

PHYSICS AND PHILOSOPHY (MPhysPhil) Programme Specification

1. Awarding institution/body	University of Oxford
2. Teaching institution	University of Oxford
3. Programme accredited by	Institute of Physics
4. Final award	MPhysPhil (four-year) or BA (three-year)
5. Programme	Physics and Philosophy
6. UCAS code	VF53 MPhysPhil
7. Relevant subject benchmark statement	Physics (QAA), Philosophy (QAA)
8. Date of programme specification	September 2009

9. Educational aims of the programme

- To provide a course of the highest academic quality in physics and philosophy in a challenging but supportive learning environment that attracts the very best students from the UK and elsewhere.
- To provide students with an in-depth knowledge of physics with particular focus on theoretical foundations.
- To enable students to appreciate the interest and importance of philosophical questions on a variety of topics and especially in the philosophy of physics, and to contribute to the discussion of these questions.
- To develop transferable skills related to problem solving, communication, practical technique and computing, as well as to promote the ability to think independently, to develop powers of critical analysis, of sustained argumentation and of clear and effective communication both orally and in writing.
- To bring students to a position on graduation that allows them to choose confidently from many different careers, including academic careers in physics or in philosophy, and enables them to contribute rapidly to their chosen employment.

10. Programme outcomes

A. Students will develop a knowledge and understanding of:

- the general theoretical principles and techniques of physics
- a range of physics topics on all scales from the sub-atomic to the whole cosmos
- relevant mathematical techniques and how they are applied to physical problems
- some experimental procedures, including data recording and analysis and how to write up an experiment
- selected philosophical texts and central philosophical issues and the concepts needed to discuss those texts and issues in an effective manner
- the elements of mathematical logic and philosophy of science

- a broad range of topics in the philosophy of physics and in-depth knowledge of the foundations of special relativity and quantum mechanics

Related teaching/learning methods and strategies:

- Lectures provide the systematic exposition of material in all four years of the course.
- Classes (small groups of up to 10 students) in physics are used to discuss and expound problem sets related to the material in lectures, in philosophy to encourage students to present their own views on a set topic, for discussion by their peers, under the general guidance of a tutor familiar with the topic.
- Tutorials (usually in pairs) are used to discuss the more difficult concepts, stretch the most able students and provide focused help for those having difficulty. In the case of philosophy tutorials students will normally present an essay on a topic prescribed beforehand, which will then be discussed by the tutor, who will aim to give constructive criticism of what has been written, to point out any important aspects of the topic that have been overlooked, and to open up further lines of thought.
- Physics practicals (usually in pairs) enable students to develop experimental skills and to attempt some of the key experiments on which the subject is based.
- Private study, particularly during the vacations is both necessary and expected, as it provides opportunities for consolidation and for reading beyond and around the syllabus.

Assessment:

Formative assessments are carried out through tutorials, classes and termly examinations (collections). These are provided at a college level and have no influence upon university examinations. Assessment occurs as well within the context of the teaching laboratories through physics practicals.

Public (University) examinations are normally taken at the end of the summer term of most if not all of the years of the courses. Students may opt to submit a thesis in philosophy and/or a research project in physics in the final year (see section 11 below).

The Moderations Examination in Physics and Philosophy is a pass/fail examination covering foundation topics of the first year in physics, mathematics, philosophy and logic. It must be passed (a resit is allowed in September) to proceed further on the four-year course. The marks do not count towards the degree classification.

The Final Examination for the four-year Honour School in Physics and Philosophy is taken in three Parts A, B, C taken at the ends of the second, third and fourth years, respectively. Successful completion of the course will lead to the award of an MPhysPhil. There is also the possibility of graduating at the end of the third year, and successful completion of this course based on results for Parts A and B will lead to the award of a B.A.

