that is detected on Earth can be used to develop a physical model of the Sun, stars, planets, our Galaxy and external galaxies as well as the Universe as a whole. Topics will include stellar evolution, the rotation curves of galaxies and the need for Dark Matter as well as the expanding Universe, Dark Energy and cosmology.

Pre-requisite(s):	Direct entry to level two at the University of St Andrews with a degree intention of astrophysics, physics, theoretical physics or a joint degree with one of these.	
Anti-requisite(s)	You cannot take this module if you take AS1001 or take AS1002 or take PH1501	
Co-requisite(s):	You must also take PH2011	
Learning and teaching methods of delivery:	**Weekly contact**: 3 x 1hr lectures x 4 weeks, 1hr tutorial x 4 weeks, 1hr Q&A x 4 weeks, 2.5 hr lab x 2 weeks	
	Scheduled learning: 25 hours	**Guided independent study:** 25 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%	
	As used by St Andrews: Coursework (Class test = 50%, laboratory work = 25%, take-home exam = 15%, online quizzes = 10%) = 100%	
Re-assessment pattern:	1-hour Written Examination = 75%, Existing Laboratory work = 25%	
Module coordinator:	Dr A Weijmans	

Additional information from Schools:

AS1101 - Astrophysics (Direct Entry)

Aims & Objectives

The aim of this module is for students to obtain an elementary understanding of the structure of the observable Universe, and our position within it. We explore the physical content of the Universe, its structures and interactions. We discuss how properties of planets, stars and galaxies can be determined from observations, coupled with theoretical models based on physical principles. The module comprises 12 lectures on Elementary Astrophysics, Stars and Stellar Evolution, The Milky Way and other Galaxies, and Cosmology, and thereby provides a complete overview of the subject at this level.

Learning Outcomes

By the end of this module, students will have gained:

- an understanding of the structure and evolution of the physical Universe
- an ability to calculate astrophysical properties of celestial objects (e.g., planets, stars and galaxies) from (simplified) observations coupled with basic physical and mathematical models

Synopsis

1. Elementary Astrophysics
2. Stars and Stellar Evolution
3. The Milky Way and other Galaxies
4. Cosmology

Recommended Books

Please view University online record:
http://resourcelists.st-andrews.ac.uk/modules/as1101.html

	General Information Please also read the additional information in the School's handbook for first and second level modules that is available via https://www.st-andrews.ac.uk/physics-astronomy/students/ug/timetables-handbooks/.

AS2001 Astronomy and Astrophysics 2

SCOTCAT Credits:	30	SCQF level 8	**Semester**	2
Academic year:	2021-2022			
Planned timetable:				
This module comprises four lecture courses which extend knowledge gained in the first level AS1001 or AS1101 module, and discusses recent developments in the subject: (i) observational techniques - modern telescopes; instruments and detectors for multiwavelength observations; essential coordinate systems; (ii) the structure and evolution of stars - nucleosynthesis, stellar properties as a function of age, a complete understanding of the HR diagram; (iii) exoplanetary science - theoretical and observational studies of planetary systems beyond our own; (iv) galactic astronomy - the distribution and motion of stars, gas, dust, and dark matter in our Milky Way and other galaxies.				
Pre-requisite(s):	Before taking this module you must (pass AS1001 or pass AS1101) and pass PH1011 and pass PH1012 and pass MT1002			
Anti-requisite(s)	You cannot take this module if you take AS2101			
Learning and teaching methods of delivery:	**Weekly contact**: 4 x 1hr lectures x 11 weeks, 1hr tutorial x 10 weeks, 2.5hr laboratory x 8 weeks			
	Scheduled learning: 87 hours		**Guided independent study:** 213 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 60%, Practical Examinations = 0%, Coursework = 40%			
	As used by St Andrews: 3-hour Written Examination = 60%, 2 x Class Tests = 15%, Laboratory work = 25%			
Re-assessment pattern:	3-hour Written Examination = 75%, Existing Laboratory work = 25%			
Module coordinator:	Professor A C Cameron			
Additional information from Schools:	To be confirmed			

