Physics

LENGTH OF COURSE

3 years (BA Physics), 4 years (MPhys), 4 years (MPhysPhil)

MINIMUM A-LEVEL GRADE REQUIREMENTS

Include Mathematics and Physics. The A* must be in Mathematics, Physics or Further Mathematics

A-LEVELS REQUIRED

A-levels: A*AA

Advanced Highers: AA/AAB

IB: 39 (including core points) with 766 at HL (the 7 should be in either Physics or Mathematics)

Or any other equivalent

ADMISSIONS TEST

The Physics Aptitude Test (PAT) is sat early in the academic year (around October) and is an advanced test of A-Level physics and maths. Although the content is not beyond what is covered in an average A-Level syllabus, the application of the content is far more mathematical and challenging, with a greater emphasis on problem solving over standard solution regurgitation. The syllabus for the PAT can be found online and it includes content that you may not have yet covered in class. You are therefore expected to independently study these topics on your own. A-Level Physics by Roger Muncaster is one the best books for this.

COURSE DESCRIPTION

Physics courses investigate the basic principles of modern physics with a strong emphasis on its mathematical foundation. They also include a significant amount of experimental work and the possibility of studying a non-physics subject. There is also a common emphasis on individual development, discussion and the ability to work with others in the laboratory.

The 3 year BA course is more appropriate for those not seeking a career in physics.

The 4 year MPhys an extended course, allowing time in addition to the 3-year BA course to pursue two or more fields up to the research frontier. It should be of interest to those who seek a possible career in physics and/or who want a degree comparable in level with advanced European degrees.

The 4 year MPhysPhil will be of interest to those who seek a deeper philosophical understanding of the basis of physics and who want a degree comparable in level with advanced European degrees. In the physics and philosophy course some of the physics subjects in each year are replaced by topics in philosophy. The Joint Honours degree in Physics and Philosophy is intended to restore the long-standing connection between natural science on the one hand and the study of its foundations in metaphysics and the theory of knowledge on the other hand. The course is also intended to equip those who take it with the ability to think scientifically, to handle difficult concepts and to present their conclusions incisively and effectively. It is a course which aims to bridge the Arts/Science divide.

In terms of teaching, students will have lectures, labs and tutorials/classes each week.

TUTORIAL/CLASS TESTIMONIAL

Tutorials are short lessons in pairs and classes are longer lessons in large groups. Tutorials will follow your classes and the distribution of each of these forms of teaching depends on your college. At New College there are typically three or four 1-1.5 hour tutorials per week, whereas at Keble College there are two ~3 hour classes per week. Some tutors like to focus solely on the problem sheets, others like to take the concepts from the module further to make you think a little more deeply about the topic. These discussions usually take place with the other physicists from your college and the tutor. Tutorials are your opportunity to ask any off topic questions to your tutor, for example, questions about certain derivations that you're unsure about or about certain contradictions that appear within certain modules (things that are not strictly on syllabus but are still well worth understanding as part of your education). Unfortunately these tutorials are not long, only being about 20 to 30 minutes in length.

LABS TESTIMONIAL

Labs average to one day a week. On lab days, you will follow a script that instructs you on how to use equipment and what measurements to take in order to carry out a series of small experiments. The course at Oxford is very theoretical and labs don't form a big part of the physics education here.

STRUCTURE OF MODULES

First year: Newtonian mechanics; introduction to Lagrangian and Hamiltonian mechanics; special relativity; electromagnetism; circuit theory; introduction to geometric and wave optics; linear algebra (vectors, matrices, etc.); complex numbers; ordinary differential equations; calculus; vector algebra and vector calculus; normal modes and wave motion. One short option choice out of astronomy, complex analysis and quantum ideas. First year needs to be passed to progress onto second year.

Second year: Thermal physics; electromagnetism and optics; quantum physics; linear algebra; partial differential equations; Fourier series; probability and statistics; a choice of one of serveral short options including classical mechanics and the physics of climate change.

Third year: Fluids; symmetry and relativity; atomic and laser physics; nuclear and particle physics; general relativity; condensed-matter physics; practical work mini project; choice of one of several short options including plasma physics and advanced quantum mechanics.

Fourth Year: For MPhys students, 4th year consists of a research project and two options out of astrophysics; laser science and quantum information processing; condesed matter physics; particle physics; atmospheres and oceans; theoretical physics and biological physics.

For MPhysPhil: The first year deals with rival seventeenth century conceptions of space and time, and in the next two years the philosophy of special relativity and quantum mechanics are studied at an intermediate level. In the final, fourth year, advanced philosophy of physics is taught through lectures and classes, rather than tutorials. Any Joint Honours degree is bound to have a heavy workload, and Physics and Philosophy is no exception. Undergraduates are expected to be as fluent in mathematics as are their Single Honours peers in physics and as competent in writing essays as their colleagues in philosophy. The course necessarily involves a lot of work, but the unity of the selections taken from each subject does give scope for the subject matter to come together once the basic skills have been mastered. A limited amount of practical work in physics (involving three experiments) is undertaken in the second year, and an option exists in the fourth year for a more advanced practical project to replace one of the physics papers.