B. Skills and other attributes

Students will have the opportunity to develop the following skills during the course:

I. Intellectual skills

- Appreciation of the unity of the underlying principles of physics
- Ability to assimilate and relate a wide range of physical phenomena and facts using these fundamental principles
- Ability to apply appropriate mathematical or numerical techniques to model physical phenomena

- Ability to solve a range of known physics problems and tackle unseen and more open ended ones
- Ability to digest and assess several diverging answers to philosophical questions, to make up their own minds on the issues, and to argue for their own view in a clear and cogent fashion
- Skills of analysis and argumentation, of independent and creative philosophical thinking, and of effective presentation
- Reading and writing skills: the skill to write clearly and accurately under time pressure, and to analyse and dissect written texts, including historical texts
- Ability to collate, analyse and interpret complex experimental information and infer conclusions

Ability to summarise physical arguments and facts and give succinct oral and written presentations, using IT based methods where appropriate

Teaching/learning methods and strategies

The first seven skills listed above are acquired through lectures, classes, tutorials and self study, and the final two through tutorials, practical sessions in the teaching laboratories and project work.

Assessment

The first seven are assessed through written examinations and written class and tutorial assignments; the eighth through assessed practical work; the last through public presentations and the project report.

II. Practical skills

One of the first things students must learn is how to organise their time effectively, giving due attention to their academic work, while at the same time leaving room for other interests of their own. Another is how to work for deadlines, for tutorial essays are frequently required and must not be late, and limited periods are available for longer projects and theses. Such skills are needed in many types of career. (They are learnt by experience, and are not usually ‘taught’, except insofar as it is insisted that academic work of an adequate standard is produced on time. But advice will be offered if someone is clearly in difficulty on these points. The acquisition of such skills is not something that needs separate ‘assessment’.)

Further practical skills in physics are related to

- Awareness of the need for safety in the practical laboratories with due reference to the risks of ionising radiation, lasers, cryogenics, compressed and flammable gases, electronic and electrical equipment
- Ability to carry out accurate measurements using a range of physical techniques and data acquisition systems

These are assessed through the marking and discussion of individual experiments by demonstrators in the teaching laboratories.

III. Transferable skills

As already noted, all the skills mentioned in B (I) and B(II) above are transferable skills. As a means to acquiring them, students also learn how to make effective use of libraries, information technology and other sources of information. This too is a transferable skill. It is taught right at the start of the student’s career, at what are called ‘induction sessions’ at the beginning of the first year. It is not assessed, except insofar as the work that results from it is assessed, as already explained.

11. Programme Structures and Features

Year 1 Moderations

Subjects

The first year covers foundation material in physics, mathematics, logic and philosophy:

CP1: Physics 1

CP3: Mathematical Methods 1

CP4: Mathematical Methods 2

Elements of Deductive Logic

Introduction to Philosophy

The last subject is in two parts: (i) an introduction to some of the prominent problems in epistemology and metaphysics, and (ii) the Leibniz-Clarke Correspondence. The latter is taught as an introduction principally to the philosophy of space and time.

Assessment

For assessment at College level, see 10A above. The University examinations at the end of the first year (*'Moderations' in Physics and Philosophy*) comprise 2.5-hour papers in the first three subjects, and 3-hour papers in the last two subjects. The results of this examination are not classified, except insofar as candidates may be awarded a distinction, which recognises first class work in physics or in philosophy, or in both. Otherwise candidates either pass or fail, and must pass if they are to be permitted to proceed to work for the final examination. (Candidates failing papers may retake these in September.) But the precise marks obtained on each paper are made known to the candidate in question and to his or her tutors, and may guide them in choosing how to structure the remainder of the course.

Year 2 Final Honour School Part A

Subjects [Note that the current cohort has different options open to them from previous cohorts hence the apparent inconsistency between years two and three in this description.]

A1: Thermal Physics (Kinetic Theory, Thermodynamics, Statistical Mechanics)

A2P: Electromagnetism

A3: Quantum Physics

Mathematical Methods

Three physics practicals: Free and bound electrons, Michelson interferometer, and Stern-Gerlach effect.

