Programme Specification: Undergraduate

For students starting in Academic Year 2017/2018

1. Course Summary

Names of programme(s) and award title(s)	BSc (Hons) Physics BSc (Hons) Physics with International Year (see Annex A for details)
Award type	Single Honours
Mode of study	Full time
Framework of Higher Education Qualification (FHEQ) level of final award	Level 6
Duration	3 years 4 years with International Year
Location of study	Keele University – main campus
Accreditation (if applicable)	This programme will be put forward for accreditation by the Institute of Physics (IoP) – for further details see Section 12
Regulator	Higher Education Funding Council for England (HEFCE)
Tuition Fees	**UK/EU students:** Fee for 2017/18 is £9,250* **International students:** Fee for 2017/18 is £15,250** The fee for the international year abroad is calculated at 15% of the standard year fee
Additional Costs	Refer to section 18

How this information might change: *Please read the important information at http://www.keele.ac.uk/student-agreement/. This explains how and why we may need to make changes to the information provided in this document and to help you understand how we will communicate with you if this happens.*

2. What is a Single Honours programme?

The Single Honours programme described in this document allows you to focus more or less exclusively on Physics. In keeping with Keele's commitment to breadth in the curriculum, the programme also gives you the opportunity to take some modules outside Physics, in other disciplines and in modern foreign languages as part

** These fees are regulated by Government. We reserve the right to increase fees in subsequent years of study in response to changes in government policy and/or changes to the law. If permitted by such change in policy or law, we may increase your fees by an inflationary amount or such other measure as required by government policy or the law. Please refer to the accompanying Student Terms & Conditions. Further information on fees can be found at http://www.keele.ac.uk/studentfunding/tuitionfees/*

*** We reserve the right to increase fees in subsequent years of study by an inflationary amount. Please refer to the accompanying Student Terms & Conditions for full details. Further information on fees can be found at http://www.keele.ac.uk/studentfunding/tuitionfees/*

of a 360-credit Honours degree. Thus it enables you to gain, and be able to demonstrate, a distinctive range of graduate attributes.

3. Overview of the Programme

Physics is one of the fundamental curiosity-driven science subjects that has applications and makes an enormous contribution to other areas of sciences and a range of industries such as power, nuclear, electronics, IT, data-mining, telecommunications, medical, pharmaceutical and food technology.

The broad educational aims of this programme are informed by the QAA Benchmark Statement for Physics. The programme aims to provide a thorough education in the core areas of physics (as defined by the Institute of Physics [IoP] accreditation standards), to extend this subject knowledge to more advanced topics, informed by the research interests of staff, together with providing a theoretical and practical understanding of the analytical, experimental and computational techniques that are of particular importance to physics graduates. Successful graduates will have achieved a demonstrable understanding of the fundamentals of physics and be able to apply this knowledge to solve problems, plan investigations, analyse results and to report and present their work in ways described in more detail below.

On successful completion of the Physics programme at Keele, students will be equally qualified and well prepared for postgraduate studies or for graduate level employment in a wide variety of industrial sectors. Tuition will be based on a modular system with varied modes of delivery, ranging from traditional lectures through to laboratory work, problem-solving classes and tutorials in smaller groups. Mathematics and computing form important parts of the programme and are taught both within dedicated modules and synoptically throughout the programme by staff in the Physics department. A mixed set of assessment modalities include examination, report-writing, presentations, problem sheets, laboratory work, essays, dissertations and vivas, with an overall balance of approximately 50% examination and 50% continually assessed, dependent on the exact module diet.

Whilst the dual honours Physics programme focuses almost exclusively on the IoP “core curriculum” in years 1 and 2, the Single Honours Physics programme goes beyond this in terms of breadth and depth. There is an additional emphasis on Mathematics, Statistics and Computing and the application of Physics to solving problems; further opportunities for both individual and team practical work and an individual dissertation in year 3.

4. Aims of the Programme

The broad aims of the programme are to enable you to:

- achieve a knowledge and understanding of the fundamentals of Physics and be able to apply this knowledge and understanding to solving problems;
- develop competence in mathematical, statistical and numerical techniques and employ these to solve physical problems;
- develop competence in laboratory activities and computer programming by the end of year 2 and undertake project work both individually and within a team by the end of year 3;
- acquire the skills required to assimilate new knowledge and to communicate your work and ideas in a variety of formats;
- acquire a range of subject-specific skills including how to formulate and tackle problems in Physics; how to plan, manage, execute and report the results of an investigation; how to use mathematics to describe the physical world; and how to deploy these skills to tackle issues within the subject;
- acquire a range of cognitive, generic and transferable skills including problem-solving skills, investigative skills, analytic skills, communication skills, IT skills, time management skills and interpersonal skills.

Employability

The programme will enable you to:

- engage in independent learning, and make use of textbooks, research papers and other learning resources;
- critically analyse data, understand statistical information and to use information responsibly and ethically;
- plan projects and investigations, and perform an evaluation of the possible costs and benefits of a course of action;
- develop a range of technical and transferrable skills which would enable entry to employment across a range of professions that place high value on the analytical, computational, statistical and experimental skills gained within a Physics degree programme and value the ability to communicate complex ideas and information to a variety of audiences.

5. What you will learn

The intended learning outcomes of the programme (what students should know, understand and be able to do at the end of the programme), can be described under the following headings:

- Subject knowledge and understanding
- Subject specific skills
- Intellectual skills
- Key or transferable skills (including employability skills)

Subject knowledge and understanding

The subject knowledge in the Single Honours Physics programme is underpinned by a core curriculum as set out by the Institute of Physics and includes the fundamentals of classical and quantum mechanics, electromagnetism, optics, thermodynamics, solid state, atomic and nuclear physics, together with the mathematics that is used to describe them. The programme goes beyond this to explore broader areas of physics and mathematics, computational and statistical techniques and the applications of these in addressing physical problems. Successful students will be able to demonstrate:

- knowledge of the fundamental principles of Physics and competence in applying these principles to diverse areas of the subject;
- the ability to solve problems in Physics using appropriate mathematical and computational tools including the ability to make sensible approximations;
- the ability to design, execute, and analyse critically, an experiment or investigation and draw valid conclusions;
- the ability to estimate levels of uncertainty in their results, compare their results with expected outcomes, theoretical predictions or published data, and evaluate the significance of their results in this context;
- the development of a wider knowledge and understanding of advanced topics and their applications, and the acquisition of skills in the critical reading and understanding of published work in Physics.

