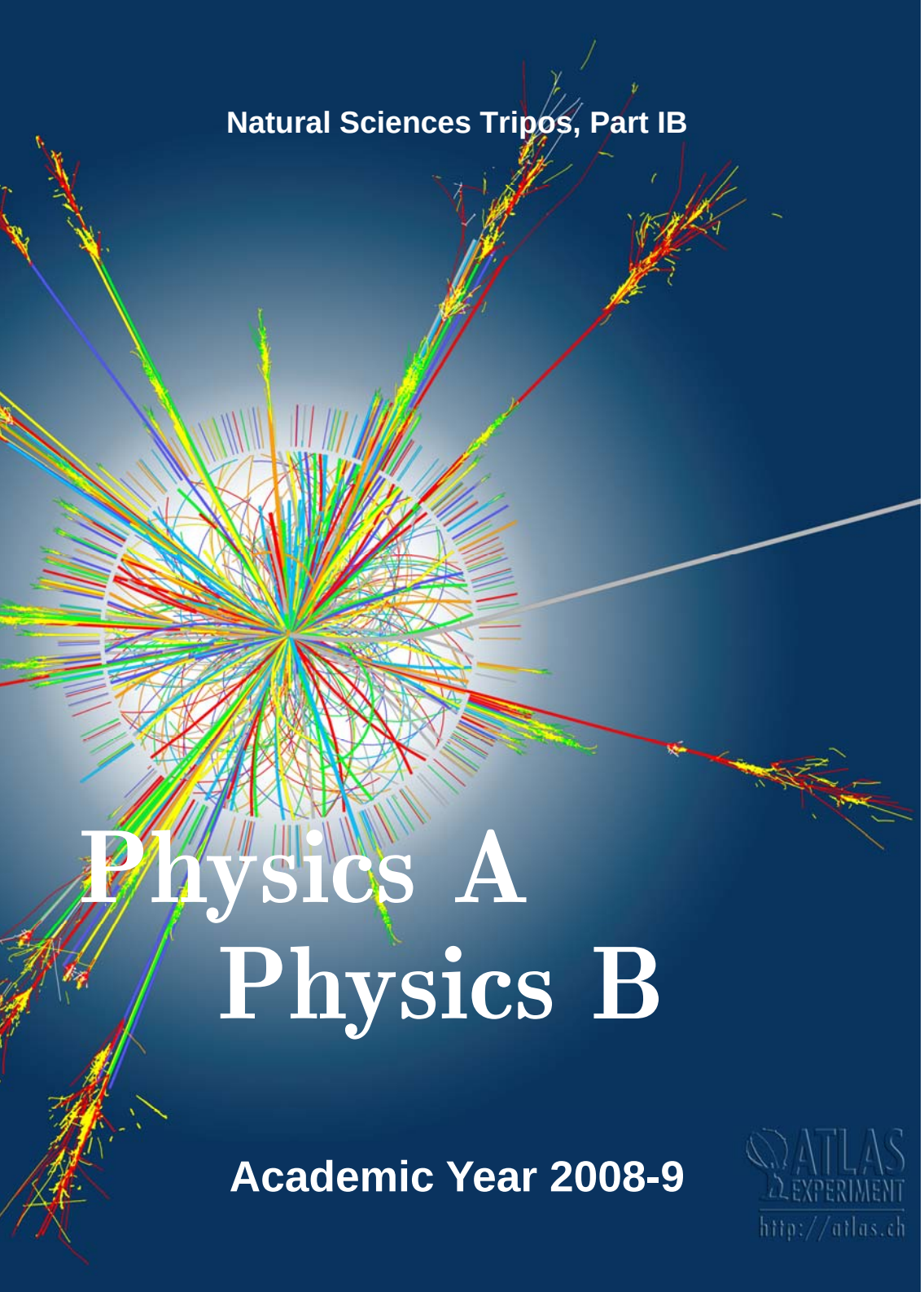


Part IB Physics courses 2008-9

The second-year courses provided by the Department of Physics build on the knowledge you have acquired in the Part IA course, and prepare you for our Part II courses. The Department provides two subjects in Part IB: *Physics A* and *Physics B*. You will need to take both courses if you intend to take Part II Experimental and Theoretical Physics (ETP). However, either course can also be taken on its own, with two other Part IB subjects.

The two courses run in parallel. *Physics A* is a self-contained course in Waves, Quantum Mechanics, and the Wave Properties of Condensed Matter, while *Physics B* covers the main areas of classical physics – Electromagnetism, Dynamics and Thermodynamics. *Physics B* also introduces scientific programming, using the C/C++ language. The mathematical level of the *Physics B* course is more consistently demanding than that of *Physics A*, reflecting the fact that the majority of students taking the subject will proceed to Part II/III ETP and other quantitative subjects.

