Examination Skills in Physics

These notes have been prepared by the Teaching Committee in the Department of Physics to give you some general advice on preparing for Cambridge Physics exams. This may seem presumptuous, since skill in passing exams is one of the things which has helped you get to Cambridge. Nevertheless, Tripos exams are somewhat different in style from school levels, and harder. Of course, all students are different, and you should get more detailed personal advice from supervisors and Directors of Studies. Although most of the advice given here is fairly obvious, experience suggests that it will do no harm to give you these reminders. Some of the remarks are specific to Physics, but much is applicable to other subjects.

1 Preparing for the exams

- Make sure you know what the structure of each paper will be – which courses will be examined; how many questions etc. The previous year's paper is generally a good guide, and if there are any changes from previous practice, a *Form and Conduct Notice* will have been published in the *University Reporter* (available on the web). Your Director of Studies should know about changes, and in the case of Part II and Part III, a notice will be placed on the notice board in the Cavendish near the Pippard lecture theatre.

- Only approved and appropriately marked calculators can be used in the exams. Make sure you have such a calculator (available from Cavendish Stores), and are well practised in using it.

- Copies of the *Mathematical Formulæ* Handbook will be available in the Physics exam only. Make sure you are familiar with its contents, so that you do not waste time remembering, possibly wrongly, any of the formulæ that are readily available. You can buy a copy from the Cavendish Stores for £1.50.

- Revision: revise actively. It's not very effective simply to read through your notes and try to memorise them. Writing *brief* summaries of key topics is often an efficient way of organising and memorising material. Doing essay questions or "bookwork" parts of problems from old exam papers is another effective way of focussing your revision in relevant areas.

- Practice doing questions against the clock. You might start by looking at a question, then revising that area of the course, and then doing the question in the required time. Nearer to the exams, try doing questions without notes/books. This will help you to decide what things you need to memorise, and how much you can rely on deriving in the exams.

- Problems in the exam papers are often quite similar to questions you have done during the year. So keep your supervision work well organised throughout the year, and after supervisions rewrite answers if necessary so that you have a complete set of correct solutions to refer to during revision.

- Start preparing for exams early (probably in the Easter vacation), and try to establish a program of when you are planning to do what. You may not manage to stick to it, but it will help. There is no single right way to organise your revision; some students prefer to focus intensively on a single course while others are happier with a more varied program of work. The main thing is to find a system which works for you.

- For most people, steady work is more effective than trying to cram everything in at the last minute. Try to settle into a pattern of work in the Easter Term (and indeed every term), including a certain amount of relaxation and social life. Sleep and eat sensibly, and drink in moderation, if at all. Try to relax completely for an hour or so before going to bed.

- The revision period is quite different in Part IA/IB, when you have new lecture courses in the Easter Term to cope with as well as revision, and Parts II/III, where you have the whole term in which to revise. In both cases organization and self-discipline tend to be the secret to successful preparation, but you need to be increasingly self-reliant in the later years.

- Play to your strengths. You don't need to understand everything in every course to do well. If you have two-thirds of the material well under control, you should find enough questions on the papers to choose from.

- Stress: try not to worry: it's very difficult to fail. Do seek help if you are feeling the effects of stress, earlier rather than later. For example, Tutors, Directors of Studies, College Nurses and your friends can all help. A subject group in a College can often help each other along by talking and working together in the run-up to the exams.

2 During the exams

- Make sure you know exactly where (which building and room) your exams will be held. If you haven't been there before, consider going along beforehand so as to avoid unnecessary stress on the day of the exam.

- First, read the cover page carefully to make sure you understand what you are expected to answer.

- The number of marks for each question, and for individual parts of longer questions, is indicated on the exam paper. Use this information to help you make effective use of your time.

- *"Section A" questions.* In most Physics exams, Section A contains short compulsory questions: *you must attempt them all*. It should be possible to answer these questions in less than a page, and they don't usually require a lot of detailed mathematical analysis. They may involve a certain amount of lateral thinking. Even if you do not have a clear understanding of the whole question you must say something about the physics involved. Making yourself write *something* down, and/or draw a diagram as appropriate, should help you understand how to do the question more fully. If you don't answer one of these questions, then you'll get zero… if you do attempt it, however poorly it may seem to you at the time, you may get some marks. Section A is typically worth about a quarter to a third of the marks, so spend about a corresponding fraction of the available time on this section in total. It is probably wise to aim to do these questions in less than this time, but leave some time at the end of the exam so that you can look at your answers in a fresh light, and to make sure you have not made any obvious mistakes.