Subject specific skills

Successful students will have:

- the ability to work safely in a laboratory and a knowledge and awareness of standard safety procedures;
- a sound familiarity with laboratory apparatus and techniques;
- competency in the use of appropriate IT packages/systems for the analysis of data and the retrieval of information;
- an ability in numerical manipulation and estimation, statistical interpretation and the ability to present and interpret information graphically;
- an ability to use mathematical analysis and computational techniques to model physical behaviour;
- an ability to research, record and communicate scientific information, in particular through clear and accurate scientific reports and a dissertation;
- an ability to question, learn and assimilate knowledge and to evolve their views of the world in response to that new knowledge;
- an ability to contribute through research to the development of knowledge in Physics;

- an ability to acquire knowledge and understanding of science themselves, and to work productively on scientific problems on an individual basis or in a team.

Intellectual skills

Successful students will be able to:

- analyse and solve problems;
- evaluate evidence and make critical judgements;
- interpret and critique text;
- interpret and critique mathematical and numerical information;
- abstract and synthesise information;
- develop a reasoned argument;
- assess contrasting theories, explanations and policies on the basis of evidence;
- take responsibility for their own learning and critique that learning.

Key or transferable skills (including employability skills)

Successful students will have the ability to:

- manage their own learning and to make appropriate use of textbooks, research-based materials and other learning resources;
- find information and make responsible use of it;
- make effective written and oral presentations;
- work with numerical and statistical data;
- make sensible estimates;
- evaluate the costs and benefits of their actions;
- work effectively with a variety of types of Information Technology;
- formulate a problem and solve it using computational methods;
- plan, manage, execute and report an investigation;
- learn and gain understanding and to pass on that understanding to others;
- work effectively both as an individual and as part of a team;
- sustain motivation for an extended period of time;
- recognise their responsibilities as an individual and as part of a team or an organisation.

Keele Graduate attributes [excluded from CID]

Engagement with this programme will enable you to develop your intellectual, personal and professional capabilities. At Keele, we call these our ten Graduate Attributes and they include independent thinking, synthesizing information, creative problem solving, communicating clearly, and appreciating the social, environmental and global implications of your studies and activities. Our educational programme and learning environment is designed to help you to become a well-rounded graduate who is capable of making a positive and valued contribution in a complex and rapidly changing world, whichever spheres of life you engage in after your studies are completed.

Further information about the Keele Graduate Attributes can be found here: http://www.keele.ac.uk/journey/

6. How is the Programme taught?

Learning and teaching methods used on the programme vary according to the subject matter and level of the module. They include the following:

- Lectures;
- Tutorials;
- Laboratory classes;
- Computational laboratory classes;
- Exercise/problem-solving classes;

- Individual progress interviews;
- Problem sheet assignments;
- Group and individual projects;
- Directed reading and independent study;
- Literature research tasks;
- Use of e-learning/the Keele Learning Environment (KLE).

In a typical week, a student would expect to be engaged in the majority of these activities. Students are also provided with regular opportunities to talk through particular areas of difficulty and any special learning needs they may have with their Personal Tutors or module lecturers on a one-to-one basis.

Much of the core knowledge in Physics is described and explained in lectures. These lectures also map out the academic content and are used to provide examples and case studies. The application of this knowledge is developed in tutorials and problem classes, where there is a greater emphasis on co-operative learning in a more informal setting. Laboratory work and computational classes are designed to reinforce material covered in lectures, but more importantly to foster the many transferable skills discussed in section 2. Students will also gain experience of planning and performing investigations and reporting on them both individually and as part of a team.

All students are also expected to engage in independent learning, with regular directed reading, literature research and assessed problem sheets. In this way they will advance their own understanding but also develop their critical abilities and capabilities for discrimination between different sources of information, the merits of different theories and ideas etc. Students will be expected to manage their time against known targets and deadlines, take responsibility for their own learning and acquire a reflective, self-critical attitude to their own work – attributes that will serve them well in their ongoing professional development.

All modules make extensive use of the Keele Learning Environment (KLE) to post learning resources; these include (and vary from module to module) lecture notes, module and laboratory handbooks, exercises, quizzes, assignments, problem sheets, interesting web links, additional reading; screencasts; collaborative pages. The KLE is also used for electronic submission of course work and feedback in some cases.

Apart from these formal activities, students are also provided with regular opportunities to talk through particular areas of difficulty, and any special learning needs they may have, with their Personal Tutors or module lecturers on a one-to-one basis.

7. Teaching Staff

The Physics academic staff exhibit a research profile with two main areas of expertise; astrophysics and condensed matter physics. Keele performs internationally renowned work in the fields of exoplanets, stellar physics (both observational and theoretical), high energy extragalactic astrophysics and in the study of soft condensed matter such as polymers and biological molecules. All research-active staff play a role in teaching and most also undertake administrative roles, either within our teaching or research activities. The teaching and research profiles of the staff that currently deliver the Physics programme can be found at http://www.keele.ac.uk/physics/people/. Timetabled teaching is always lead by academic staff.

The University will attempt to minimise changes to our core teaching teams, however, delivery of the programme depends on having a sufficient number of staff with the relevant expertise to ensure that the programme is taught to the appropriate academic standard.

Staff turnover, for example where key members of staff leave, fall ill or go on research leave, may result in changes to the programme's content. The University will endeavour to ensure that any impact on students is limited if such changes occur.

8. What is the Structure of the Programme?

The academic year runs from September to June and is divided into two semesters. The number of weeks of teaching will vary from course to course, but you can generally expect to attend scheduled teaching sessions between the end of September and mid-December, and from mid-January to the end of April.

