We must raise the courage of those timid people who dare invent nothing in physics, and confound the insolence of those rash persons who produce novelty in theology.

-Blaise Pascal (1647)

Instructor information

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Course summary

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<th>Mon. &amp; Wed. 10-10:50</th>
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<td>Thurs. 11:30 - 12:20</td>
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<td>Laboratory sessions (S115)</td>
<td>Wed. 12:30 - 3:20</td>
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<td>Thurs. 1:30 - 4:20</td>
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<td>Laboratory discussions (S109)</td>
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Introduction and course objectives

Suppose that your local newspaper reports that Norway is ahead of Sweden in ranking, based on medals won, at the 2008 summer Olympics in Beijing. Norway has won a gold, a silver and two bronze medals; Sweden has one three silver and two bronze medals. What would you conclude: is this story true or false? How do you know?

Or suppose that you were listening to a political candidate on the radio, and he were to claim that it is morally wrong for North Korea to possess nuclear weapons. What would you conclude: is this claim true or false? How do you know?

These two questions: Is this true? and How do I know? are two of the most important questions that one can ask. How we answer them, and whether we even choose to ask them, has far reaching implications on how we conduct our lives. The primary objectives of this course are to develop in you

(i) the habit of asking such questions, particularly in the context of natural science, and

(ii) the ability to answer them for yourself.

You will be learning a great deal of physics in this course, but developing these two skills will serve you more in life than memorizing any number of scientific formulas or theories. These skills constitute important intellectual virtues (i.e. good habits), which will be very valuable in your future study of natural science, theology, political science, journalism, or any other discipline.
In addition to the primary objectives, the secondary objectives of this course are to develop in you

(i) the ability to use scientific concepts (e.g. the principle of inertia) to analyze unfamiliar problems
(ii) improved vocabulary and reading comprehension skills
(iii) improved verbal and written communication skills (grammar, logic and rhetoric)
(iv) improved mathematical skills (algebra, geometry and calculus)

Our class discussion, laboratory and homework assignments are designed to address these objectives.

Studying great scientific works

In order to meet our course objectives, we will be reading and analyzing great scientific works. Great scientific works are distinguished from other scientific works by the fact that they have been recognized, over time, as being highly influential in shaping man’s philosophy of nature. This does not mean that everything they contain is true. In fact many great scientific works contradict one another. This is the case with both ancient and contemporary works. How do we distinguish that which is true and from that which is false?

Teaching and learning methodology

The method which we shall be employing in this course will perhaps be new to you. In many of your courses, you probably listen to a professor lecture for an extended period of time on topics covered in a textbook. In this course, the great scientific texts themselves serve as the lectures. In fact, they are some of the best scientific lectures ever written. Your first job, as a student in this class, is to read the assigned lectures before coming to class.

The time that we spend in the classroom will be devoted to understanding and analyzing the lectures. As the discussion leader, I will primarily be asking you questions regarding specific ideas which are found in the lectures. For instance, I may ask, “What does the author mean by the term weight.” Or I may ask, “Is it true that all objects have weight?” And if so, “How do you know?”

Your second job will be to try, as a group, to answer these questions.

Typically, different students will present different ideas. You should consider these different ideas and weigh the evidence for each. Some ideas will turn out to be problematic, and will be either refined or rejected altogether by the group. This should not be thought of as failure, but as the primary method by which we can approach the truth. In fact, this method is precisely the method used by scientists themselves in order to discover and evaluate competing theories.

Guidelines for participating in classroom discussion

Here are some guidelines which will allow us to have focused, fruitful and enjoyable discussions.

1. These guidelines were adapted from “What’s the Matter?” published by the Great Books Foundation.
• Read the assigned lecture before participating in the discussion. This ensures that all participants are equally prepared to talk about the ideas in the work, and helps prevent talk that would distract the group from its purpose.

• Support your ideas with evidence from the text. This keeps the discussion focused on understanding the selection and enables the group to weigh textual support for different answers and to choose intelligently among them.

• Discuss the ideas in the selection, and try to understand them fully before exploring issues that go beyond the selection. Reflecting on a range of ideas and the evidence to support them makes the exploration of related issues more productive.

• Listen to others and respond to them directly. Our discussion is about the give-and-take of ideas, a willingness to listen to others and to talk with them respectfully. Directing your comments and questions to other group members, not always the leader, will make the discussion livelier and more dynamic. During discussion, you may speak freely; you need not raise your hand. Nonetheless, any comment or question you make during class time must be made public so that others can hear it and respond.