AS2101 Astrophysics 2

SCOTCAT Credits:	15	SCQF level 8	**Semester**	2
Academic year:	2021-2022			
Availability restrictions:	Normally available only to those who took 'direct entry' to second year			
Planned timetable:				
This module is designed to extend the knowledge gained in the first level AS1001 or AS1101 module and to prepare the way for more advanced material appearing in the honours astrophysics modules. The module has three basic components dealing with the physics of stellar structure and evolution, the components and dynamics of galaxies, and exoplanetary science - theoretical and observational studies of planetary systems beyond our own . The module is based on the physical principles and mathematical techniques acquired earlier, and applied to the astrophysical concepts covered in AS1001 or AS1101.				
Pre-requisite(s):	Before taking this module you must (pass AS1001 or pass AS1101) and pass MT1002 and pass PH2011			
Anti-requisite(s)	You cannot take this module if you take AS2001			
Learning and teaching methods of delivery:	**Weekly contact**: 3 or 4 lectures and 1 tutorial.			
	Scheduled learning: 50 hours		**Guided independent study:** 100 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 80%, 2 x Class Tests = 20%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor A C Cameron			
Additional information from Schools:	To be confirmed			

PH1011 Physics 1A

SCOTCAT Credits:	20	SCQF level 7	**Semester**	1
Academic year:	2021-2022			
Planned timetable:				
This module covers the core subjects of mechanics, waves and optics, and also provides an overview of the physical properties of matter. It is suitable for those who have studied physics to the level of Higher Physics or equivalent. It includes lectures on Newton's laws, work and energy, simple harmonic motion, the different types of wave motion, geometrical and wave optics, and the nature and composition of nuclei, atoms, molecules and solids, and their interactions. Relevant laboratory work is an important part of the module.				
Pre-requisite(s):	Students must have Higher or A-Level physics and mathematics (both at grade B or better), or equivalent.			
Anti-requisite(s)	You cannot take this module if you take AS1002			
Learning and teaching methods of delivery:	**Weekly contact**: 4 x 1hr lectures x 10 weeks, 1hr problem-solving workshop x 5 weeks, 1hr tutorial x 9 weeks, and 2.5 hr lab work x 9 weeks			
	Scheduled learning: 79 hours		**Guided independent study:** 121 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%			
	As used by St Andrews: 2-hour Written Examination = 60%, Class Test = 15%, Laboratory Work = 25%			
Re-assessment pattern:	2-hour Written Resit Examination = 60%, combined with existing Laboratory Work = 25%, existing Class Test = 15%			
Module coordinator:	Dr P Woitke			
Additional information from Schools:	To be confirmed			

PH1012 Physics 1B

SCOTCAT Credits:	20	SCQF level 7	**Semester**	2
Academic year:	2021-2022			
Planned timetable:				
This module covers an introduction to quantum mechanics, the mechanics of rotation and gravity 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 origins of quantum theory, its application to atoms and other small-scale systems; 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. Relevant laboratory work is an important part of the module.				
Pre-requisite(s):	Before taking this module you must pass PH1011			
Anti-requisite(s)	You cannot take this module if you take AS1002			
Learning and teaching methods of delivery:	**Weekly contact**: Typically 4 lectures, 1 workshop, 1 tutorial and 1 x 2.5 hr laboratory. Group Discovery Project replaces some lectures for part of the semester.			
	Scheduled learning: 71 hours		**Guided independent study:** 129 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 60%, Practical Examinations = 0%, Coursework = 40%			
	As used by St Andrews: 2-hour Written Examination = 50%, Class Test = 10%, Laboratory work = 25%, Group Discovery Project = 15%			
Re-assessment pattern:	2-hour Written Resit Examination = 50%, combined with existing Laboratory work = 25%, and existing Group Discovery Project = 15%, existing class test 10%			
Module coordinator:	Dr H M Cammack			
Additional information from Schools:	To be confirmed			

PH1501 Mathematics for Physicists 1A

SCOTCAT Credits:	20	SCQF level 7	**Semester**	1
Academic year:	2021-2022			
Availability restrictions:	Available only to those on the Physics and Astronomy (Gateway) Programme and the Physics and Astronomy International Gateway Programme.			
Planned timetable:				
This module is designed to give physics students a secure base in elementary calculus and other mathematical tools to enable them to access the mathematics modules needed for progression into physics and astronomy degrees. Participants will learn to use this mathematics effectively and efficiently in the context of work in physics. Some of the work is a revision and practice of material that will normally have been seen in the Scottish Higher and some A-Level maths syllabuses. The content is similar to that in MT1001 and will allow students to progress to MT1002 in semester 2.				
Pre-requisite(s):	Students must have gained entry to Physics and Astronomy (Gateway) or International Gateway programmes.			
Anti-requisite(s)	You cannot take this module if you take MT1001			
Co-requisite(s):	You must also take PH1011 and take PH1502			
Learning and teaching methods of delivery:	**Weekly contact**: 4 or 5 x 1hr lectures x 10 weeks, 1hr tutorial x 9 weeks, 2 x 1hr workshops x 10 weeks			
	Scheduled learning: 99 hours		**Guided independent study:** 101 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 70%, Practical Examinations = 0%, Coursework = 30%			
	As used by St Andrews: 2-hour Written Examination = 50%, Coursework (Class Tests, 20%, Other Coursework,30%) = 50%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr I Leonhardt			
Additional information from Schools:	To be confirmed			