The Physics and Mathematics Departments jointly offer an integrated master's level course in Mathematical and Theoretical Physics. Physics students are able to apply for transfer to a fourth year studying entirely mathematical and theoretical physics, completing their degree with an MMathPhys. The course offers research-level training in: Particle physics, Condensed matter physics, Astrophysics, Plasma physics and Continuous media.

Physics and philosophy: More information on the philosophy and physics course can be found online on the Oxford website.

WHY PHYSICS?

Generally, choosing to study physics is the result of a curiosity about how the world works. Personally, I was fascinated by maths and how its applications elegantly describe the inner workings of the world. Physics at university is very different to studying physics at school; the maths involved is of a much higher level. In fact, maths is a tool that physicists use to describe phenomena and it was this idea – using maths as a tool to explain concepts rather than 'maths for the sake of maths' that intrigued me.

CAREER PROSPECTS

Many physicists go into finance or into academia. Physics is a fantastic degree to have for the corporate world and can also benefit you greatly when searching for jobs in data science and tech consultancy. It is also possible to do a law conversion and become a patent attorney, for which a science background is important. However, one should note that physics is not a vocational degree and therefore does not lead clearly into a profession such as engineering, since it is very abstract and high level rather than being immediately applicable. There are many career options available to the physicist, but if one has a clear profession in mind it may be worth considering whether engineering, computer science or chemistry leads into it more naturally.

APPROXIMATE NO. OF CONTACT HOURS PER WEEK

Tutorials: <1 (classes sometimes followed by 20 min 'tutorials)
Lectures: 9-11
Labs: 7 hours (1 day is dedicated to labs)
Seminars/classes: 5-8, spread across two classes

Tips

PERSONAL STATEMENT TIPS

- Get involved with physics (or maths) olympiads (British Physics Olympiad is a great one) or take part in Isaac Physics events to show your passion for solving physics problems and physics itself
- There are plenty of popular science books that introduce interesting ideas. Remember that the purpose of including a book is to show how the text impacted your understanding of physics, rather than name-checking various books or scientists. It may even be better to avoid mentioning book names entirely, and instead focus on what concepts you have read about
- If you're struggling with structure, write with a narrative. I talked about the inspiration I drew from articles and books I'd read and talks I'd attended and how being involved with physics events outside of sixth form had played a role in my personal physics journey

INTERVIEW TIPS

- Interview problems are based on a mix of maths and physics concepts (graph sketching, mechanics, circuit theory, optics and occasionally some Fermi-type questions).
- Make sure you're familiar with your A Level maths and physics concepts and perhaps go over any notes you made as preparation for the PAT
- The interviewer will try to expand on your current knowledge, so the more you're confident with your A Level content, the more you can learn from the interview
- Talk the tutors through your thought process. They're not looking for someone who has all the answers ready, they're trying to see if they can teach you something new. Even if you know you're wrong, voicing your thoughts helps the tutors to guide you in the right direction
- Do not be too proud to ask for clarification or help

PAT TIPS

- The PAT syllabus is published on the Oxford physics website. Make sure you're familiar and comfortable with the material that could appear on the test
- Going through past papers will ensure you're familiar with the type of questions and the time limit
- Go through the solutions on https://oxfordpat.wordpress.com/ or consult a teacher to check your work
- The test is very difficult but with good preparation it is manageable

ONE THING I WISH I KNEW WHEN I WAS APPLYING

One thing I wish I knew was the value and consideration worth giving to the physics and philosophy degree. I dismissed it without thinking about it and went for pure physics, but when I'm studying relativity and discussing the nature of time in tutorials, I can't help but feel a bit jealous of the physics and philosophy students who are trained to argue and think about such topics in a deep and meaningful way. Physics and philosophy is a subject well worth doing despite the higher workload, and you should strongly, strongly consider applying for it instead, especially if you're the kind of person interested in the philosophical (and perhaps even theological) implications of your problem sets.

Recommended reading/viewing

- Roger Muncaster's "A Level Physics" – great for preparing for the PAT, as well as for Physics Olympiads
- Carlo Rovelli's "Seven Brief Lessons on Physics" – introduces relativity and quantum mechanics in accessible, story-like lessons. One of my favourite books!
- YouTube channel "MinutePhysics" - explains concepts from anti-matter to paradoxes about time travel, all in 3-5 minute videos
- "Physics Review" magazines – these take the concepts you learn at A Level a little further, bringing in the real world consequences to the Physics you learn in the classroom. They also contain useful tips for solving questions in exams.
- Mathematical Method for Physics and Engineering (Riley, Hobson, Bence)
- Introduction to Classical Mechanics: With Problems and Solutions (David Morin)
- Introduction to Electrodynamics Fourth Edition (David Griffiths)
- Introduction to Optics Third Edition (Pedrotti, Pedrotti and Pedrotti)
- Optics (Smith and Thomson)
- Vibrations and Waves (A.P. French)
- Special Relativity (A.P. French)

EXAMPLE TIMETABLE