# *Physics 150: Introductory Physics I* *Spring 2012*

*URLs in the PDF version of this syllabus are clickable links*

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| | Room | Time |
|---|---|---|
| Lecture | Eaton 110 | 11:15-12:10 MWF |
| Laboratory 11 | Eaton B13 | 1:30-5:00 M |
| Laboratory 12 | Eaton B13 | 1:30-5:00 T |

**Texts & Materials**

- Hugh Young, Roger Freedman, and A. Lewis Ford, *University Physics*, 13th Edition
- Physics 150 Laboratory Manual, available at the College Store
- Hayden-McNeil Physical Sciences Lab Notebook, ISBN 978-1-930882-70-6
- Instructors' Solution Manual, on reserve in the library
- Simple scientific calculator with 1 variable statistics such as the CASIO *fx-260*

**Course Objectives**

Physics is the fundamental study of the behavior of matter, energy, space, and time. It is a quantitative and mathematical science. By the end of the course, students should have a working knowledge of the elementary principles of mechanics and waves and their expression in mathematical form. Students should be able to apply these principles to simple problems stated in plain English.

**About Your Professor**

Prof. Allen is a theoretical physicist working on particle physics and gravitation. He received his Ph.D. from Caltech in 1988 for work in string theory. He has been teaching at the University of Wisconsin, the California Institute of Technology, SUNY Utica/Rome, and HWS since 1980. Besides physics, some of his other interests are calligraphy, computers, electronics, yoga, and the martial art Aikido.

**About Physics 150**

The subjects covered in this class relate to phenomena that are common and objects that are visible. Most of what we'll study was well understood before the 20th century; this is perhaps the last "common sense" physics course, though we will study a little relativity and quantum mechanics, some of the more exciting developments of the 20th century.

This course is primarily a problem-solving course. There are only a few principles a week that we will study, however there are many ways to use those principles. Learning to use the principles is best accomplished through solving lots of problems. Working together in groups is a good way to learn this material. Just having a numerical answer is usually not very useful for understanding; it is much better to spend time first trying figure out how to get to the answer from what you know and *then* calculating the answer. To do well in this course, most students will need to study at least ten hours per week outside of class. Going to office hours, at least occasionally, is also necessary for most students and strongly recommended.

This class satisfies both goal 3 (quantitative reasoning) and goal 4 (scientific inquiry).

**Syllabus Revisions**
Except for the grading policy, this syllabus is subject to revision. Any revised version will be distributed on my website and notice of revision will be given in class.

**Course Requirements**

- Laboratory
- Recitation
- Daily reading assignments in text
- Class attendance and involvement
- Homework
- Quizzes
- 2 Hour Exams
- Final Exam

**Grading**
The class will be graded on a straight percentage with the following breakdown:

A: 88% – 100% B: 75% – 87% C: 60% – 74%
D: 50% – 59% F: < 50%

The exams are not graded on a "curve," unless there is evidence that the exams were inappropriately difficult. In that case, extra points will be added to each exam to bring the average up to the appropriate level. In other words, an exam score of 80% is guaranteed to be at least a "B−." The final grade will be composed of five elements, three of which are the quizzes and exams. The other two elements are the laboratory and participation. The numerical grade will be computed using two schemes and your final grade will determined by the higher of the two.

| $\alpha$ | $\beta$ | Element |
|---|---|---|
| 10% | 10% | participation |
| 20% | 20% | laboratory |
| 30% | 15% | hour exams |
| 10% | 5% | quizzes |
| 30% | 50% | final exam |

**Late Policy**
If you miss a quiz and you have a valid excuse, you may take a quiz the next day for 80% credit. If you miss an hour exam and have a valid excuse (a note from your physician or an acceptable alternative), you will be allowed to count the other hour exam for twice the weight. You must check with me ***before*** you miss the exam unless you fall ill suddenly before the exam, in which case you should contact me as soon as you are well. ***There will be no makeup for the final exam.***

**Homework**
***It is very important that you do the homework.*** Doing the homework thoroughly and correctly is the most important and valuable part of the course, at least insofar as learning the material is concerned. It is also helpful to do additional problems of your own choosing from the course text or any other source. Your grade is more a reflection of how much useful work you did outside of class than of how "mentally quick" you are.