PH1502 Physics Skills 1A

SCOTCAT Credits:	20	SCQF level 7	**Semester**	1
Academic year:	2021-2022			
Availability restrictions:	Available only to those on the Physics and Astronomy (Gateway) Programme and the Physics and Astronomy International Gateway Programme			
Planned timetable:				
This module develops academic and transferable skills in problem-solving, team-working, information retrieval and analysis, and study skills. It is a core module of the level one programme Physics and Astronomy (Gateway).				
Pre-requisite(s):	Students must have gained entry to Physics and Astronomy (Gateway) or International Gateway programmes.			
Anti-requisite(s)	You cannot take this module if you take AS1101			
Co-requisite(s):	You must also take PH1011 and take PH1501			
Learning and teaching methods of delivery:	**Weekly contact**: 7.5hr workshops x 10 weeks , 2.5hr x 9 weeks laboratory sessions, 1.5hr supported study session x 10 weeks			
	Scheduled learning: 100 hours		**Guided independent study:** 100 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	60% new assignments, 40% marks for the assignments that make up the first assessment specification of the module.			
Module coordinator:	Dr L J Jakeman			
Additional information from Schools:	**PH1502 - Gateway - Physics Skills 1A** **Aims & Objectives** Students will develop their understanding of the core subjects that a Physics degree programme builds upon in addition to developing laboratory and problem solving skills. This module consists of a series of workshops, supported self-study sessions as well as group exercises covering topics designed to run alongside material developed in PH1011 and PH1501/MT1002. **Learning Outcomes** By the end of this module, students should • have experienced and demonstrated different methods of studying; • be able to work independently and as part of a group; • be able to express scientific ideas to their peers; • have enhanced their communication skills by applying their subject knowledge to a particular topic and presenting their finding to their peers at an appropriate level. **Synopsis** Problem solving: problem solving strategies, peer instruction tutorials and regular problem solving workshops relevant for the material covered in PH1011. Practical Laboratory work to develop basic lab skills. Independent and group research into a specific areas of physics. Study skills and communication: the production of revision summaries, regular reflection on own learning and supported study sessions. The creation and production of a variety of pieces of work on a chosen area of physics. **Recommended Books** Please view University online record: http://resourcelists.st-andrews.ac.uk/modules/ph1502.html			

	General Information Please also read the additional information in the School's handbook for 1st and 2nd level modules that is available via https://www.st-andrews.ac.uk/physics-astronomy/students/ug/timetables-handbooks/.

PH1503 Physics Skills 1B

SCOTCAT Credits:	20	SCQF level 7	**Semester**	2
Academic year:	2021-2022			
Availability restrictions:	Available only to those on the Physics and Astronomy (Gateway) Programme and the Physics and Astronomy International Gateway Programme			
Planned timetable:				
This module develops academic and transferable skills in problem solving in physics, in mathematical modelling of physical systems, in numerical/computational work applied to physics, and in study skills. It is a core module for the level one programme Physics and Astronomy (Gateway).				
Pre-requisite(s):	Students must have gained entry to Physics and Astronomy (Gateway) or International Gateway programmes.			
Co-requisite(s):	You must also take PH1012			
Learning and teaching methods of delivery:	**Weekly contact**: 2 lectures, 3 x 1.25-hour workshops, 1 x 3-hour lab, 1 x 2-hour supported study session			
	Scheduled learning: 132 hours		**Guided independent study:** 68 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	60% new assignments, 40% marks for the assignments that make up the first assessment specification of the module.			
Module coordinator:	Dr L J Jakeman			
Additional information from Schools:	**PH1503 - Gateway - Physics Skills 1B** **Aims & Objectives** The second Gateway skills module is designed to build upon the PH1502 module. Students will develop their understanding of the core material covered in PH1012 as well as continuing to practise and enhance their basic mathematical skills and lab skills developed in semester 1. Students will undertake a short astronomy course to allow students to be eligible for AS2001. This is brought about by a series of workshops, supported self-study sessions as well as group exercises covering topics designed to run alongside material developed in PH1012 and MT1002. **Learning Outcomes** By the end of this module, students should • have developed their fundamental subject knowledge and be able to express scientific ideas to their peers; • be able to work independently and as part of a group; • have experienced and demonstrated different methods of studying; • have enhanced their communication skills by applying their subject knowledge to a particular topic and presenting their finding to their peers at an appropriate level. • have gained an understanding of the structure and evolution of stars and galaxies as well as the origin and fate of the universe. In addition, students should be able to calculate astrophysical properties of stars using basic physical models and simplified data.			