• Expect the leader to ask questions, rather than answer them. The leader is a kind of chief learner, whose role is to keep discussion effective and interesting by listening and asking questions. The leader’s goal is to help the participants develop their own ideas, with everyone (the leader included) gaining a new understanding in the process. When participants hang back and wait for the leader to suggest answers, discussion falters.

Grading of the classroom discussion

The classroom discussion will account for 15% of your semester grade. Each student will receive a weekly discussion grade which will range from 0% to 100%. What follows are a few example students and the grade each received for one particular week.

• The 100% student is actively engaged in the classroom discussion every day of the week. He raises relevant questions regularly during the discussion. His ability to cite relevant points from the text in response to questions raised by the instructor and by other students is evidence that he has studied the assigned text and put significant thought into analysis prior to attending class.

• The 85% student is actively engaged in the classroom discussion on most days. Although she found the assigned text difficult to understand, she wrote down some questions which came to mind while reading the text. She makes a concerted effort to raise these questions during the discussion. Her ability to cite relevant points from the text in response to questions raised by the instructor and by other students is evidence that she has already studied the assigned text.

• The 70% student is occasionally engaged in the classroom discussion. He found the assigned text difficult to understand, but did not take the time to write down any specific questions. He does, however, ask one question which comes to mind during the discussion. He speaks out in class twice during the week, but has trouble providing specific textual or rational support for his views.
• The 40% student is not engaged in the classroom discussion. She sits silently but politely. She read the assigned text before coming to class, but has not thought enough about it to formulate any questions. She uncritically accepts whatever is said by the author, the instructor and the other students in the class.

• The 0% student comes to class, but instead of presenting his views to the class publicly, he whispers them to his friends. The instructor and other students find this distracting and a bit rude.

Weekly homework assignments

Weekly homework assignments are available for download from the instructor’s personal web page. The homework assignments are based on the week’s lecture. They will typically include a combination of essay questions and numerical problems. Essays should be written or typed legibly and should display thoughtful reflection which incorporates specific points addressed in the lectures and discussion. You may work on the homework assignments with other students, but each student must hand in his or her own homework assignment by Saturday afternoon at 2 p.m. at the latest. Homework problems may be handed in earlier, but full credit should not be expected for late homework. Please refer to the Student Handbook for the College’s policies on cheating and plagiarism. Suffice it to say here that you should never copy more than one or two words of text from a web page or any other source without specifically citing the source. When citing a web page, be sure to include the URL address and the date it was accessed.

Electronic homework submission

If you choose to send your homework to me electronically, I cannot accept .docx or WordPerfect files. Be sure to convert them to a .pdf, or .doc document. Also, be sure to label your homework using this exact format:

PHY201_HW#_studentlastname.pdf

For example, I would hand in a file with the name

PHY201_HW4_kuehn.pdf

Also, be sure to include PHY201_HW# in the subject line of your email. If you do not label your file and your email subject line properly, I will likely not grade your homework, since my mail program automatically sorts my incoming mail according to subject.

Included with the homework problems is a list of scientific terms and concepts with which you need to be familiar. This will not only help your reading comprehension for this class, but will also help you prepare for standardized tests such as the GRE, MCAT, GMAT or LSAT. There will be a vocabulary identification section on each test in this course and on the final exam.
Also included with the assigned homework problems each week will be one or two *optional* MCAT-like practice problems. The primary goal of this course is *not* to prepare you for any specific standardized test. However, for the few of you who are preparing to take the MCAT, spending some additional time solving these problems will familiarize you with the style of questions which are posed on that test.

**Laboratory sessions**

Suppose that you were a journalist preparing an article about how the United Nations really works, and you were granted three hours to interview anyone in the government whom you wished. Whom would you interview? How would you formulate your questions? How would you know if what he or she told you was true? What follow-up questions could you ask to verify the truth of his or her statements?

Natural science is very similar to journalism in that we pose questions in hopes of finding out how something really works. One of the most difficult parts is deciding what questions to ask so as to reveal the most essential truths about nature. During your assigned laboratory session each week, you will be given approximately three hours to develop experimental techniques to answer questions related to the week’s lecture. You will be provided with equipment and some general questions or suggestions, and it will be your responsibility to devise experiments to gain as much information as you can. The instructor will serve as a guide so as to help you refine your experimental techniques and procedures.