Our degree courses are organised into modules. Each module is usually a self-contained unit of study and each is usually assessed separately with the award of credits on the basis of 1 credit = 10 hours of student effort. An outline of the structure of the programme is provided in the tables below.

There are two types of module delivered as part of this programme. They are:

- Compulsory core module – a module that you are required to study on this course;
- Optional core module – these allow you some limited choice of what to study from a list of modules;

In both years 1 and 2 (Levels 4 and 5) students take eight modules. These modules (plus Electromagnetism in year 3) will cover the entire core IoP curriculum but also include a much broader range of material (see the IoP core of physics specification). In year 3 (Level 6) you will take a further eight modules. Four of these are compulsory core modules, the remaining four are options. The majority of modules are taught over one semester, but several are taught over two semesters. In years 1 and 2 the student workload is roughly the same in each semester. In year 3 the work load balance between semesters will depend on which option modules are selected.

Year 1 (Level 4)

At level 4, Physics students require a common knowledge and skills base. In the Single Honours Physics programme students study eight core Physics modules, all worth 15 credits, over the first two semesters of the programme. These consist of four modules that directly address core material as specified by the IoP, which include distinct mathematics and laboratory components. These four modules are common to the dual honours Physics programme. There are then four other modules that develop much broader physical, mathematical, computational, statistical and laboratory competencies. There is one module and several other components of laboratory and project work that are distinct from the single honours Physics with Astrophysics programme, but transfer between these two programmes is possible at any point before semester 2 of year 1.

These modules are taught through a mixture of traditional lectures, problem class learning, smaller group tutorials and practical and computer-based laboratory work. The module descriptors provide detailed synopses of each module with suggested study reading and are available on the KLE.

Five of the modules are taught within a single semester (two in semester 1 and three in semester 2). Three of the modules have elements of teaching and assessment over both semesters, though they are designed so that there is roughly equal student workload in each semester when considering the programme as a whole.

Semester 1	***Semester 2***
PHY-10022 Mechanics, Gravity and Relativity (15 Cr)	PHY-10020 Oscillations and Waves (15 Cr)
PHY-10024 Nature of Matter (15 Cr)	PHY-10021 Electricity and Magnetism (15 Cr)
	PHY-10031 Instrumentation Physics (15 Cr)
PHY-10030 Scientific Practice (15 Cr)	
PHY-10028 Scientific Programming (15 Cr)	
PHY-10032 Applied Mathematics and Statistics (15 Cr)	

Year 2 (Level 5)

At level 5 students continue to be taught the fundamentals of Physics, with four core modules that directly address the IoP core curriculum and which are common to the dual honours programme. The additional core modules that are specific to the single honours programme further develop the skills of mathematical and computational analysis in semester 1. In the second semester the focus switches to the application of Physics, with modules looking at the uses of Physics in modern society and technology and a specific module dealing with the interactions of radiation with matter in the context of power generation, health applications and safety.

All of these modules are worth 15 credits and all modules are taught and assessed within a single semester.

Semester 1	***Semester 2***
PHY-20006 Quantum Mechanics (15 Cr)	PHY-20026 Statistical Mechanics and Solid State Physics (15 Cr)
PHY-20027 Optics and Thermodynamics (15 Cr)	PHY-20009 Nuclear and Particle Physics (15 Cr)
PHY-20032 Mathematical Physics (15 Cr)	PHY-20033 Applied Physics and Emerging Technologies (15 Cr)
PHY-20030 Numerical Methods(15 Cr)	PHY-20029 Radiation Physics (15 Cr)

Year 3 (Level 6)

At level 6 there are four core modules: Electromagnetism, Quantum Mechanics II and students will complete a dissertation and an independent research project. In addition, students will choose four option modules from a list of available modules. Note that not all option modules may run in any given year, dependent on student preferences and staff availability.

Semester 1	***Semester 2***
Compulsory Core modules	***Compulsory Core modules***
PHY-30012 Electromagnetism (15 Cr)	PHY-30029 Quantum Mechanics II (15 Cr)
PHY-30007 Physics Project (15 Cr, Semesters 1 & 2)	
PHY-30015 Dissertation and Communication Skills (15 Cr, Semesters 1 & 2)	
Plus 4 Option Modules from*:	
(Option modules may be run in either semester)	
PHY-30001 Cosmology (15 Cr)	PHY-30002 Physics of the Interstellar Medium (15 Cr)
PHY-30010 Polymer Physics (15 Cr)	PHY-30003 The Physics of Compact Objects (15 Cr)
PHY-30033 Particle Physics and Accelerators (15 Cr)	PHY-30025 Life in the Universe (15 Cr)
PHY-30024 Binary Stars and Extrasolar Planets (15 Cr)	PHY-30030 Physics of Fluids (15 Cr)
PHY-30031 Atmospheric Physics (15 Cr)	PHY-30032 Plasma Physics (15 Cr)
PHY-30027 Data Analysis and Model Testing (15 Cr)	

*The Optional core modules and their timing may vary each year depending on student preferences and staff availability.

Students may also take a 15 credit free elective module instead of one of the option modules above, subject to timetabling constraints.

Our teaching puts an emphasis on problem solving. This occurs in problem classes where practice problems are solved with staff and teaching assistants available to help; in laboratory teaching where practical and computational problems are addressed; and in directed work for assessment. Students are encouraged to call upon module leaders and year tutors for guidance. The staff will be willing to see students at almost any time (we operate an "open-door" policy) and there will be one-to-one progress interviews each semester. The teaching team will monitor progress and attendance, and will contact students if they are not achieving and advise on improvement strategies.

Students benefit from a flexible approach to learning the mathematical and computational skills that are essential to the learning and application of Physics. In years 1 and 2 there are dedicated Mathematics modules but Mathematics is also embedded as part of several other modules in each year. Similarly, although programming and computational skills are taught in specific modules, there is an expectation that these skills will increasingly be put into practice in later modules.