Knowledge and Reality or Philosophy of Science

Intermediate Philosophy of Physics (Special Relativity)

Assessment

Examinations at the end of the summer term on the fundamental principles of physics consist of 3-hour written papers on each of subjects A1 and A3, and a 1.5-hour paper on A2P. The mathematical methods subject underpins the material in all three papers. Practical work is assessed on the basis of a record of successful completion of the three experiments. There are no philosophy examinations in this year.

Year 3 Final Honour School Part B

Subjects

- BT: Classical Mechanics
- B1: Atomic Physics, Special Relativity and Sub-Atomic Physics
- B2: Condensed Matter Physics and Photonics
- B3: Astrophysics and Atmospheric Physics
- B4: Mathematical Physics

[Students do choose to do one of B1-B4 papers]

Philosophy of Science

Intermediate Philosophy of Physics (Quantum Mechanics)

Philosophy Option (The Philosophy Option involves a relatively free choice from among about twenty philosophical papers that are available.)

Assessment

In the examination at the end of the summer term, the 3 hour physics written paper BT is compulsory. The second physics paper is chosen from B1, B2 and B3 and is also 3 hours, as is each of the three philosophy papers. These are Knowledge and Reality (which includes a section on the Philosophy of Science), Intermediate Philosophy of Physics and the Philosophy Option. These papers cover all the philosophical material studied in years 2 and 3. A Thesis may also be offered in place of the Philosophy Option. A provisional classification is prepared for all students on the basis of Parts A and B, and any student leaving at the end of the 3rd year or at any time before completing Part C can be awarded a BA degree with this classification.

Year 4 Final Honour School Part C

Subjects

- C1: Astrophysics
 - C2: Atoms, Lasers and Optics
 - C3: Condensed Matter Physics
 - C4: Particle Physics
 - C5: Physics of Atmospheres and Oceans
 - C6: Theoretical Physics
 - C7: Biological Physics
- Philosophy Options, including the option of a Philosophy Thesis

Assessment

Candidates not on an exchange scheme offer a total of three units chosen in any combination from the lists for Physics and for Philosophy, or an approved collection of course options if taking part in an exchange scheme. A unit in Physics consists of either a written paper on a Major Option, or a project report on either advanced practical work or other advanced work. A unit in Philosophy consists of one of a number of available subjects (including Advanced Philosophy of Physics) or a Thesis if this was not offered in Part B. Each unit in Philosophy other than a Thesis is examined by a 3 hour written paper together with an extended essay.

For remarks about the classification of results, see section 15 below.

12. Support for students and their learning

A. Libraries

Undergraduates at Oxford have access to a wide range of libraries. First and foremost is the Bodleian Library, which together with its associated central libraries caters for all academic departments. For physics, the associated library is the (non-lending) Radcliffe Science Library. For philosophy, the Bodleian services are supplemented by the Philosophy Faculty Library, which keeps on open shelves most of the books that undergraduates in the course will need, and which is a lending library with multiple copies of the books that are most used. The OLIS cataloguing system incorporates the holdings of all major university libraries and Faculty libraries, and of most college libraries. Students should have no difficulty in obtaining access to the books that they need.

B. IT Resources

There is an extensive network of IT resources and support within Oxford. The colleges provide good IT resources and Support Officers prepared to train and assist students. In addition the Oxford University Computing Services (OUCS) provides facilities and classes for undergraduates at a variety of levels, from those suitable to complete beginners through to those aimed at students who wish to learn to use very sophisticated programs and computing languages.

The use of IT within the undergraduate degree course is significant and growing. Course bibliographies, learning materials and past examination papers can be downloaded from the Web and undergraduates are encouraged to develop their IT skills.

The Philosophy Centre provides computing facilities for students studying formal logic (namely, *Logic Works*, *Tarski's World*, and *TABLEAU*; an online *Introduction to Logic* is also available through the Philosophy website).

C. Academic Support

At the start of their course students will attend induction programmes given by their College, by their Faculties and by the Bodleian Library. These provide an initial orientation and essential information in a user-friendly form.

