ROYAL HOLLOWAY
University of London

PROGRAMME SPECIFICATION

This document describes **BSc Honours Degree programmes in Physics**. For Combined and Joint Honours Degree programmes, please also refer to the equivalent document(s) for the other subject(s). This specification is valid for entrants from **September 2012**.

The aims of all Honours Degree programmes in Physics are:

- to impart a secure knowledge of the fundamental elements of Physics;
- to nurture confidence in the use of appropriate mathematical techniques;
- to develop the skills and knowledge required for experimentation and/or theoretical modelling;
- to promote oral and written communication skills;
- to teach the effective use of information technology and computing facilities for the treatment and presentation of experimental data;
- to provide a sound awareness of safety procedures and environmental issues;
- to develop and strengthen problem solving abilities;
- to provide a firm foundation for postgraduate research and further study in the physical sciences or for entry into a wide range of both scientific and non-vocational careers.

Programmes are delivered in three stages, each of which comprises one year of full-time study during which the student must follow courses to the value of four units (one unit is roughly equivalent to 30 national credits). For some programmes there is the option of part-time study. In that case a stage may be spread over two years of study; in each part-time year the student will follow courses to the value of two units. The curriculum is characterised by strong progression and opportunities for specialisation throughout the programme. Stages one and two provide a foundation for the later stages through a compulsory spine of courses that complete a core, discipline-specific, knowledge base. Stage three offers a wide range of optional courses for Single Honours students; for those taking Joint or Combined Honours, the compulsory spine extends into this stage.
Specifically, stage one gives a balanced foundation for progression, offers opportunities for students to select and move between degree programmes according to their interests and provides a foundation which serves students from a wide variety of educational backgrounds. The stage one curriculum aims:

1. to extend and develop classical physics covered at A-level, to bring students to a common level and to set their knowledge into an appropriate context;
2. to develop modern physics and establish it on a firm foundation, enabling students to experience the flavour of modern physics, without excessive technical detail;
3. to extend and develop the mathematics covered at A-level;
4. to start the programme of discipline-specific and transferable skills.

Stage two builds on this and applies the skills and knowledge acquired to specific subjects. The available courses complete the essential physics core consisting of classical and modern physics, emphasising Electromagnetism, Quantum Mechanics, and Classical and Statistical Thermodynamics. Skills are further developed and Physics specialists take courses in Mathematical Methods, Solid State Physics, Optics, and Atomic and Nuclear Physics. Other courses are available for the other programmes.
In stage three, students take a number of advanced courses including options depending on their degree programme and personal interests. An important component of the final year is a project, PH3110, which may be of an experimental, theoretical, computational or electronics nature. Some third year courses closely reflect the research interests of members of staff, who are active specialists in their fields.

Further information

This document provides a summary of the main features of the programme(s), and of the outcomes which a student might reasonably be expected to achieve if full advantage is taken of the learning opportunities provided. Further information is contained in the College prospectus, the College Regulations and in various handbooks issued to students upon arrival. Whilst Royal Holloway keeps all its information for prospective applicants and students under review, programmes and the availability of individual courses are necessarily subject to change at

any time, and prospective applicants are therefore advised to seek confirmation of any factors which might affect their decision to follow a specific programme. In turn, Royal Holloway will inform applicants and students as soon as is practicable of any substantial changes which might affect their studies.

Learning outcomes

Teaching and learning in the programmes are closely informed by the active research of staff. In general terms, the programmes provide opportunities for students to develop and demonstrate the following learning outcomes:

Knowledge and understanding

- a broad knowledge of the inanimate physical universe to a level appropriate for a Bachelor's degree;
- a sound knowledge of the fundamental concepts of Physics and how these may be applied to understand complex physical systems and address associated problems;
- an understanding of the quantum and continuum descriptions of natural phenomena;
- an appreciation of the microscopic and macroscopic structure of all the states (phases) of matter and their interactions with different forms of energy;
- a knowledge and understanding of important physical laws and principles, and competence in the application of these principles to more diverse areas of physics and, where appropriate, to other disciplines;
- a secure understanding of the experimental and/or theoretical techniques and diagnostic tools appropriate to the particular field of endeavour and an awareness of such techniques in other fields;
- a critical approach to the gathering, collating, analysis and reporting of experimental data based on an understanding of errors and the limits of measurement;
- an understanding of mathematical modelling and of the role of approximation.