**Quizzes**
There will be short quizzes in lecture or recitation every so often, announced in advance. They will usually be a single problem, sometimes two or three very short problems. You will be allowed to bring a ***handwritten*** 3″× 5″ card (one side) of notes to each quiz.

**Exams**
There will be two hour exams and a final exam. The hour exams will be in lecture on February 24 and April 4. The final exam will be during the period set by the Registrar's

office, which should be Tuesday, May 8, 2012 at 8:30 AM. The hour exams will each be at least three problem pages. You will be allowed to bring one ***handwritten*** 8.5″× 11″ page (one side) of notes to each hour exam and two ***handwritten*** 8.5″× 11″ pages (two sides total) to the final exam.

**Discussion**
The discussion section is a place to get your questions answered, to see if you did the homework correctly, to learn how to approach problem solving, and to discuss the reading. I expect students to attend recitation and to be interactive. Recitations happen during the normal laboratory time and take place in Eaton B13, the same room in which you have lab.

**Laboratories**
The laboratories are taught by Dr. Peter Spacher. ***All of the laboratories must be completed in order to pass the course. A laboratory is not complete until you have handed in a laboratory report.*** You must have a laboratory manual and you must bring the lab manual, your lab notebook, and a calculator to each laboratory. Be sure that the lab notebook that you purchase is a Composition Book that is ***bound*** and ***has quadrille (graph paper) lines.*** Laboratory sections do not meet every week, so you should pay attention to the meeting times in the syllabus. You must have studied the lab manual *before* entering the laboratory. All students in laboratory are expected to contribute to their lab group's efforts and to solve any problems that may arise by thinking about what they should do to get the experiment to work and trying it before asking for help. Keeping a neat lab notebook is important (especially since concise, neat notebooks are generally much more helpful when you are writing your lab report.) If you cannot state what you are doing or what you learned simply and concisely, then you probably need to think more about it! Laboratory reports are due in discussion section the following week.

**Office Hours**
Office hours initially are Tuesday 10:30 - noon, Wednesday 1:30 - 3:00, and Friday 2:00 - 4:00, and by appointment. You may stop by any time to see if I am free to discuss physics, life, the universe, or anything else. If my office door is closed, I am very likely to be busy.

**Physics Teaching Fellows Program**
Assistance with course concepts is available through the Teaching Fellows Program. The Teaching Fellows Program provides a collaborative approach to teaching and learning. The Fellows were nominated by the physics department and selected jointly by the Center for Teaching and Learning (CTL) and the department. The fellows have been trained by the CTL.

The Teaching Fellows act as learning facilitators, helping their peers adapt to a subject's discourse and promoting academic interaction between students and faculty as well as among students. Time spent working with a fellow is time well spent. Note that the Fellows are not meant to replace the one-on-one tutoring offered through CTL, which remains available, nor to replace faculty-student interaction.

The Physics Teaching Fellows hold sessions in Eaton 105. Their hours will be posted outside the door. The physics department encourages you to take full advantage of this program.

# *Syllabus: Topics and Laboratories*

This is the schedule of the subjects to be discussed in lecture and the laboratories that will be done that week in your laboratory section, either on Monday or Tuesday, depending on which laboratory section you are in. On a week in which your laboratory section does not meet, your section will meet me for a discussion section. Following this table, there is a table of homework assignments and reading, keyed by lecture number.