For further information on the content of modules currently offered please visit:
www.keele.ac.uk/recordsandexams/az

Learning Outcomes [excluded from CID– unless required by PSRB]

Year 1 (Level 4)

Learning Outcome *Successful students will be able to demonstrate knowledge & understanding of:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
Understand basic concepts in mechanics, nature of matter, oscillation and waves, electricity and magnetism, mathematics and statistics, instrumentation physics, and scientific programming. Demonstration of this understanding by solving physical problems. Understanding of mathematical techniques necessary for application to physics. Understand how to search for information and to disseminate scientific knowledge in various formats including reports and oral presentations. Understand the principles of scientific programming and to apply computational and mathematical methods to solving physics problems. Perform practical work and keep accurate accounts of it, including professionally maintained records of purpose, methodology, and results.	All outcomes delivered across all modules: Mechanics, Gravity and Relativity Nature of Matter Oscillations and Waves Electricity and Magnetism Applied Mathematics and Statistics Scientific Practice Instrumentation Physics Scientific Programming	Laboratory diary and laboratory reports Engagement with problem classes Problem sheets; Laboratory reports Oral and written presentations; Unseen two hour examinations Class tests. Computing tests Computing projects

Communicate the process and results of practical work in formal, written presentations. Enter, manipulate, and present data with the aid of computer tools.		

Year 2 (Level 5)

Learning Outcome *Successful students will be able to:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
Comprehensive understanding of the relevant theoretical and experimental background of quantum mechanics, optics, thermodynamics, nuclear physics, particle physics, statistical mechanics and solid state physics and the interactions of radiation with matter. Use a range of established techniques for critical analysis of numerical calculations in connection with problems in quantum mechanics, optics, thermodynamics, nuclear physics, particle physics, statistical mechanics and solid state physics.	All modules: Quantum Mechanics Optics and Thermodynamics Mathematical Physics Numerical Methods Statistical mechanics and Solid State Physics Nuclear and Particle Physics Applied Physics and Emerging Technologies Radiation Physics	Problem Sheets Unseen examination Engagement with problem classes Project reports Class Tests
Extended abilities in the execution and reporting of laboratory work within the context of physics; work safely in a laboratory and have a knowledge and awareness of standard safety procedures; gain a sound familiarity with laboratory apparatus and techniques	Optics and Thermodynamics Nuclear and Particle Physics Numerical Methods Radiation Physics	Engagement with laboratory classes Laboratory reports Project reports Risk assessment
Work effectively both as an individual and as part of a team. Recognise their responsibilities as an individual and as part of a team or an organisation.	Radiation Physics Nuclear and Particle Physics	Laboratory work Laboratory reports Project reports Group reports
The ability to select and deploy appropriate mathematical, computational or statistical analysis techniques to solve problems.	Numerical Methods Mathematical Physics Quantum Mechanics Statistical mechanics and Solid State Physics	Unseen examination Problem sheets Engagement with problem classes Project reports Class tests

Year 3 (Level 6)

Learning Outcome *Successful students will be able to:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
Describe the central role played by the theory of electromagnetism and Maxwell's equations in understanding the universe and the world around them; describe electromagnetic waves, their production, their propagation and their interaction with non-conductive and conductive media; appreciate the connection between electricity, magnetism and special relativity.	Electromagnetism	Continuously assessed problem sheets and unseen examination.
Demonstrate good comprehension, planning and execution of an individual project; give a short presentation on the progress of the project; produce of a clear, accurate and informative project report; demonstrate a good understanding of the literature associated with the project theme.	Physics Project	Outcomes assessed by oral presentation, benchwork and by the project report.
Describe cosmological observations; be able to apply basic physics principles to the universe as a whole; and will be able to calculate conditions in the universe at different times and use mathematics to relate the theory with the observations.	Cosmology	Outcomes assessed by problem sheets and unseen examination.
Describe the contents of the ISM; understand and appreciate the impact of stars on the ISM; describe how the above is observationally determined; and understand the interaction between different components of this ISM	Physics of the Interstellar Medium	Outcomes assessed by problem sheets and unseen examination
Describe of the properties of degenerate matter; the differences between normal and compact stars; how microscopic physical laws can be applied to macroscopic systems. Students will appreciate how observations of compact stars can be used to probe physical laws at very high densities and be aware of the most recent research on the subject.	The Physics of Compact Objects	Outcomes are assessed by problem sheets and unseen examination.
Describe the structure of polymer molecules and the application of physical characterisation	Polymer Physics	Outcomes are assessed by problems sheets and unseen

techniques. Describe microstructure and macrostructures in polymer materials and its characterisation using x-ray scattering techniques. Understand the relationship between the structure and mechanical properties of polymers in relation to their industrial applications.		examination.
Collect information on physics topics and present to a peer group via an oral presentation and poster; assemble and review information on a specific topic and produce a substantial, detailed dissertation.	Dissertation and Communication Skills	Outcomes are assessed by oral presentation, poster presentation and dissertation.
Detail the ingredients and physical structure of the Standard Model; analyse the relativistic dynamics of particles in interactions and of particle beams in accelerators; compare and contrast the operation, design and relative advantages of different types of particle accelerator; describe and calculate key phenomena in lepton physics; explain and apply the quark model to classify hadrons and account quantitatively for their measured properties; understand and apply some of the key ideas and empirical foundations of quantum field theories for the fundamental forces.	Particle Physics and Accelerators	Unseen examination, problem sheets and essay.
Apply celestial mechanics and stellar astrophysics to the interpretation of observations of binary star and exoplanet systems; demonstrate an understanding of the interactions between stars and planets such as mass transfer, common envelope evolution and tidal interactions; appreciate the physics and practicalities of methods for studying exoplanet atmospheres.	Binary Stars and Extrasolar Planets	Outcomes assessed by problems sheets, unseen examination and computer- based simulation exercises.
Demonstrate an understanding of the physical processes that govern the formation and evolution of planets, planetary atmospheres and Life; describe the possibilities of searches for extra-solar planets	Life in the Universe	Outcomes are assessed by problems sheets, unseen examination and a mini project.