Students taking both courses combine them with one other IB subject. For those who are strongly committed to Physics and have coped well with Part IA *Mathematics*[1], Part IB *Mathematics* is an obvious choice. However, depending on your interests, the selection of another experimental subject can complement Physics in different ways, and provides a greater choice of Part II/III courses. Common choices of the third subject are *Materials Science*, *Minerals Science*, *Chemistry A* or *B*, *Geology A*[2], *Psychology*, and *History and Philosophy of Science*.

Physics A

Physics A deals with waves and quantum matter. It is designed to be appropriate for scientists with a wide range of potential career destinations. As such, it would be a useful addition for students also taking a variety of other Part IB subjects, such as *Chemistry A*, *Materials Science*, and *Minerals Science*. The mathematical level of the course is set by the syllabus for Part IA *Mathematics* and any additional material, such as Fourier methods, will be taught within the body of the course. There is also an integrated practical class (see below).

The main lecture courses are:

Waves and Optics

An understanding of waves is fundamental to many areas of physics. This course develops the ideas presented in the Part IA "Oscillations and Waves course". It looks at both the free and driven responses of general linear systems, including coupled oscillators. The wave equation is revised, and applied to a variety of physical systems. These ideas are then further developed in the context of classical optics, with particular regard to diffraction and interference phenomena.

[1] References to mathematics courses are to Part IA *Mathematics for the NST* and Part IB *Mathematics for the NST*, unless otherwise noted.
[2] The *Geology B* and *Physics B* lectures conflict.

Quantum Physics

This is probably the single most important course you will do in Physics. It gives a mathematical introduction to quantum theory, introducing both wave and operator methods, and applying these to the canonical problem of hydrogen-like atoms. It concludes with an overview of multi-particle systems, and the quantum mechanics of spin and identical particles.

Condensed Matter Physics

The material from the two previous courses provides a powerful understanding of many problems of condensed matter (solid-state) physics. This brief introduction introduces quantised lattice vibrations (phonons) and shows how the specific heats of materials reveal details of their structure. It also looks at electronic properties, including the notion of band structure.

Experimental Methods

This short course directly supports the practical work. It examines measurement errors – both random and systematic – and shows how they can be minimized through careful experimental design. There is also a brief discussion of the estimation problem – how can the values of parameters best be estimated from the available data?

Physics B

Physics B runs in parallel with *Physics A* and offers material that generally requires a more sophisticated mathematical approach while covering more specialised topics that lead naturally to Part II/III Physics and other quantitative subjects.

We would not expect many students to take *Physics B* without also taking *Physics A*. However, it may appeal to students who want to explore areas of theoretical physics, while still intending to proceed to Chemistry or Materials Science in Part II, and who feel that they will gain sufficient knowledge of quantum mechanics from their other courses.

Electromagnetism

The electromagnetism course further develops the ideas on electric and magnetic fields introduced in Part IA, with electrostatics and magnetostatics being treated as special cases of Maxwell's equations. The course introduces dielectric and magnetic media, and examines wave propagation in free space, as well as in insulating and conducting media and on transmission lines and waveguides.

Classical Dynamics and Fluids

Again, this course builds on the ideas introduced in Part IA, using the machinery of vector calculus taught in Part IA *Mathematics*. The main areas covered are orbits, rigid body dynamics, normal modes, and continuum mechanics (elasticity and fluids).

Thermodynamics

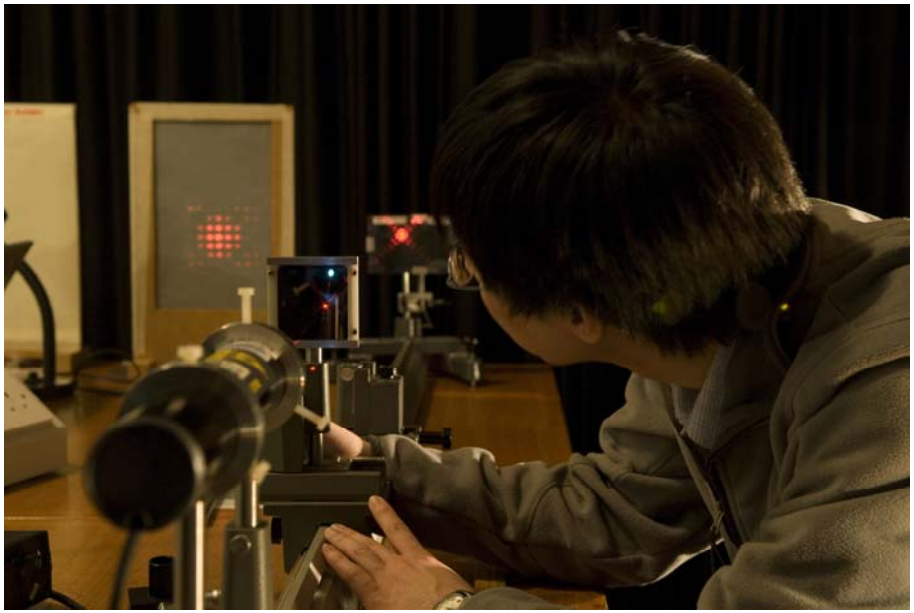
This is a general introduction to classical thermodynamics, with an emphasis on analytical techniques. If you have taken Part IA *Chemistry*, some of this material will already be familiar to you. The final part of the course is an introduction to statistical mechanics, which forms a foundation for the Part II course "Thermal and Statistical Physics".