- *Longer questions.* You have a choice; you have to attempt typically about 50% of the questions. The papers are generally structured so that you have to answer questions on every course. There are two main types of question:

  - **Problems.** These will generally start with a piece of *bookwork*: either a standard derivation, or a brief discussion of some relevant topic(s). The bookwork will generally be related to the problem which follows, and therefore may give you a useful indication of how to proceed. The problem is often followed by a *rider* inviting you to comment on or interpret your result.
  - **Essays.** This may be a single essay, or two or three shorter *brief notes* on separate subjects with some element of choice.

- Read each question *carefully* and *completely*. Do not rush into starting a question before you are sure of what is being asked. The examiners will have chosen the detailed wording with some care. Look carefully for cuewords like "small", "approximately" etc., which will give you the clue that you can make an appropriate approximation to help solve the problem. The word "estimate" indicates that a different level of precision is required compared to "calculate". Use a highlighter or underline these and other key words and phrases (e.g. "Define", "Explain", "State", "Derive", "Write notes on *three* of…", "Give *two* examples of…"). Remember that all parameters given in the question will be useful. The later parts of a question may well give you a clue about how to attempt the earlier parts, or vice versa.

- Remember that you will probably get many more marks in, say ten minutes, attempting the start of a new question than spending the same amount of time trying to finish off a question that you've already spent a lot of time on. So you must make sure that you attempt *the correct number of questions*, and do not leave it until too near to the end of the exam to start your last question.

- Read *every* question, including those on subjects that you think you are not good at. It may be that the question set on your poor subjects is unusually easy, or that it is like a question on this subject that you did during the year that you *did* understand and can remember. Of course the chances are that you will not answer questions on your weaker subjects, but *read every question* to make sure you don't miss something easy.

- Essay type questions are as important as the problems, and in some papers, such as in Part II, you are obliged to write essays. The essay type questions are "safe" questions in the sense that you should not get very low marks on such questions, although it may be difficult to get full marks (though not as hard as you may imagine). With more mathematical questions you may get almost all of the marks if things work out well, but you may get very few if they don't. Ideally you should hope to do questions for which you can get nearly all of the marks, but if mathematical questions do not work out, or if you know you aren't very good at solving problems under pressure, then it may be a good idea to plan to do more essay type questions.

- Don't be put off by long questions. These are usually broken into many small parts, which means that even if one part of the question does not work out you can attempt all the other parts. Short questions, on the other hand, often depend on you deriving one particular thing — which is fine if you can, but not if you can't!

- Do not make the mistake of thinking that questions will be based on one or other term's work only. In practice physics is not naturally divided into separate pieces that correspond to single courses, and there are likely to be some questions that use knowledge from more than one course. This is particularly true for Section A questions.

3 Answering the questions

- Put down sufficient words of explanation of the physics. Don't be afraid to say the obvious.

- Draw diagrams whenever appropriate. Make the diagram large enough to be clear. Be sure to define your terms/symbols carefully; an annotated diagram is often a help in doing this.

- In the "wordy" parts of questions you can, and indeed should, use equations and diagrams as appropriate to explain the physics. Similarly, in the "maths" parts of questions you should use words and/or diagrams to (i) help yourself understand the physics, and (ii) explain things to the examiners.

- If you do an "essay question", make short notes of all the points that you want to make first — then do the essay in full and check you have included all the points. It's fine to include equations, but don't include detailed mathematical derivations unless you are asked to – it's better to sketch the basic method with the aid of a few equations. It is often helpful to use one or two examples to illustrate your ideas. Clarity and good organization of material are more important than literary style. Don't be afraid to use note form, or bulleted lists, if time is running short or if you think it aids clarity. Try to be critical and include relevant material; don't just scribble down everything you can remember.

- Make sure you answer the bookwork parts of problems fully — these are often the easiest parts of the questions, so make sure you take full advantage.