and extra-terrestrial life; critically evaluate the possibilities and limitations of interstellar travel and communication. Exercise initiative in designing and executing an experiment, and communicate ideas related to the experiment's context and objective.		
Use Dirac notation and Pauli spin matrices to describe and analyse the behaviour of quantum systems; interpret the rotation-vibration and Raman spectra of diatomic molecules; describe the applications of quantum effects such as entanglement and quantum state teleportation to cryptography, quantum computing and the investigation of the interpretations of quantum mechanics.	Quantum Mechanics II	Outcomes are assessed by problem sheets, article and unseen examination.
Demonstrate an understanding of the basic principles and laws governing the physics of fluids (e.g. momentum/Euler equations); apply the laws of fluid dynamics to specific environments found in nature and space (e.g. tsunamis); use computer programs to solve basic problems in fluid dynamics as well as manipulate the equations of fluid dynamics in an applied context and numerically solve related problems.	Physics of Fluids	Outcomes are assessed by problem sheets and unseen examination.
Demonstrate an understanding of the statistical techniques used to analyse physical data; solve data analysis problems and interpret scientific data using computer-based analysis techniques; critically evaluate data from primary sources; communicate judgements by applying established numerical analysis techniques.	Data Analysis and Model Testing	Outcomes are assessed by problems sheets, unseen open-book class test and a data analysis project.
Describe quantitatively the structure and dynamics of atmospheres; use the principles of thermodynamics to determine the structure of atmospheres; solve the equation of radiative transfer to evaluate the effect of radiation on	Atmospheric Physics	Outcomes are assessed by problem sheets and unseen examination.

atmospheric structure; apply the laws of motion to describe atmospheric dynamics and waves.		
Demonstrate an understanding of the properties of plasmas in both Physics and Astrophysics contexts, including : the properties and production of plasmas; Saha equation; motion of charged particles in electromagnetic fields; the propagation of electromagnetic and magnetohydrodynamic waves in plasmas; plasma diagnostics and plasma confinement.	Plasma Physics	Outcomes are assessed by problem sheets, essay and unseen examination.
Demonstrate their knowledge of the fundamental principles of Physics and competence in applying these principles to diverse areas of the subject. Demonstrate competency in the use of appropriate IT packages/systems for the analysis of data and the retrieval of information; Demonstrate an ability in numerical manipulation and estimation, statistical interpretation and the ability to present and interpret information graphically; Demonstrate an ability to use mathematical analysis and computational techniques to model physical behaviour. To question, learn and assimilate knowledge and to evolve their views of the world in response to that new knowledge To acquire knowledge and understanding of science themselves, and to work productively on scientific problems on an individual basis or in a team. Develop a wider knowledge and understanding of advanced topics and their applications, and the acquisition of skills in the critical reading and understanding of published work in Physics.	All modules	Unseen examinations Problem sheets Project reports Dissertation Oral presentations Mini projects Essays

To record and communicate scientific information		
Solve problems in Physics using appropriate mathematical and computational tools including the ability to make sensible approximations.	Electromagnetism Quantum Physics II Physics of the ISM Physics of Compact Objects Polymer Physics Binary Stars and Extrasolar Planets Particle Physics and Accelerators Physics of Fluids Life in the Universe Data Analysis and Model Testing Atmospheric Physics Plasma Physics Physics Project	Unseen exam Problem sheets Project reports Class Tests
Design, execute, and analyse critically, an experiment or investigation and draw valid conclusions. Estimate levels of uncertainty in their results, compare their results with expected outcomes, theoretical predictions or published data, and evaluate the significance of their results in this context.	Physics Project Life in the Universe Data Analysis and Model Testing	Oral presentation Laboratory Benchwork Project report Mini project
To contribute through research to the development of knowledge in Physics.	Dissertation and Communication Skills Physics Project	Oral presentations Dissertation Project report Poster

9. Final and intermediate awards

Credits required for each level of academic award are as follows:

Honours Degree	360 credits	You will require at least 120 credits at levels 4, 5 and 6 You must accumulate at least 255 credits in Physics (out of 360 credits overall), with at least 60 credits in each of the three years of study, to graduate with a named single honours

		degree in Physics.
Diploma in Higher Education	240 credits	You will require at least 120 credits at level 4 or higher and at least 120 credits at level 5 or higher
Certificate in Higher Education	120 credits	You will require at least 120 credits at level 4 or higher

Physics with International Year: in addition to the above students must pass a non-credit bearing module covering the international year in order to graduate with a named degree in Physics with international year. Students who do not complete, or fail the international year, will be transferred to the three-year Physics programme.

10. How is the Programme assessed?

Year 1 (Level 4) lecture modules are assessed by a mixture of continuous assessment (mostly in the form of problem classes, problem sheets, laboratory work and laboratory reports, though also including at least one oral presentation and some short essays) and examination. A risk assessment also forms part of the laboratory work.The skills component of these modules is assessed on your work at the bench, your understanding of the experiment as displayed in discussion with the staff in the laboratory and in the laboratory reports you are required to write. Problem classes and tests that occur periodically throughout the year specifically assess the mathematics component, although mathematics is an embedded and inherent part of all other assessments including examinations and problem sheets. The computational strand is assessed by specifically by computer tests and project work. The module marks from FHEQ Level 4 count for progression purposes but do not contribute to any final degree classification.

Year 2 (Level 5) lecture modules are assessed by a mixture of continuous assessment (mostly in the form of problem classes and problem sheets), laboratory work and examination. Laboratory work is assessed on your work at the bench, your understanding of the experiment as displayed in discussion with the staff in the laboratory and in the laboratory reports you are required to write, both individually and as part of a team. A risk assessment also forms part of the assessed laboratory work. The laboratory work is connected to the content of the lecture modules and the marks for the laboratory are therefore convolved with the examination and continuous assessment marks to give a final mark for each module. There are also specific class tests associated with Computing and Mathematics. The module marks from FHEQ Level 5 count towards progression and also make up one third of the aggregate marks for the purposes of final degree classification.