Skills and other attributes

The programme is designed to allow students to acquire competence in the ability to:

- use appropriate mathematical and/or computational tools to formulate and tackle problems in physics and to model physical behaviour, making necessary approximations, thus comparing critically the results of calculations with those from experimental observation;
- use appropriate methods to analyse data and to evaluate the level of its uncertainty and to relate any conclusions to current theories of the physics involved;
- execute an experiment or investigation, analyse critically the results of it and draw valid conclusions including evaluation of the level of uncertainty in the results and comparison with expected outcomes, published results or theoretical predictions;
- plan, execute and report the results of an experiment or investigation in physics;
- communicate scientific information clearly and accurately with correct use of technical language;*
- use a range of laboratory apparatus competently and safely;
- read demanding textbooks, and other available literature, search databases and listen carefully and interact with colleagues to extract important information. Make use of appropriate IT packages/systems for the retrieval and analysis of this data;*
- manipulate numerical data, and present and interpret information graphically;*
- analyse complex information, manipulating precise and intricate ideas to construct logical arguments and then presenting them in a clear and concise manner.*

* transferable skills

In addition, the programmes foster the development of a range of personal attributes that are important in the world of work, and that strengthen our graduates' abilities to engage in lifelong learning and contribute to the wider community. These include: personal motivation and initiative; the ability to work independently and with others; the ability to meet deadlines; listening skills; the ability to interact constructively with other people; self-awareness and self-management; empathy and insight; intellectual integrity; awareness of responsibility as a local, national and international citizen; interest in lifelong learning; flexibility and adaptability; creativity.

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Teaching, learning and assessment

Teaching is mostly by means of lectures, seminars, laboratory practical classes and problem-solving sessions; the latter generally providing a forum for students, with the support of their instructors, to work through problem sets and applications in a smaller and more interactive setting. Learning is through participation in lectures and seminars, designated reading, completion of problem sets and guided independent study and research. All students are expected to meet basic standards in information technology, for which training is provided by the College Computer Centre. Assessment of knowledge and understanding is mainly by formal, unseen written examination; coursework exercises, laboratory reports, oral and poster presentations and a Project dissertation are also assessed. A detailed mapping of the ways in which particular courses and modules achieve the programmes' learning outcomes may be found in the Department of Physics Student Handbook.

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Details of the programme structure(s)

Please note that the list of available courses offered is subject to change. Definitive current information is provided in the Department of Physics Student Handbook. A summary is provided in the tables below. The entries indicate:

Comp - compulsory courses must be passed in order to progress to the next stage;
Core - core courses must be taken at the designated stage of the programme;
Option - option courses may be chosen, with guidance, by students.

Single Honours Degree programmes and Combined Honours programmes taught wholly within Physics

Students take the following courses:			F300 Physics	F340 Theoretical Physics	F511 Astrophysics	F370 Physics with Particle Physics
Stage 1						
Mathematics for scientists 1	PH1110	1/2 unit	comp	comp	comp	comp
Mathematics for scientists 2	PH1120	1/2 unit	comp	comp	comp	comp
Scientific skills 1	PH1140	1/2 unit	core	core	core	core
Scientific skills 2	PH1150	1/2 unit	core	core	core	core
Mechanics and Relativity	PH1320	1/2 unit	core	core	core	core
Fields and Waves	PH1420	1/2 unit	core	core	core	core
Classical Matter	PH1620	1/2 unit	core	core	core	core
Physics of the Universe	PH1920	1/2 unit	core	core	core	core
Stage 2						
Mathematical methods	PH2130	1/2 unit	core	core	core	core
Scientific computing skills	PH2150	1/2 unit	core	core	core	core
Quantum mechanics	PH2210	1/2 unit	core	core	core	core
Optics	PH2310	1/2 unit	core	core	core	
Electromagnetism	PH2420	1/2 unit	core	core	core	core
Atomic and Nuclear Physics	PH2510	1/2 unit	core	core	core	core
Particle Detectors and Accelerators	PH2520	1/2 unit				core
Classical and Statistical Thermodynamics	PH2610	1/2 unit	core	core	core	core
The Solid State	PH2710	1/2 unit	core	core		core
Astronomy	PH2900	1/2 unit			core	
Physics options	x 1/2 unit		0	0	0	0
Stage 3						
Experimental or Theoretical Project	PH3110	1/2 unit	core	core	core	core
Energy	PH3040	1/2 unit	option	option	option	option
Further Mathematical Methods	PH3150	1/2 unit	option	core	option	option
Nonlinear Systems and Chaos	PH3160	1/2 unit	option	option		option
Quantum Theory	PH3210	1/2 unit	option	core	core	core
Particle Physics	PH3520	1/2 unit	option	option	core	core
Semiconductors and Superconductors	PH3710	1/2 unit	option	option		option
Modern Topics in Condensed Matter	PH3730	1/2 unit	option	option		option
Frontiers of Metrology	PH3810	1/2 unit	option	option		option
General Relativity and Cosmology	PH3910	1/2 unit	option	core	core	option
Stellar Astrophysics	PH3920	1/2 unit	option	option	core	option
Particle Astrophysics	PH3930	1/2 unit	option	option	core	core
Planetary Geology and Geophysics	GL3510	1/2 unit	option	option	option	option
Optics	PH2310	1/2 unit				core
Particle Detectors and Accelerators	PH2520	1/2 unit	option	option		
The Solid State	PH2710	1/2 unit			core	
Astronomy	PH2900	1/2 unit	option	option		option