| **Date** | **#** | **Lecture Topics** | **Laboratory** |
|---|---|---|---|
| Wed 18 Jan | 1 | Space, Time, Mass – Units – Uncertainty – Order of Magnitude – Scaling | |
| Fri 20 Jan | 2 | Displacement – Velocity – Acceleration | |
| Mon 23 Jan | 3 | Motion with Constant Acceleration – Free Fall | *Random Error &* |
| Wed 25 Jan | 4 | Vectors – Components – Algebra – Geometry | *Experimental* |
| Fri 27 Jan | 5 | 2D & 3D Motion – Projectiles | *Precision* |
| Mon 30 Jan | 6 | Circular Motion – Relative Motion – Frames of Reference | |
| Wed 1 Feb | 7 | Einsteinian Revolution – Simultaneity – Time Dilation | *Discussion* |
| Fri 3 Feb | 8 | Forces – Newton's Laws – Weight – Free Body Diagrams | |
| Mon 6 Feb | 9 | Using Newton's Laws | *Instantaneous* |
| Wed 8 Feb | 10 | Friction | *Velocity* |
| Fri 10 Feb | 11 | Dynamics of Circular Motion – Fundamental Forces | |
| Mon 13 Feb | 12 | Work – Kinetic Energy – Work-Energy Theorem | |
| Wed 15 Feb | 13 | Work & Energy in General – Power | *Discussion* |
| Fri 17 Feb | 14 | Gravitational Potential Energy – Elastic Potential Energy | |
| Mon 20 Feb | 15 | Conservative Forces – Force & Potential Energy – Energy Diagrams | |
| Wed 22 Feb | 16 | Momentum – Momentum Conservation | *Force Table* |
| Fri 24 Feb | | **Exam 1** | |
| Mon 27 Feb | 17 | Inelastic & Elastic Collisions – Center of Mass | |
| Wed 29 Feb | 18 | Relativistic Energy & Momentum – Correspondence Principle – Collisions | *Discussion* |
| Fri 2 Mar | 19 | Angular Motion – Angular Kinematics | |

| Date | # | Lecture Topics | Laboratory |
|---|---|---|---|
| Mon 5 Mar | 20 | Relating Linear & Angular Motion – Rotational Energy | *Newton's* |
| Wed 7 Mar | 21 | Torque – Newton's 2nd Law for Rotation | *Second* |
| Fri 9 Mar | 22 | Rotation about a moving axis – Angular Work & Power | *Law* |
| Mon 12 Mar | 23 | Angular Momentum – Gyroscopes & Precession | |
| Wed 14 Mar | 24 | Equilibrium – Center of Gravity | *Discussion* |
| Fri 16 Mar | 25 | Deformations – Stress – Strain – Elasticity | |
| | | **Spring Break March 17 – 25** | |
| Mon 26 Mar | 26 | Fluids – Density & Pressure – Hydrostatic Pressure | *Simple* |
| Wed 28 Mar | 27 | Buoyancy – Describing Fluid Flow | *Harmonic* |
| Fri 30 Mar | 28 | Bernoulli's Equation | *Motion* |
| Mon 2 Apr | 29 | Universal Gravitation – Potential Energy – Spherical Mass Distributions | |
| Wed 4 Apr | | **Exam 2** | *Discussion* |
| Fri 6 Apr | 30 | Kepler's Laws – Satellites – Black Holes | |
| Mon 9 Apr | 31 | Simple Harmonic Motion – Governing Differential Equation – Energy | *Standing* |
| Wed 11 Apr | 32 | Pendula – Damped Oscillations – Resonance | *Waves* |
| Fri 13 Apr | 33 | Waves – Wave Equation & Solutions – Sinusoidal Waves | |
| Mon 16 Apr | 34 | Waves on a String – Energy & Power in Waves | |
| Wed 18 Apr | 35 | Superposition – Interference – Boundary Conditions | *Discussion* |
| Fri 20 Apr | 36 | Standing Waves – Normal Modes | |
| Mon 23 Apr | 37 | Quantum Revolution – Einstein – de Broglie – Energy Quantization | |
| Wed 25 Apr | 38 | Sound Waves – Sound Speed – Sound Intensity – Normal Modes of Pipes | *Discussion* |
| Fri 27 Apr | 39 | Resonance – Interference – Beats – Doppler Effect | |
| Mon 30 Apr | 40 | **Summary & Final Exam Review** | *Discussion* |
| Tue 8 May | | **Final Exam 8:30 AM** | |

# *Syllabus: Reading and Homework Problems*

The assigned readings and homework are in Young and Freedman. *The reading assignments are to be done before lecture* on the day in which they are assigned.