Year 3 (Level 6) modules are self-contained. Lecture modules are assessed using a mixture of continuous assessment (mostly in the form of problem sheets, though some feature essays, mini-projects or computer exercises) and examination. The Physics project module is assessed in terms of the originality and ingenuity you display, the quality and methods of research employed and on the final report. You are given the opportunity to display these qualities in a project plan, an interim report, a one-to-one interview and in your final report. The Dissertation and Communication Skills module is assessed on the scientific content and presentation of the dissertation and also on an oral presentation and a poster presentation that you are required to produce. The module marks for FHEQ Level 6 make up two thirds of the aggregate marks for the purposes of degree classification.

The wide variety of assessment methods used within Physics at Keele reflects the broad range of knowledge and skills that are developed as you progress through the degree programme. Teaching staff pay particular attention to specifying clear assessment criteria and providing timely, regular and constructive feedback that helps to clarify things you did not understand and helps you to improve your performance.

The following list is representative of the variety of assessment methods used within Physics:

- **End of module examinations** test the ability of the student to describe, explain, and critically discuss the principles of the subject and to demonstrate competence in applying these principles to applications and to solve problems from appropriate areas of the discipline.

- **Assessed Problem Sheets** assess the student's skills in solving numerical and other problems within the discipline by drawing on their scientific understanding and knowledge, and experience of experimental techniques. Students may also be assessed on their skills of research and communication and on their ability to deploy appropriate mathematical, computational and numerical techniques.

- **Laboratory and Project Reports** – structured proformas and full lab reports are formal summaries of work carried out in the laboratory and test students' understanding of the practical aspects of the programme and assess the skills necessary to enable students to present and analyse their results.

- **Observation of laboratory skills and laboratory notebooks**: Throughout the extensive laboratory and other practical work in this programme, many types of assessment are utilised to achieve the learning outcomes. Notebooks are used to communicate the results of work accurately and reliably and to encourage good working practice, including managing risk assessments and following safe working practices.

- **Oral and/or Poster presentations** on project work demonstrate the ability of the student to present complex concepts and information in a clear and concise manner, to interact and communicate effectively to a wide range of professional environments, including to both scientific and non-scientific audiences. They also test how effectively students have been able to research and sift information.

- **In-class exercises and tests** taken either conventionally or online via the Keele Learning Environment (KLE) assess students' subject knowledge and their ability to apply it in a more structured and focused way.

- **Group oral presentations and reports** assess individual student's subject knowledge and understanding. They also test their ability to work effectively as members of a team, to communicate what they know orally and visually, and to reflect on these processes as part of their own personal development.

- **Engagement with problem classes** assess the extent to which students are able to work on problems and present their solutions in a logical, structured and coherent way.

- **Dissertation** assesses the student's ability to engage with an advanced area of physics, to research and sift information, and to communicate effectively via an extended piece of writing.

- **Computing Tests** specifically assess a student's computational skills and their ability to design and produce code to solve physics problems.

- **Mini-projects** short projects that form a minor part of module assessments designed to test subject knowledge but also to assess many of the skills components.

- **Risk assessments** are produced by students to test their appreciation of how to design experiments and consider the health and safety aspects of their work.

Marks are awarded for summative assessments designed to assess your achievement of learning outcomes. You will also be assessed formatively to enable you to monitor your own progress and to assist staff in identifying and addressing any specific learning needs. Feedback, including guidance on how you can improve the quality of your work, is also provided on all summative assessments within three working weeks of submission, unless there are compelling circumstances that make this impossible, and more informally in the course of tutorial and seminar discussions.

11. Contact Time and Expected Workload

This contact time measure is intended to provide you with an indication of the type of activity you are likely to undertake during this programme. The data is compiled based on module choices and learning patterns of students on similar programmes in previous years. Every effort is made to ensure this data is a realistic representation of what you are likely to experience, but changes to programmes, teaching methods and assessment methods mean this data is representative and not specific.

Undergraduate courses at Keele contain an element of module choice; therefore, individual students will experience a different mix of contact time and assessment types dependent upon their own individual choice of modules. The figures below are an example of activities that a student may expect on your chosen course by year/stage of study. Contact time includes scheduled activities such as: lecture, seminar, tutorial, project supervision, demonstration, practical classes and labs, supervised time in labs/workshop, fieldwork and external visits. The figures are based on 1,200 hours of student effort each year for full-time students.

Activity	Year 1 (Level 4)	Year 2 (Level 5)	Year 3 (Level 6)
Scheduled learning and teaching activities	32%	27%	28%
Guided independent Study	68%	73%	72%
Placements	0%	0%	0%

12. Accreditation

This subject/programme will be put forward for accreditation by The Institute of Physics (IoP). The dual honours Physics and Major honours Physics programmes that form a *subset* of Single Honours Physics have already achieved full accreditation. Please note the following:

- Graduates with accredited BSc degrees are eligible for Associate Membership of the IoP. After a period of relevant post-degree experience and professional development they may apply for full membership of the IoP and for Chartered Physicist status.

13. Regulations

The University Regulations form the framework for learning, teaching and assessment and other aspects of the student experience. Further information about the University Regulations can be found at: http://www.keele.ac.uk/student-agreement/

14. What are the typical admission requirements for the programme?

Subject	A-level	Subjects not included	International Baccalaureate	BTEC	Access to Higher Education Diploma	GCSE requirements
Physics (Single Honours)	ABC Including A level Physics and Maths with a grade A required in either Physics or Maths. ***A Pass in Physics Science Practical will be required if applicant is taking A level Physics (England)** ** Science practical only required from applicants taking reformed A level Biology, Chemistry or Physics in England. *** If applicant has not had opportunity to sit A level in England, please contact admissions@keele.ac.uk	General Studies and Critical Thinking	32 points to include Higher Level Physics and Maths at 5 and 6 in any order.	DDD You must have taken sufficient units with Physics/Mathematics content. Please contact us for advice	Access to HE Diploma with 45 L3 credits, including Distinction in at least 30 suitable L3 credits in Physics and Mathematics. You must also have taken sufficient Physics and Mathematics credits, please contact us for advice.	Maths @ C (or 4) if not taken at A level. English Language @ C (or 4)

Applicants who are not currently undertaking any formal study or who have been out of formal education for more than 3 years and are not qualified to A-level or BTEC standard may be offered entry to the University's Foundation Year Programme.

