

Physics 302- Advanced Quantum Mechanics - 2010
Walter Smith
Course information and syllabus

A brief caveat

You should expect this to be a challenging course. Quantum mechanics at this level is quite formal and mathematical, although every effort will be made to maintain contact with reality. We also need to move fairly quickly to cover the canonical content of the course. I have tried to structure the course to encourage everyone to stay up-to-date and engaged. (In other words, you *should expect to work very hard.*) Most importantly, however, quantum mechanics is the crowning glory of physics; you will find it enormously satisfying and even enjoyable to have made a serious start on mastering it.

Course organization

Instructor: Walter Smith Bryn Mawr office: Park 344 Haverford office: KINSC L110
 896-1332 (office), 896-1565 (home)
 Office hours at BMC: Mon 9:00-10:00, Tues 10:30-11:30, Wed 9:00-10:00,
 Thurs 10:30-11:30 & 1:00-2:30
 Fri 9:00-10:00
 Office hours at HC: Tues 2:00-3:00, Wed 10:30-11:30,
 Thurs 3:00-4:30
 Fri 10:30-11:30, 1:30-2:30

Location and times:

- Lecture – TT 11:30-1:00 in Park 337. Attendance is expected.
- Recitation TBA. Attendance is expected.

Textbook:

- John S. Townsend, *A Modern Approach to Quantum Mechanics*

Other texts that might be helpful if Townsend is not clear:

- Richard L. Liboff, *Introductory Quantum Mechanics*, 2nd Ed.
- David S. Saxon, *Elementary quantum mechanics*;
- P.J.E. Peebles, *Quantum Mechanics*;
- A. P. French and E. F. Taylor, *An Introduction to Quantum Physics*.

Assignments:

- ◆ Written work will be assigned each Friday, to be due the following Friday at 10:00 am. There will be two portions to each assignment.
 - Group problems: For these problems, you are encouraged to work together in small groups, of no more than 5 people, *after attempting each problem on your own*. Make sure that you are contributing to the group effort.
 - Individual assignment: other exercises will be assigned for all students to work individually. No collaboration is allowed on these problems. You may consult with any textbooks you like, and with the instructor, but not with any other human.
 - It is important that you write your answers to the assignments in a way which is easily legible and comprehensible. A liberal arts college is supposed to teach you to communicate well; this includes physics problems. Frequently, you will need to add a few words of text to explain what you're doing, although often the equations can speak for themselves, so long as you lay them out clearly, using arrows, equation numbers, etc. as needed. For many of you, this means you may need to recopy some problems once you've figured out the correct way to do them.
- ◆ Independent project:
 - In addition to the relatively wide knowledge of quantum mechanics that you will acquire through the lectures, reading, and problem sets, it is important and satisfying to explore one aspect in greater depth. After spring break, you will begin work on this project. You may select from a list of suggestions or come up with your own project, subject to approval by the instructor. Most projects will culminate in a paper (about 10 pages) or computer program and accompanying documentation. Towards the end of the semester, the number of regular assigned problems will be decreased somewhat to allow more time for your project.

Tests:

- There will be 2 mid-term examinations (see detailed syllabus for coverage and dates) and a cumulative final exam.
- The exams will be timed, closed-book, take-home tests.

Grading procedures for specific elements of the course:

- Your course grade will be computed using the following weighting:

Hourly exams	28% (14% each)
Final exam	25%
Homework	32%
Independent project	15%

- Written exercises-- **We will use a two-pass procedure for handling problem sets – please read carefully! PLEASE USE REGULAR PENCIL OR BLACK INK FOR YOUR PROBLEM SETS!!** After you turn in a problem set, it will be graded using red ink. Half of the grade for the homework will be based on this first grading pass.

Your paper will then be turned back to you **the following Monday morning**, along with “skeleton” solutions. (These are not complete written-out versions of the problems, but rather

guidelines and waypoints to help you along.) At this point, consulting the skeleton solutions as needed, **using blue ink or blue pencil**, and writing on the same paper you originally turned in, you will complete any problems which you were unable to do at first, and write out complete corrections to problems which you did incorrectly. The goals of doing the grading this way are to ensure that you understand each problem fully, and also to give you a “second chance” on problems that you muff. You will then turn in your revised problem set on the following Monday in class. Your revised assignment will then be re-graded (using green ink for grading), and assigned the remaining 50% of the grade. In principle, everyone should have a perfect revised version, since you may consult the skeleton solutions as needed in preparing this.

To make this whole scheme work, it is essential that you leave space on your problem set to write in corrections. You may wish to leave space at the bottom of each page, or to use the back of the preceding page.

There will be no rewrite on the final assignment, since it will be due on the last day of classes.

You will be graded on the presentation and comprehensibility of your assignments. This does not mean that we require you to have neat handwriting! However, we do expect you to make an effort to make your writing legible. Perhaps more importantly, we expect you to present your problems in a logical and easy-to-follow manner. Your assignment will be marked with a circled “P” (for “presentation”) any problem which is not presented clearly. You will receive a one point deduction for each P. (A typical problem or significant subpart of a problem is worth 2 or 3 points.) **For the first two assignments, no deductions will be taken for P’s.** This will give you a chance to get used to our expectations. **If the reason you got a P for any problem is unclear, please see me about it.**

- Exams--understanding is the key. Partial credit will be given for sensible efforts even without a completely correct answer. We will also use a two-pass system for the two mid-term exams, with 60% of the weighting from the first pass and 40% from the second pass. The first pass will be closed book and timed, while the second pass will be open book and untimed. (You are not allowed to consult any human other than me for the second pass.) The final exam will be one pass only.