Physics options	x 1/2 unit		7	4	1	3
In choosing options you may take no more than a total of 2 level-2 courses in the third year.						
Options taken in the second year may not be taken again in the third year.						

Combined Honours programmes with Physics as the major element

Students take the following courses:			F3W3 Physics with Music	F3V5 Physics with Philosophy
Stage 1				
Mathematics for Scientists 1	PH1110	1/2 unit	comp	comp
Mathematics for Scientists 2	PH1120	1/2 unit	comp	comp
Scientific Skills 1	PH1140	1/2 unit	core	core
Mechanics and Relativity	PH1320	1/2 unit	core	core
Fields and Waves	PH1420	1/2 unit	core	
Classical Matter	PH1620	1/2 unit	core	core
Physics of the Universe	PH1920	1/2 unit	core	core
Fundamental Questions in Philosophy	PY1001	1 unit		core
Minor options	x 1/2 unit		1	0
Stage 2				
Mathematical Methods	PH2130	1/2 unit	core	core
Scientific Computing Skills	PH2150	1/2 unit	core	core
Quantum Mechanics	PH2210	1/2 unit	core	core
Atomic and Nuclear Physics	PH2510	1/2 unit	core	
Classical and Statistical Thermodynamics	PH2610	1/2 unit	core	core
The Solid State	PH2710	1/2 unit	core	core
Fields and Waves	PH1420	1/2 unit		core
The Dialogues of Plato	CL2653	1 unit		*option*
Contemporary Political Theory	PR2490	1 unit		*option*
Modern Political Thought	PR2560	1 unit		*option*
Introduction to European Philosophy 1	PY2001	1/2 unit		*option*
Mind and World	PY2002	1/2 unit		*option*
Introduction to European Philosophy 2	PY2003	1/2 unit		*option*
Varieties of Scepticism	PY2004	1/2 unit		*option*
Philosophy and the Arts	PY2005	1/2 unit		*option*
Minor options	x 1/2 unit		2	2
PY2001 is to be taken together with PY2003				
PY2004 is to be taken together with PY2005				
Stage 3				
Experimental or Theoretical Project	PH3110	1/2 unit	core	core
Energy	PH3040	1/2 unit	option	option
Further Mathematical Methods	PH3150	1/2 unit	option	option
Nonlinear Systems and Chaos	PH3160	1/2 unit	option	option
Quantum Theory	PH3210	1/2 unit	option	option
Electromagnetic Theory	PH3420	1/2 unit		core
Particle Physics	PH3520	1/2 unit	option	option
Semiconductors and Superconductors	PH3710	1/2 unit	option	option

Modern Topics in Condensed Matter	PH3730	1/2 unit	option	option
Frontiers of Metrology	PH3810	1/2 unit	option	option
General Relativity and Cosmology	PH3910	1/2 unit	option	option
Particle Astrophysics	PH3930	1/2 unit	option	option
Optics	PH2310	1/2 unit	core	core
Electromagnetism	PH2420	1/2 unit	core	
Atomic and Nuclear Physics	PH2510	1/2 unit		core
The Politics of Toleration	PR3560	1/2 unit		*option*
Radical Political Theory	PR3540	1 unit		*option*
Social Justice: From Theory to Justice	PR3570	1/2 unit		*option*
Issues in Democratic Theory	PR3630	1 unit		*option*
Modern European Philosophy 1	PY3002	1/2 unit		*option*
Modern European Philosophy 2	PY3003	1/2 unit		*option*
Recovering Reality	PY3004	1/2 unit		*option*
The Self and Others	PY3005	1/2 unit		*option*
Minor options	x 1/2 unit		3	2
Physics options	x 1/2 unit		2	2