Applicants for whom English is not a first language must provide evidence of a recognised qualification in English language. The minimum score for entry to the Programme is Academic IELTS 6.0 or equivalent.

Please note: All non-native English speaking students are required to undertake a diagnostic English language assessment on arrival at Keele, to determine whether English language support may help them succeed with their studies. An English language module may be compulsory for some students during their first year at Keele.

Accreditation of Prior Learning (APL) is considered on a case-by-case basis and those interested should contact the Programme Director. The University's guidelines on this can be found here:
http://www.keele.ac.uk/qa/accreditationofpriorlearning/

15. How are students supported on the programme? [excluded from CID]

All the academic staff in Physics operate an open-door policy for students. If they are available then, at any time in the working day, students may seek help and guidance. If staff are not immediately free they will arrange a future meeting for such discussions. Our department is reasonably small; students have many opportunities in labs, problem classes and tutorials to discuss their work and progress with staff. Students should feel free to approach any lecturer or module leader to discuss any academic issues.

In addition to this informal assistance there are many other avenues of help for students:

Keele Learning Environment (KLE)

All the Physics modules are supported by learning materials that are accessible to students via the KLE at https://students.keele.ac.uk/webapps/login/. Online guidance and support for the KLE is available at:
http://www.keele.ac.uk/klehelp/

Personal Tutor

All students are assigned a Personal Tutor as a part of the University's Personal Tutor system for the duration of their studies at Keele. There is a formal requirement for the Personal Tutors to meet with their first year tutees during the first week of the semester one. Subsequently, Personal Tutors should meet at least four times per year to discuss progress and offer support and advice on academic or any other matter. During the subsequent undergraduate years Personal Tutors and tutees should meet at least three times per year. Students can make arrangement to seek help or advice on any matter that affects their life and work as a student at Keele. More details available at:
http://www.keele.ac.uk/personaltutoring/

Year Tutor

Each year of study has an associated Year Tutor who monitors the students and the modules to ensure the course is running smoothly and that students are making the progress they should. They will note any problems and bring them to the attention of the Course Management Committee who will decide on an appropriate course of action. Students should regard the year tutor as their first point of contact to discuss any topic related to the courses or their own academic performance.

Students with disabilities

If you have long-term disabilities, you will have the assistance of the Disability Coordinator and the Examinations Office and from academic and support staff who liaise with these services.

Health and Safety

All students are briefed on Health and Safety as part of their induction and this is repeated at the beginning of the first laboratory session. Students are required to sign an agreement that they have read the Safety

Handbook, and that they will abide by the rules and regulations governing the safety and welfare of all members within the University. The Safety handbook can be accessed from the internal physics/astrophysics web page at: http://www.keele.ac.uk/physics

Further information

It is essential that students check the Physics web page (http://www.keele.ac.uk/physics) and KLE (http://students.keele.ac.uk/) for up to date information on course and teaching materials related to their Physics modules.

16. Learning Resources [excluded from CID]

The Physics and Astrophysics section of the School is housed in the Lennard-Jones Building, which contains well-equipped undergraduate Physics teaching laboratories and a dedicated PC laboratory supporting both Windows and Linux. There are rooms available in the building for students to work and socialise with their peers. There are dedicated boxes located in the building for submission of the problem sheets and laboratory reports. In addition, the School Office is open continuously during the week from 9am to 5pm to answer student questions.

17. Other learning opportunities

Study abroad (semester)

Students on the Physics programme have the potential opportunity to spend a semester abroad in their second year studying at one of Keele's international partner universities.

Exactly which countries are available depends on the student's choice of degree subjects. An indicative list of countries is on the website (http://www.keele.ac.uk/studyabroad/partneruniversities/); however this does not guarantee the availability of study in a specific country as this is subject to the University's application process for studying abroad.

No additional tuition fees are payable for a single semester studying abroad but students do have to bear the costs of travelling to and from their destination university, accommodation, food and personal costs. Depending on the destination they are studying at additional costs may include visas, study permits, residence permits, and compulsory health checks. Students should expect the total costs of studying abroad to be greater than if they study in the UK, information is made available from the Global Education Team throughout the process, as costs will vary depending on destination

Whilst students are studying abroad any Student Finance eligibility will continue, where applicable students may be eligible for specific travel or disability grants. Students studying in Erasmus+ destinations may be eligible for grants as part of this programme. Students studying outside of this programme may be eligible for income dependent bursaries at Keele.

Students travel on a comprehensive Keele University insurance plan, for which there are currently no additional charges. Some governments and/or universities require additional compulsory health coverage plans; costs for this will be advised during the application process.

Study Abroad (International Year)

A summary of the International Year, which is a potential option for students after completion of year 2 (Level 5), is provided at Annex A.

Other opportunities

There are other opportunities such as the *Student Ambassador Scheme* and *e-mentoring scheme* for students to enhance their employability skills.

18. Additional costs

As to be expected there will be additional costs for inter-library loans and potential overdue library fines, print and graduation.

These costs have been forecast by the University as accurately as possible but may be subject to change as a result of factors outside of our control (for example, increase in costs for external services). Forecast costs are reviewed on an annual basis to ensure they remain representative. Where additional costs are in direct control of the University we will ensure increases do not exceed 5%.

We do not anticipate any further costs for this undergraduate programme.

19. Quality management and enhancement [excluded from CID]

The quality and standards of learning in Physics are subject to a continuous process of monitoring, review and enhancement.