Late policies:

- For weekly homeworks, you are permitted two 1-week extensions (either on a first pass or on a second pass) without any penalty during the semester when you are stressed out with work. Just turn in a sheet of paper indicating that you are giving yourself a "free extension." The two extensions must be used for separate problem sets; they cannot be combined to get a two-week extension on one problem set.

If you take an extension on the first pass, you automatically receive a one-week extension on the second pass as well, without this counting as your second free extension. You may not consult the skeleton solutions on your first pass, but must wait for the second pass (just as if you had not taken the extension). Also, you may not consult the complete solutions until after you have turned in the second pass.

Save these extensions for when you really need them. I will only grant additional extensions for truly grave cases, such as a death in the family or severe illness; such extensions must be asked for in advance. Other than these extensions, work turned in late will not be graded.

- Exams must be turned in not later than the stated times, except by prior agreement.

Honor code matters:

We value Bryn Mawr's honor code for the integrity it fosters and the pedagogical flexibility it affords. The important guiding principle of academic honesty is that you must never represent the work of others as your own. The following guidelines should govern your behavior in the course; please request clarification if you find yourself in any doubtful situations.

- You may seek assistance from the instructor or from your fellow students in doing the weekly assigned exercises (except for "individual problems") but *only after attempting each problem yourself*. (Discussion *without* prior effort, except to clarify what the question is asking, is not permitted.) You may work together with other members of the class on these assignments and this is often quite beneficial. For your own good, avoid situations in which you are either contributing either too much or too little to such collaborations. Do not work in groups of more than five people; three or four is usually ideal. Just copying someone else's work is clearly a representation of another student's work as your own and is a violation of the Code.

You may consult with the instructor about any problem (including individual problems), but again only after attempting it yourself.

Your textbook gives the answers for some of the exercises. These are given so that you will know if you have done a problem correctly. It is not sound learning procedure to try to work backwards from given answers, but doing so is not a violation of the honor code.

- Solutions to the written exercises will be made available on the due date for the second pass. If you have taken an extension, you are not allowed to consult the solutions until you've turned in your second pass.
- The take-home exams must be entirely your own work. Detailed instructions will be given on the exams themselves and discussed in advance. You will be allowed to use a page of notes prepared in advance, and a calculator, but no other materials. No collaboration of any sort is allowed once you start an exam. The allowed time (a single contiguous block) must be strictly observed.
- I will be re-using some materials from previous years. Therefore, you are not allowed to look at materials from previous years. I will provide plenty of practice questions to help you prepare for the exams.

Advice

You may need to improve your study habits in order to do well in this course. The following suggestions are based on the experience of previous students:

Review your class notes between lectures, and come prepared to ask questions. *Annotate* your class notes as you read them.

Stay up to date on the reading; preferably read the assigned material *twice*; for example, once before the relevant lecture, and once after.

Read with pen in hand to work out things described only briefly in the text or lecture. Ask yourself "what is the main point of each section", and *answer* the question.

When you take notes in class, *don't just write down equations!* Qualitative information is often essential!

Don't spend more than 1 hour on a single homework problem. Show clearly where you're stumped and just move on. Don't feel badly if this happens occasionally, or worry about the effect on your grade. Consistency in doing the homework is more important.

You need to allocate about 9 hours for study and homework per week (plus class time).

Do stop in to see the instructor if you have questions or suggestions.

When you're studying for an exam, review the *solutions* to problems and previous exams.

Remember that if the material is a new or unfamiliar for you, learning will take time, just as learning a new language takes time. Try not to become discouraged if the going is rough at times, and don't prejudge your ability to master the material. Generations of students have done it before you. There is no magic method of presenting the material that we can use to make it easy.

Students who think they may need accommodations in this course because of the impact of a disability are encouraged to meet with the instructor privately early in the semester. Early contact will help to avoid unnecessary inconvenience and delays.

Exam Schedule:

Exam 1 will be distributed 2/19 and due 2/26; Exam 2 will be distributed 3/26 and due 4/2. The final exam will be held during finals week. (!) **Note that the amount of new material covered on the second exam is greater than the first exam.** Plan your study time accordingly! (The weights assigned to these exams have been adjusted accordingly.)

Assignment #1

Due: Friday, 29 January at 10:00 am.

Reading: Chapter 1 of Townsend

Group problems:

1.3 Ans. to part c: $\Delta S_z = \frac{\hbar}{2}(\sin \theta)$ (Your answer will include a factor of $e^{i\delta}$. It is conventional to choose $\delta = 0$.)

1.4 Ans. for the probability of finding $S_x = -\frac{\hbar}{2}$ is $\frac{1}{2}(1 - \sin \theta \cos \varphi)$

1.5 Ans. for probability of finding $S_y = +\frac{\hbar}{2}$ is $\frac{1}{2}(1 + \sin \theta \cos \varphi)$

1.6

1.7

Individual-problem: 1.8