	Synopsis Problem solving: problem solving strategies, peer instruction tutorials and regular problem solving workshops relevant for the material covered in PH1012. Practical laboratory work to develop basic lab skills. Independent research into a chosen area of physics. Study skills and Communication: The production of revision summaries, regular reflection on own learning and supported study sessions. The creation and presentation of a poster on a chosen area of physics. Astronomy short course: stars and elementary astrophysics - including stellar brightness, magnitudes, distance, colours, Hertzsprung-Russell diagram, stellar spectra and classification, stellar evolution; structure of the Milky Way - structure of the Milky Way, populations, rotation curve; the universe - types of galaxies, expansion of the universe, birth, evolution and fate of the universe. **Recommended Books** Please view University online record: http://resourcelists.st-andrews.ac.uk/modules/ph1503.html **General Information** Please also read the additional information in the School's handbook for 1st and 2nd level modules that is available via https://www.st-andrews.ac.uk/physics-astronomy/students/ug/timetables-handbooks/.

PH2011 Physics 2A

SCOTCAT Credits:	30	SCQF level 8	**Semester**	1
Academic year:	2021-2022			
Planned timetable:				
This module covers the subjects of mechanics, special relativity, oscillations, and thermal physics. It is suitable for those who have taken the specified first year modules in physics and mathematics, or have good Advanced Higher or A-Level passes or equivalent in physics and mathematics. It includes lectures on the dynamics of particles and rigid bodies, Einstein's special theory of relativity, free, forced and damped harmonic motion, and lectures on thermal physics including elementary thermodynamics and the notion of entropy.				
Pre-requisite(s):	Students should have passed PH1011, PH1012 and MT1002 or have passes in Advanced Higher physics and mathematics or A-Level physics and mathematics, both normally at grade A or equivalent.			
Anti-requisite(s)	You cannot take this module if you take AS1002			
Learning and teaching methods of delivery:	**Weekly contact**: 4 or 5 x 1hr lectures x 10 weeks, 1 hr tutorial x 9 weeks, 2.5-hr laboratory x 9 weeks, 1hr Q&A x 10 weeks, 1hr workshop x 2 weeks			
	Scheduled learning: 88 hours		**Guided independent study:** 212 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 70%, Practical Examinations = 0%, Coursework = 30%			
	As used by St Andrews: 3-hour Written Examination = 60%, Class Test = 10%, Laboratory work = 25%, online quizzes = 5%			
Re-assessment pattern:	3-hour Written Resit Examination = 60%, combined with existing Class Test = 10%, Laboratory Work = 25%, and lecture and pre-online quizzes = 5%			
Module coordinator:	Professor G A Turnbull			
Additional information from Schools:	To be confirmed			

PH2012 Physics 2B

SCOTCAT Credits:	30	SCQF level 8	**Semester**	2
Academic year:	2021-2022			
Planned timetable:				
This module covers the subjects of quantum physics, electricity and magnetism and classical waves. It includes lectures on the origin of Schroedinger's equation in quantum mechanics and its solution for simple one-dimensional potentials; an elementary introduction to the electromagnetic field comprising electrostatics, magnetostatics, electromagnetic induction and circuit theory; and lectures on waves, acoustics, polarisation of light, and interference.				
Pre-requisite(s):	Before taking this module you must pass PH2011			
Learning and teaching methods of delivery:	**Weekly contact**: 4 or 5 lectures, 1 workshop, 1 tutorial and 1 x 2.5-hour laboratory.			
	Scheduled learning: 84 hours		**Guided independent study:** 215 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 70%, Practical Examinations = 0%, Coursework = 30%			
	As used by St Andrews: 3-hour Written Examination = 60%, Class Test = 10%, Laboratory work = 25%, online quizzes = 5%			
Re-assessment pattern:	3-hour Written Resit Examination = 60%, combined with existing Class Test = 10%, Laboratory Work = 25%, and online quizzes = 5%			
Module coordinator:	Professor G A Turnbull			
Additional information from Schools:	To be confirmed			