- In problem questions, check your starting equations carefully to make sure you are happy with them before you plough on with the algebra. Also check, as much as possible, your algebra as you go along (use dimensions, units, limits, symmetry…).

- When you get a numerical answer, underline it, and check the units and number of significant figures if appropriate.

- If you get stuck, *do not panic*. Read the question again, to make sure you are not trying to answer the wrong question, or that there is not some hint or crucial cueword like "small" which you missed. (You should have read the question carefully in the first place, but check anyway.) Try to write something down about what you know, and what direction you want to go in (this in itself may help you see how to proceed).

- When you "finish" a question, go back and read the question — check that you have answered *all* the parts of the question! You may want to go back and add a few more words of explanation to indicate to the examiner what you were trying to do, or where the equations came from, or what your assumptions were, or what approximations you made. Remember that you are trying to communicate your ideas to the examiner as clearly as possible.

- If you realize that your answer is wrong, then write this down, making it clear *why* you know it is wrong. If you don't have time to sort out the correct answer, then at least the examiners will know that you do realise that something has gone wrong, and why, and they may give you credit for this.

- If you are running out of time, it is probably best *not* to try to solve algebra in the last few minutes. Instead, explain in words what you are trying to do, and what physics you would use to answer the question(s) more fully, if you had the time.

- Use *all* the available time. Attempt the right number of questions.

- Once the exam is over, don't waste time in detailed post-mortems. It's better to spend your time ensuring that you approach the next paper in the best possible state.

4 What are the examiners looking for?

- For each examination, a group of examiners is appointed. Formally they are responsible to the University rather than the Physics Department, though in practice of course they are members of the Cavendish. Although they are autonomous, they are supplied with guidelines agreed by the Teaching Committee of the Department, and therefore follow rather standard procedures. In addition, in Part II and Part III, two *External Examiners* from other Universities are appointed, who take part in setting and marking papers. Their rôle is to ensure that all procedures are followed fairly and that the standards of the different classes assigned are comparable with those in other Universities.

- When setting the exam papers, the examiners will have prepared model answers and agreed on a detailed marking scheme. Occasionally the marking scheme may need to be modified when the scripts are received, for example to account for students using methods which the examiners had not anticipated. A different examiner will double mark a sample of scripts to ensure that the main marker has applied the marking scheme fairly and consistently.

- In a *problem*-type question, the marking scheme will typically be broken down into quite small elements, even one or two marks, for reaching various stages of the calculation correctly. This means that it is important for you to explain your working clearly, so that if you didn't get the question completely right, the examiner can give you credit for all the things you did do correctly.

- In an *essay*-type question, the marking scheme might have marks awarded for individual points which the examiner hopes you might make. There may in addition be some marks assigned for the general impression of competence and coherence which your answer gives.

- In general the examiners are concerned about whether you *understand* the basic physics, rather than testing detailed knowledge. So, for example, in a problem, quite a lot of credit may be be given for analysing the problem correctly and

setting up the initial equations. If you mess up the algebra or the numerical calculation, you will lose marks, but not everything. Or in an essay question, they will be less impressed by a parrot-like regurgitation of the lecturer's notes than by an answer in which you have organised the material well in your own way.

- The examiners also look at the continuously assessed work which you have done through the year, to convince themselves that it has been marked fairly, and marks are sometimes adjusted. They also decide the relative weight given to the exam mark and the assessed work, though it won't differ much, if at all, from what you have been told.

- The final classes which are assigned are based on the following approximate aggregate marks:

I	≥ 67 %
II.1	60–66 %
II.2	50–60 %
III	33–49 %
Fail	< 33 %

  Unlike A-level, when most of you were probably accustomed to answering almost everything perfectly, in Tripos you can get quite a few questions wrong and still get a First. Very few students get more than 75%. So don't get depressed or panic if not everything works out in the exam. If you have done, say, half the questions well, and picked up some marks elsewhere, you will probably have done quite well.

- The mark you eventually get told after the exams may not be the raw mark obtained. The examiners sometimes apply scaling to the marks to get the boundaries between classes in the right place. For example, in IA and IB, they have to aim for specified fractions of students in each class, in order that the combination of marks from all different combinations of subjects can operate fairly.

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