In addition, there is a "Mathematical Methods" course, which is designed to meet the needs of students not doing Part IB *Mathematics*. Those who *are* offering *Mathematics* are expected to attend the non-examinable course "Great Experiments in Physics", which explores the experimental basis underlying a number of areas in modern physics.

Everyone also takes a first course on "Computational Physics", which introduces you to computing in C/C++ on Linux.

Practical classes

The Michaelmas practicals are on the theme "Systems and Measurement", and aim to develop general experimental skills. In Lent, the experiments are all on "Waves and Optics" and explore wave behaviour in a variety of physical situations. Those taking both *Physics A* and *Physics B* do six long (6—8 hours) experiments in Michaelmas, and a further six experiments (plus a short introductory session) in Lent. Students taking just one physics course do half this number, on appropriate topics.



While the practical work for each of *Physics A* and *Physics B* stands alone, it is nonetheless helpful for those taking *Physics B* to attend the *Physics A* Michaelmas Term lectures on "Experimental Methods" for useful, but non-examined theoretical background.

Do you need to take Part IB Mathematics?

You will already have covered the mathematics required for the Part IB courses in Part IA *Mathematics*. The material is revised at the start of Part IB *Mathematics*, but if you choose not to take this subject, then the *Physics B* Michaelmas course on "Mathematical Methods" also revises the necessary techniques. So Part IB *Mathematics* is not necessary for either Part IB course, nor indeed for the Part II "core" courses.

However, there is no way of disguising the fact that Physics is a mathematical subject, and the more maths you do, the easier you will find the more analytical aspects of the course. In *Physics A*, the "Quantum Physics" course makes intensive use of the ideas of eigenfunctions and eigenvalues, which are most easily treated in matrix form. In *Physics B*, Electromagnetism and Dynamics, which lay the foundation for much of Part II, assume a familiarity with the vector calculus taught in the Part IA *Mathematics* course. Waves appear in almost all courses, and require an understanding of the wave equation and its solutions.

For those wishing to take either or both of the theoretical options in Part II (Theoretical Physics 1 & 2), then it's true that Part IB *Mathematics* is more or less a prerequisite. If you have a good reason for taking a third experimental option in Part IB, and nevertheless wish to take TP1 or TP2 in Part II, then you will definitely need to put in some significant effort over the long vacation in order to familiarise yourself with the material you have missed out.

Routes into Part IB Physics

We assume that you have taken *Physics* and *Mathematics* in Part IA of the Natural Sciences or Computer Science Triposes. Students who have taken the "Maths with Physics" option in Part IA of the Mathematics Tripos are also very well-placed for Part IB Physics. It is also possible to transfer from Part IA Engineering.

After Part IB

We offer two courses at Part II level. In both cases we assume that you have taken both *Physics A* and *Physics B* from Part IB of the NST.

Part II Experimental and Theoretical Physics (ETP)

The great majority of double-subject students continue to Part II ETP, a full-time course. It completes the presentation of core material, and gives some insight into the four major research themes of the Cavendish Laboratory – Astrophysics, Particle Physics, Quantum Condensed Matter, and Soft Condensed Matter & Biophysics. Option A, the 3-year course, leads to the award of the BA. Provided that you get at least a 2.ii in Part IB overall, you may choose instead Option B, which leads to Part III ETP and the double degree of BA and MSci.

Those taking Option B can apply to substitute a year working at the Massachusetts Institute of Technology for Part II itself. Whilst at MIT, you would be expected to take specified physics courses that cover most of the same ground as Part II Option B, with a similar choice between experimental and theoretical options.

Half-subject Physics

As the name suggests, this consists of roughly half of the material contained in Part II ETP. It is part of Part II Physical Sciences, and can be taken either with another Part II half-subject, or with a Part IB NST course that you have not previously offered for examination.

Students with *Physics A*, *Physics B* and Part IB *Mathematics* can also choose to take Part II Astrophysics in the third year (which may then lead to Part III Astrophysics).

Those who have taken another experimental subject (or *HPS*) rather than Part IB *Mathemetics* can usually choose to continue with their third subject – double physics is an excellent preparation for Part IIs in Materials Science, Geophysics and theoretical and physical Chemistry.

For more information

You can get information about the current Part IB courses direct from the Physics teaching website, at www.phy.cam.ac.uk/teaching/Ib.php [Note that several changes to the courses are mentioned in this leaflet, but will not appear on the website until later in the summer.] Otherwise, in the first instance you should contact your Director of Studies. If he or she can't answer your questions, please email Mrs Helen Marshall in the Teaching Office, at teaching-office@phy.cam.ac.uk, and we will do our best to help.

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