Students are provided with relevant parts of the University's *Examination Decrees and Regulations*, which specifies the overall structure of their course and gives the syllabuses of the various examination papers available in it. They are also given two *Course Handbooks*, one for Physics and Philosophy and one for Physics, which repeat this information in a more digestible form, include further relevant information (e.g. on assessment criteria) and offer advice on how to set about organising one's work and choosing one's options. Students may also consult past examiners' reports, which are available in libraries and on the Web and which contain some advice on good and bad ways of answering an examination question. The Philosophy Faculty Library will in the future contain some specimen undergraduate theses in philosophy, with an indication of the mark that they received, so that those who are contemplating writing a thesis may gain some idea of the standard expected. Finally, links to physics websites worldwide are provided by the Physics Department website (www.physics.ox.ac.uk).

There is a dedicated Philosophy of Physics website ([www. http://users.ox.ac.uk/~ppox/](http://users.ox.ac.uk/~ppox/)), with extensive documentation on the Physics and Philosophy Degree and up to date information on local events (including the visiting speakers research seminar in philosophy of physics). The site also contains links to electronic archives and other philosophy of physics centres world-wide.

College tutors provide academic guidance throughout the student's course. They make it clear to the student how he or she is progressing and they assist in making decisions on what options to choose. They arrange the student's tuition and expect to be available for consultation and on any topic, including pastoral matters. Most colleges are able to house most of their undergraduates throughout the course and provide social and sports facilities.

In the 4th (final) year of the course, classes in the Major Option physics subjects are organised by the Physics Department and, where possible, given by members of the permanent teaching staff. College tutors are informed on a termly basis of their students' progress (more frequently if problems arise).

D. Pastoral, Welfare and Financial Support

The colleges have many ways of providing support and guidance on pastoral, welfare and financial matters. Each undergraduate will have a college tutor assigned to him or her, who is primarily responsible for offering such assistance. (This may be one of his or her subject tutors, or may be another person, often called a 'moral' tutor.) This tutor is usually the undergraduate's first recourse in cases of academic or personal or financial difficulty. But others available in such a case usually include the head of the college, the Senior Tutor, the Dean (or Assistant or Sub-Dean), JCR Welfare Officers, the college Chaplain, the Adviser to Women, the college Nurse or the college Doctor. All colleges also have harassment advisers and many have funds to alleviate genuine cases of financial hardship.

The University provides a Counselling Service for those in need of professional advice and there are also University Committees on Student Health, on Hardship and on Disabilities, which are responsible for special provision in appropriate cases. Special arrangements are made for candidates in University examinations who are dyslexic or disabled or in some other way unable to conform to the behaviour expected of most candidates (e.g. because they cannot sit papers on the Jewish Sabbath). Information about these services is contained in college Handbooks and in Course Handbooks.

The University Careers Service is very active, and very successful, in helping to find employment for those soon to finish an undergraduate degree.

13. Criteria for Admissions

Admissions are the responsibility of the colleges, which aim to select, from among the many who apply, those who have the greatest potential to benefit from the intensive course that we offer. Colleges take into account the applicant's school record, the recommendations of their teachers, the specimens of school written work that they have submitted. Applicants must take two tests; one in Mathematics and one in Physics before they are invited for interview. Those that can are also asked to submit a written essay based on A-level course work. Where, as is usual, candidates have not yet completed their A-level examinations (or equivalent), the offer of a place is made conditional upon subsequent performance in these examinations. It is usual to require a result of at least grade A in Physics, Mathematics (single subject) and one other subject, or the equivalent in other systems (e.g. Scottish Highers, CSYS or IB).

Tutors are looking for enthusiastic and highly motivated students, with a physicist's ability to apply basic principles to unfamiliar situations and the philosopher's ability to handle abstract arguments and to write and speak with clarity and precision. The course requires a good level of mathematical competence, but the key technical requirement is the ability to formulate a problem mathematically and to be able to extract the physical consequences from the solution.