Joint Honours Degree programmes with Physics as an equal element

Students take the following courses:			**GF13 Mathematics and Physics**
Stage 1			
Scientific skills 1	PH1140	1/2 unit	core
Mechanics and Relativity	PH1320	1/2 unit	core
Classical Matter	PH1620	1/2 unit	core
Physics of the Universe	PH1920	1/2 unit	core
Stage 2			
Scientific computing skills	PH2150	1/2 unit	core
Classical and Statistical Thermodynamics	PH2610	1/2 unit	core
The Solid State	PH2710	1/2 unit	opt
Fields and Waves	PH1420	1/2 unit	core
Stage 3			
Experimental or Theoretical Project	PH3110	1/2 unit	core
Nonlinear Systems and Chaos	PH3160	1/2 unit	core$
Electromagnetic Theory	PH3420	1/2 unit	core*
Optics	PH2310	1/2 unit	core
Atomic & Nuclear Physics	PH2510	1/2 unit	core

$ PH3160 is the same as MT3280 so it may be counted as a Physics or a Maths module			
* PH3420 is the same as MT3240 so it may be counted as a Physics or a Maths module			

Single Honours Degree programmes and Combined Honours programmes taught wholly within Physics Part-Time

Students take the following courses:			F300 Physics	F340 Theoretical Physics	F511 Astrophysics	F370 Physics with Particle Physics
Stage 1a						
Mathematics for scientists 1	PH1110	1/2 unit	comp	comp	comp	comp
Mathematics for scientists 2	PH1120	1/2 unit	comp	comp	comp	comp
Mechanics and Relativity	PH1320	1/2 unit	core	core	core	core
Physics of the Universe	PH1920	1/2 unit	core	core	core	core
Stage 1a						
Scientific skills 1	PH1140	1/2 unit	core	core	core	core
Scientific skills 2	PH1150	1/2 unit	core	core	core	core
Fields and Waves	PH1420	1/2 unit	core	core	core	core
Classical Matter	PH1620	1/2 unit	core	core	core	core
Stage 2a						
Mathematical methods	PH2130	1/2 unit	core	core	core	core
Quantum mechanics	PH2210	1/2 unit	core	core	core	core
Atomic and Nuclear Physics	PH2510	1/2 unit	core	core	core	core
Classical and Statistical Thermodynamics	PH2610	1/2 unit	core	core	core	core
Physics options	x 1/2 unit		0	0	0	0
Stage 2b						
Scientific computing skills	PH2150	1/2 unit	core	core	core	core
Optics	PH2310	1/2 unit	core	core	core	
Electromagnetism	PH2420	1/2 unit	core	core	core	core
Particle Detectors and Accelerators	PH2520	1/2 unit				core
The Solid State	PH2710	1/2 unit	core	core		core
Astronomy	PH2900	1/2 unit			core	
Stages 3a and 3b						
Experimental or Theoretical Project	PH3110	1/2 unit	core	core	core	core
Energy	PH3040	1/2 unit	option	option	option	option
Further Mathematical Methods	PH3150	1/2 unit	option	core	option	option
Nonlinear Systems and Chaos	PH3160	1/2 unit	option	option		option
Quantum Theory	PH3210	1/2 unit	option	core	core	core
Particle Physics	PH3520	1/2 unit	option	option	core	core
Semiconductors and Superconductors	PH3710	1/2 unit	option	option		option
Modern Topics in Condensed Matter	PH3730	1/2 unit	option	option		option
Frontiers of Metrology	PH3810	1/2 unit	option	option		option
General Relativity and Cosmology	PH3910	1/2 unit	option	core	core	option
Stellar Astrophysics	PH3920	1/2 unit	option	option	core	option
Particle Astrophysics	PH3930	1/2 unit	option	option	core	core
Planetary Geology and Geophysics	GL3510	1/2 unit	option	option	option	option
Optics	PH2310	1/2 unit				core
Particle Detectors and Accelerators	PH2520	1/2 unit	option	option		
The Solid State	PH2710	1/2 unit			core	
Astronomy	PH2900	1/2 unit	option	option		option

Physics options	x 1/2 unit		7	4	1	3
In choosing options you may take no more than a total of 2 level-2 courses in the third year.						
Options taken in the second year may not be taken again in the third year.						

In Stage 3 students may choose, with advice, which courses they take in which years. This is largely a matter of personal choice, although a balance of courses between the first and second terms must be ensured.