You must keep a record of your work during the laboratory sessions. To this end, you will need to purchase a lab notebook. Your lab notebook must be sturdy, must be at least 9 x 11 inches and must be quad-ruled (graph paper). You must allow the first few pages in your lab book to serve as a table of contents.

The purpose of the lab book is to serve as a single source which contains all of the information relevant to your experiments. In particular, during each laboratory session, you should record the following information in your laboratory notebook:

- Your name and your laboratory partner’s name, the date and a title for the experiment.
- A neat sketch of any experimental apparatus you use, along with labels (make and model).
- A clear description of your experimental procedure(s), including difficulties which you experienced in carrying out your experiments.
- Tables containing any data which you collect. You must never write data anywhere else: not on scrap paper, not on the back of your hand, nowhere. Also, you must write down an estimated uncertainty in any measurement which you perform. For instance, if you use a stopwatch to time a falling ball, you should estimate the precision with which you were able to record the time. This is always slightly larger than the resolution of the device being used.

Your lab report must be written in blue or black ink. It must be written in chronological order. That is, you might first describe some of your procedure, then record some data, then describe some more of your procedure, then some more data, and finally do some analysis. The important thing is that you write clearly and that you spread out your writing so that the reader of your
notebook can easily ascertain what you did, and reproduce it if necessary. If it contains computer printouts of data tables or plots, these must be trimmed to fit neatly on a page and secured with tape. Before leaving the lab, your instructor will assign you a grade based on the neatness, clarity and completeness of your laboratory notebook.

Grading of the laboratory session

The laboratory sessions will account for 10% of your semester grade. Each student will receive a weekly laboratory grade which will range from 0% to 100%. What follows are a few example students and the grade each received for one particular week.

• The 100% student conceived of an appropriate experimental program and has systematically executed it. When he ran into difficulties, he was able to arrive at a reasonable solution or work-around. His data is of good quality, and his analysis involves a reasonable assessment of sources of systematic error.

• The 80% student conceived of an appropriate experimental program and has systematically executed it. Although he was able to complete his experiments, either his data was inconclusive, or his analysis involved a significant systematic error which for which he was unable to account.

• The 60% student conceived of an appropriate experimental program, but was unable to complete significant portions of the laboratory assignment.

• The 0% student completed little or none of the laboratory assignment.

Friday laboratory discussions

After collecting your data and performing some preliminary analysis, you will be prepared to share your experiments and your results with your classmates. Therefore, on every Friday, we will spend the class period discussing the laboratory exercises. During the first half of the semester, each lab group will be assigned a Friday on which to do a formal presentation. During the second half of the semester, each group will be assigned a random Friday to do a formal presentation. The formal presentations must include:

• a description of the problem you were trying to solve, and how this relates to the week’s lecture,

• a detailed description of how you attempted to solve the problem, including a detailed description of your experimental apparatus and procedure,

• plots or tables of your data, along with a description of how you analyzed your data, and

• a summary of the significance of your laboratory work. It is not good enough to simply state your results without any analysis of their meaning. If your results are different than you had expected, then you must address this issue directly. This should include an analysis of any systematic errors.

The presentation should last at about ten or fifteen minutes, and will be followed by a question and answer session. Be sure to bring visual aides that will allow others to get a clear look at you experimental setup and any data or plots you have prepared.
If your group is not assigned to do a formal presentation, you should bring your lab notebook to class on Friday to compare your method and results to those of the other groups. Our Friday laboratory discussions will be aimed at understanding the meaning and significance of the experiments performed during lab sessions, and at discussing ways in which the experiments might have been performed so as to achieve the most meaningful results.

Grading of the Friday laboratory presentations

The Friday laboratory presentations will account for 10% of your semester grade. Each group presentation will receive a grade which will range from 0% to 100%. The grade your group receives will depend upon both the quality of your experimental data and the extent to which you address the points mentioned in the previous section.

Final thoughts

Finally, I want to encourage you to come to me with any concerns you may have during the course of the semester, whether they be physics questions or difficulties with reading or discussion or whatever. This course is designed to stretch your mind, but not to “break” you. Reading the “classics” in any field is challenging, but very rewarding. I would very much like to help you succeed and to have fun in this class. My office hours and contact information are listed at the beginning of this syllabus. Most of the time during the day when I am not in class, I will be in my research laboratory or in the machine shop in the basement of the science building. Please feel free to stop by to speak with me if you would like.

Bibliography