The selection criteria for the Physics element of the course are:

- Motivation: a real interest and strong desire to learn physics
- Ability to express physical ideas using mathematics; mathematical ability
- Reasoning ability: ability to analyse and solve problems using logical and critical approaches
- Physical intuition: an ability to see how one part of a physical system connects to another, and to predict what will happen in a given physical situation
- Communication: ability to give precise explanations both orally and numerically

The selection criteria for the Philosophy element of the course are (on the basis of written and oral presentations):

- Good basic knowledge of the topic

- Powers of analysis
- Ability to reason effectively, to construct a coherent line of argument, and to present it with clarity
- Good command of the English language, both written and oral
- To comprehend a complex piece of reasoning, and to sum it up in a suitable way
- To analyse and solve conceptual problems, giving clear and succinct reasons for the answer proposed
- To construct a well-argued case for taking a definite position on some fairly familiar question (on whatever topic)
- To appreciate fine differences in meaning

14. Methods for evaluating and improving the quality and standards of learning

Colleges have their own systems for obtaining feedback from students on the college tuition that they are offered.

The Faculties and Departments similarly obtain student feedback on lectures and University classes. In addition, *examiners* write detailed reports on the examinations that they have conducted (both 'mods' and 'finals'), which indicate (*inter alia*) the standards that the students are actually achieving. *External examiners* also submit their separate reports, which add (*inter alia*) some consideration of the appropriateness of the syllabuses for particular papers and of the way in which they are taught, and some comparison of the standards achieved at this University with the standards achieved elsewhere. Faculties pay due attention to these reports and respond to any issues that they raise. (The reports are further considered at the Divisional level.) Faculties regularly review the student feedback on lectures and University classes. There are also in each Faculty and Department *Joint Consultative Committees with Undergraduates*, containing some senior and many junior members, and any recommendations arising from these committees are again seriously considered by the Faculties and Departments. In these ways several different forms of feedback are regularly taken into account.

In addition, proposals for syllabus reform are considered at termly meetings of the *Standing Joint Committee for Physics and Philosophy*. This is the committee that runs the course, and normally comprises three physicists, three philosophers and a student representative. Such proposals are then discussed at general meetings of both the Physics Department and the Philosophy Faculty. As a result, some changes in regulations are made almost every year and the results incorporated in revised versions of the *Course Handbook* and *Examination Decrees and Regulations*.

New academic staff attend courses to train them in how to teach. These are organised by the Oxford Learning Institute, which has been set up within the University to carry out research into the training of university teachers as well as to supplement that research by employing the most effective methods of training. The Institute also runs courses to train graduate students who undertake some undergraduate teaching. In addition, each new academic member of staff is assigned an experienced member as an adviser, who is responsible for giving advice and guidance on both teaching and research, especially during the first two years. Appointments are normally made for five years in the first instance and a more formal review of the performance of new members of staff is conducted during the fifth year, with a view to determining whether re-appointment to the retiring age is appropriate.

All academic staff are subject to annual appraisal by a nominated peer appraiser, with an interview every five years (or more frequently, if requested by appraiser or appraisee). The emphasis of the appraisal scheme is on reflection and self-assessment, but it should bring to light any problems that need to be addressed at either College or Faculty/Department level.

Finally, the course is accredited by the Institute of Physics; the next accreditation review is expected in 2009.

15. Regulation of Assessment

The final assessment of a student, i.e. the class of degree that they are awarded, depends only on their performance in the final examination. This is conducted by a board of examiners, appointed partly by the Sub-Faculty of Physics and partly by the Faculty of Philosophy, but also including an external examiner appointed by the Vice-Chancellor. The Board of Examiners determines what class should be awarded to each candidate, having regard to guidelines agreed beforehand by the Joint Standing Committee for Physics and Philosophy. These guidelines are published in the *Course Handbook* and therefore known to the candidates. When the examination is completed, the examiners submit a report on what they have done, which is scrutinised both by the Standing Joint Committee and by the separate Undergraduate Studies Committees of the two Faculties involved. The report is also discussed at Faculty meetings open to all members of each Faculty and by the two Faculty Boards, before being forwarded to the Humanities and Mathematical and Physical Sciences Divisions and eventually to the Educational Policy and Standards Committee (EPSC) of the University. But if the report reveals any problems that need to be addressed, suitable action will have been taken before that final stage is reached.