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Progression and award requirements

The progression and award requirements are essentially the same across all Honours Degree programmes at Royal Holloway. Students must pass units to the value of at least three units on each stage of the programme. In the Physics department students must pass PH1110 Mathematics for Scientists 1 and PH1120 Mathematics for Scientists 2 in order to progress. On some programmes there may be a requirement to pass specific courses in order to progress to the next stage, or to qualify for a particular degree title. Students are considered for the award and classified on the basis of a weighted average. This is calculated from marks gained in courses taken in stages two and three, and gives twice the weighting to marks gained in stage three. In order to qualify for the award, students must pass courses to the value of at least nine units, three of which must be taken in stage three, and also gain a weighted average of at least 35%.

All first year students on single joint or combined honours programmes offered all or in part by departments or schools in the Faculty of Arts and Social Sciences are required to pass a Moodle-based writing skills quiz in order to progress into the second year of study. The pass mark for the test is 60%. Certificates of Distinction are awarded to students who achieve a least 80% in the quiz. Students may attempt the quiz as often as they wish with no penalties or capping. Students who meet the requirements for progression as stipulated in the College's Undergraduate Regulations (Section: Conditions for progression to the next stage) but fail to pass the Moodle-based quiz will not be permitted to progress into their second year of academic study at the College.

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Student support and guidance

- Personal Tutors: All students are allocated a personal tutor who meets with them regularly through the programme. The tutor's role is to advise on academic, pastoral and welfare issues. Students work closely with their personal tutors during the first year in tutorial groups of 3-5. There are similar sized tutorials in the second year. In the final year, academic matters are usually discussed with the Project supervisor in the first instance.
- Senior tutor: provides a back-up system of academic, pastoral and welfare advice.
- Induction programme for orientation and introduction to study skills.
- All staff available and accessible through open-door policy / dedicated office hours system.
- Detailed student handbook and course resources much of which is available electronically.
- Dedicated Departmental study/resource room, with computers, text-books and collection of articles and resources supporting teaching and learning.
- Dedicated Departmental computing facilities and teaching laboratories.
- Extensive supporting materials and learning resources in College libraries and computer centre.
- College Careers Service.
- Access to all College and University support services, including Student Counselling Service, Health Centre and the Education Support Unit for students with special needs.

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Admission requirements

Admission to the programmes normally requires a minimum of 340 UCAS tariff points at A2, with a standard A-level offer of AAB in Physics, Mathematics and another subject. However the Department also has considerable flexibility in its admissions and offers policy and strongly encourages non-standard applicants.

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Further learning and career opportunities

Students are provided with training in a range of subject-specific and transferable skills that prepare them for further study in the physical sciences or for entry into a wide range of both scientific and non-vocational careers. Students with appropriate degree classes will be well qualified to apply for Masters training programmes here and elsewhere in a range of scientific or other areas – teaching, for example. Appropriate Masters courses would be suitable for providing a route to Ph.D. research programmes here and elsewhere. There is a range of postgraduate courses nationally that develop and refine individual aspects of these programmes. Career opportunities include such areas as telecommunications, the IT industry, teaching, the civil service, industrial R&D

Employers' needs are identified mainly from information provided by the Institute of Physics and its Professional Standards Committee. We also maintain contacts with alumni in various commercial companies.

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Indicators of quality and standards

The Department performs well in the various published league tables. In the 2008 National Student Survey we were placed fourth in the category 'Overall Student Satisfaction'.

Royal Holloway's position as one of the UK's leading research-intensive institutions was confirmed by the results of the most recent Research Assessment Exercise (RAE 2008) conducted by the Higher Education Funding Council (HEFCE). In the Physics department 90% of research has been judged to be of international quality, of which 55% is internationally excellent or world leading.

In the most recent review of BSc and MSci undergraduate teaching by the Quality Assurance Agency, the Physics Department was awarded a score of 23 out of 24, which is categorized as 'Excellent'.

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List of programmes with details of awards, degree title, accreditation and teaching arrangements

All programmes are taught entirely by staff at Royal Holloway, University of London, and lead to awards of the University of London. All single honours and combined honours degree programmes are accredited by the Institute of Physics and the aims and outcomes reflect its Graduate Skills Base. The QAA subject benchmark statement in Physics describes the general features which one might expect from Honours Degree programmes in the subject, and can therefore be used as a point of reference when reading this document (see www.qaa.ac.uk). UCAS codes are given in parentheses (see www.ucas.ac.uk).

Single Honours Degree programmes in Physics and Combined Honour programmes taught wholly within Physics

BSc Physics (F300)	Available full- or part-time
BSc Astrophysics (F511)	Available full- or part-time
BSc Theoretical Physics (F340)	Available full- or part-time
BSc Physics with Particle Physics (F370)	Available full- or part-time

Combined Honours Degree programmes with Physics as a major component

BSc Physics with Music (F3W3)
BSc Physics with Philosophy (F3V5)

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