- The Learning and Teaching Committee of the School of Chemical and Physical Sciences is responsible for reviewing and monitoring quality management and enhancement procedures and activities across the School.
- Individual modules and the Physics Programme as a whole are reviewed and enhanced every year in the annual programme review which takes place at the end of the academic year and as part of the University's Curriculum Annual Review and Development (CARD) process.
- The programmes are run in accordance with the University's Quality Assurance procedures and are subject to periodic reviews under the Internal Quality Audit (IQA) process.

Student evaluation of, and feedback on, the quality of learning on every Physics module takes place every year using a variety of different methods:

- The results of student evaluations of all modules are reported to module leaders and reviewed by the Programme Committee as part of the Curriculum Annual Review and Development (CARD) process.
- Findings related to the Physics Programme from the annual National Student Survey (NSS), and from regular surveys of the student experience conducted by the University, are subjected to careful analysis and a planned response at programme and School level.
- Feedback received from representatives of students in all three years of the Physics Programme is considered and acted on at regular meetings of the Programmes Staff/Student Liaison Committee.

The University appoints senior members of academic staff from other universities to act as external examiners on all programmes. They are responsible for:

- Approving examination questions
- Confirming all marks which contribute to a student's degree
- Reviewing and giving advice on the structure and content of the programme and assessment procedures

Information about current external examiner(s) can be found here:
http://www.keele.ac.uk/qa/externalexaminers/currentexternalexaminers/

20. The principles of programme design [excluded from CID]

The Physics Programme described in this document has been drawn up with reference to, and in accordance with the guidance set out in, the following documents:

a. UK Quality Code for Higher Education, Quality Assurance Agency for Higher Education:
http://www.qaa.ac.uk/assuring-standards-and-quality/the-quality-code

b. QAA Subject Benchmark Statement: Physics, Astronomy and Astrophysics (2008) http://www.qaa.ac.uk/en/Publications/Documents/Subject-benchmark-statement-Physics-astronomy-and-astrophysics.pdf

c. The Institute of Physics Accreditation Scheme for First Degree Courses in Physics http://www.iop.org/activity/policy/Degree_Accreditation/Application Process/page_26579.html

d. Keele University Regulations and Guidance for Students and Staff: http://www.keele.ac.uk/regulations

21. Document Version History

Version history	**Date**	**Notes**
Date first created	December 2016	
Revision history	Amendments made following scrutiny meeting, March 2017	
Date approved	June 2017	ULTC

Annex A

Physics with International Year

International Year Programme
Students registered for Single Honours Physics may either be admitted for or apply to transfer during their period of study at Level 5 to the Single Honours 'Physics with International Year'. Students accepted onto this programme will have an extra year of study (the International Year) at an international partner institution after they have completed Year 2 (Level 5) at Keele. Students who successfully complete both the second year (Level 5) and the International Year will be permitted to progress to Level 6. Students who fail to satisfy the examiners in respect of the International Year will normally revert to the BSc (Hons) Physics and progress to Level 6 on that basis. The failure will be recorded on the student's final transcript. Study at Level 4, Level 5 and Level 6 will be as per the main body of this programme specification. The additional detail contained in this annex will pertain solely to students registered for 'Physics with International Year'.
International Year Programme Aims
In addition to the programme aims specified in the main body of the programme specification, the international year programme of study aims to provide students with: 1. Personal development as a student and a researcher with an appreciation of the international dimension of their subject 2. Experience of a different culture, academically, professionally and socially
Entry Requirements for the International Year
Students may apply to the 4-year programme during Level 5. Admission to the International Year is subject to successful application, interview and references from appropriate staff. The criteria to be applied are: • Academic Performance (an average of 60% across all modules at Level 5 is normally required) • General Aptitude (to be demonstrated by application for study abroad, interview during the 2nd semester of year 2 (Level 5), and by recommendation of the student's personal tutor, 1st and 2nd year tutors and programme director)
Student Support
Students will be supported whilst on the International Year via the following methods: • Phone or Skype conversations with Study Abroad tutor, in line with recommended Personal Tutoring meeting points. • Support from the University's Global Education Team
Learning Outcomes
In addition to the learning outcomes specified in the main text of the Programme Specification, students who complete a Keele undergraduate programme with International Year will be able to: i) Describe, discuss and reflect upon the cultural and international differences and similarities of different learning environments ii) Discuss the benefits and challenges of global citizenship and internationalisation

iii) Explain how their perspective on their academic discipline has been influenced by locating it within an international setting.

In addition, students who complete 'Physics with International Year' will be able to:

iv) Communicate effectively in an international setting;
v) Reflect on previous learning within an international context.

These learning outcomes will all be assessed by the submission of a satisfactory individual learning agreement, the successful completion of assessments at the partner institution and the submission of the reflective portfolio element of the international year module.

Course Regulations

Students registered for the 'Physics with International Year' are subject to the course specific regulations (if any) and the University regulations. In addition, during the International Year, the following regulations will apply:

Students undertaking the International Year must complete 120 credits, which must comprise *at least 40%* in the student's discipline area.

This may impact on your choice of modules to study, for example you will have to choose certain modules to ensure you have the discipline specific credits required.

Students are barred from studying any Physics module with significant overlap to Level 6 modules to be studied on their return. Significant overlap with Level 5 modules previously studied should also be avoided.

Additional costs for the International Year

Tuition fees for students on the International Year will be charged at 15% of the annual tuition fees for that year of study, as set out in Section 1. The International Year can be included in your Student Finance allocation, to find out more about your personal eligibility see: www.gov.uk

Students will have to bear the costs of travelling to and from their destination university, accommodation, food and personal costs. Depending on the destination they are studying at additional costs may include visas, study permits, residence permits, and compulsory health checks. Students should expect the total costs of studying abroad be greater than if they study in the UK, information is made available from the Global Education Team throughout the process, as costs will vary depending on destination.

Students studying in Erasmus+ destinations may be eligible for grants as part of this programme. Students studying outside of this programme may be eligible income dependent bursaries at Keele.

Students travel on a comprehensive Keele University insurance plan, for which there are currently no additional charges. Some Governments and/or universities require additional compulsory health coverage plans; costs for this will be advised during the application process.