In all of this the external examiners in Physics and in Philosophy play a special role. During the examination they act as impartial advisers, providing informed comment on two major issues:

- (i) To verify that standards are appropriate to the class of degree awarded, in part by comparison with the standards of comparable institutions, and to ensure that the assessment procedures and the regulations governing them are fair and otherwise appropriate;
- (ii) To ensure that the examination has been fairly conducted and that individual student performance has been properly judged in accordance with the regulations and conventions of the examining board.

The external examiners sign the final Class list, along with the internal examiners, as an endorsement that the processes of examination and classification have been fairly conducted.

After the examination the external examiners submit separate reports (officially addressed to the Vice-Chancellor), which are expected to cover all the following points:

- the standards demonstrated by the students
- the extent to which standards are appropriate to the class of degree awarded
- the design, structure and marking of examination papers
- the suitability of the procedures used in the examination, in this case including not only procedures for the examination papers but also for the oral examination and for the philosophy thesis or physics project, if offered
- whether or not external examiners have had sufficient access to, and the power to call upon, any material necessary to make the required judgements
- students' performance in relation to their peers in comparable courses
- the coherence of the policies and procedures relating to external examiners and their consonance with the explicit role required of them
- the strengths and weaknesses of the students as a cohort
- the quality of teaching and learning which may be indicated by student performance

The external examiner's report is considered by all the same bodies as consider the reports of internal examiners, and again any action required is taken long before the final stage of consideration is reached.

The following marking scheme is used:

First Class script: work displaying analytical and argumentational power, with good command of the factors and/or arguments relevant to the questions and evidence of ability to organise them with clarity, insight and efficiency.

Upper Second Class script: work displaying analytical power and argumentation of the quality associated with a First, but with less comprehensive and thorough command of evidence; or work showing considerable thoroughness but less analytical skill or less clarity of organisation.

Lower Second Class script: competent work with no major defects, but giving an incomplete account of the question, or marred by inaccuracies; or work which demonstrates lapses in (but does not lack) analytical and argumentational skills.

Third Class script: work that is generally weak with muddled argumentation, but containing some evidence of knowledge of facts and analytical skill; or work that, while competent and knowledgeable in itself, does not address the question asked by the examiners.

Pass Degree script: very poor quality work, showing only slight evidence of effective study.

Fail script: work of still lower standard, but not so poor that it should prevent the candidate from being awarded a degree if able to show better ability in enough other subjects.

Outright Fail script: work of such dismal standard that the candidate should not be awarded a Pass degree irrespective of performance in other subjects, unless the examining board finds exceptional mitigating circumstances.

16. Indicators of quality and standards

External examiners' reports have confirmed that the standards of degrees awarded are appropriate.

The Department of Physics and the Faculty of Philosophy were assessed for their teaching in QAA reviews of Autumn 1999 and 2000 and were awarded 23 and 24 out of 24, respectively.

Both Physics and Philosophy achieved a 5* grade in the last two National Research Assessment Exercises.

The Humanities and Mathematical and Physical Sciences Divisions undertake regular reviews of their constituent Faculties/Departments and the Educational Policy and Standards Committee does the same; all of these reviews have strong external representation.

In the case of Physics, the Academic Committee (charged by the Chairman of the Department and the Physics Management Committee with the responsibility for providing the undergraduate courses) monitors the quality of the physics component of the course on a regular basis. The Philosophy Faculty likewise monitors the philosophy component.

The Department of Physics and the Faculty of Philosophy each has its own External Advisory Panel, whose members are relevant experts from other universities (including universities in other countries) and from industry and government. These Panels meet from time to time to offer advice on how best to meet changing situations both within and outside this University. Their advice is taken very seriously.

Student feedback has been broadly positive.

A report on the course is provided in the accreditation process undertaken by the Institute of Physics.

First destination statistics demonstrate that graduates are highly sought after by employers.