Homework assignments are to be *done* by the lecture number in the table. Homework assignments should be *attempted* by the lecture before they are to be done. Problems that are daggered† require integral calculus, which is not a requirement of the course.

Prof. Walter Lewin's MIT lectures, while not required, are strongly recommended. Hearing his excellent explanation of the material is very helpful. These web-accessible resources are linked into the PDF version of this syllabus.

| **Lec #** | **Reading & Suggested Viewing** | **Homework Deadline** |
|---|---|---|
| 1 | Ch 1; §*1-6*; Lewin's Lec 1 | |
| 2 | Ch 2: §*1-3*; Lewin's Lec 2 | Q1.1, Q1.8, Q1.10, Q1.11; 1.1, 1.10, 1.14, 1.16, 1.21 |
| 3 | Ch 2: §*4,5* | Q2.3, Q2.5; 2.1, 2.3, 2.8, 2.9, 2.17. 2.65 |
| 4 | Ch 1: §*7-10*; Lewin's Lec 3 | Q2.15, Q2.18; 2.19, 2.23, 2.31, 2.41, 2.88 |
| 5 | Ch 3: §*1-3*; Lewin's Lec 4 | Q1.13, Q1.19, Q1.22; 1.31, 1.35, 1.39, 1.40, 1.47, 1.91 |
| 6 | Ch 3: §*4,5* | Q3.5, Q3.6; 3.4, 3.13, 3.19, 3.43, 3.59 |
| 7 | Ch 37: §*1-4* | Q3.10, Q3.11, Q3.12; 3.28, 3.29, 3.34, 3.35, 3.71, 3.79 |
| 8 | Ch 4: §*1-6*; Lewin's Lec 7 | Q37.2, Q37.5, Q37.7 ; 37.2, 37.3, 37.7, 37.9 |
| 9 | Ch 5: §*1,2*; Lewin's Lec 6 | Q4.4, Q4.28, Q4.31, Q4.40, Q4.41; 4.1, 4.4, 4.16, 4.25, 4.37, 4.43 |
| 10 | Ch 5: §*3*; Lewin's Lec 8 | Q5.1, Q5.3; 4.54, 5.6, 5.15, 5.56, 5.93 |
| 11 | Ch 5: §*4,5*; Lewin's Lec 5 | Q5.18; 5.25, 5.34, 5.35, 5.89, 5.97 |
| 12 | Ch 6: §*1,2*; Lewin's Lec 11 | Q5.23; 5.42, 5.44, 5.45, 5.47, 5.119 |
| 13 | Ch 6: §*3,4* | Q6.1, Q6.4, Q6.12; 6.3, 6.8, 6.16, 6.20, 6.18 |
| 14 | Ch 7: §*1-3* | Q6.16, Q6.20, Q6.22; 6.34, 6.35, 6.37, 6.75, 6.86, 6.101 |
| 15 | Ch 7: §*4,5*; Lewin's Lecs 12 & 13 | Q7.1, Q7.5, Q7.17; 7.5, 7.9, 7.12, 7.15, 7.30, 7.55 |
| 16 | Ch 8: §*1-3*; Lewin's Lec 15 | Q7.13, Q7.15, Q7.21; 7.34, 7.38, 7.39, 7.46, 7.63 |
| 17 | Ch 8: §*4,5*; Lewin's Lec 16 | Q8.2, Q8.9; 8.3, 8.7, 8.24, 8.31, 8.41 |
| 18 | Ch 37: §*7-9* | Q8.10, Q8.22, Q8.24; 8.24, 8.46, 8.49, 8.86, 8.106, 8.111 |
| 19 | Ch 9: §*1,2* | Q37.9; 37.27, 37.28, 37.33 |

| Lec # | Reading & Suggested Viewing | Homework |
|---|---|---|
| 20 | Ch 9: §*3,4*; Lewin's Lec 19 | Q9.4, Q9.6, Q9.7; 9.5, 9.10, 9.14, 9.15 |
| 21 | Ch 10: §*1,2* | Q9.9, Q9.10, Q9.14; 9.25, 9.45, 9.71, 9.77 |
| 22 | Ch 10: §*3,4* | Q10.1, Q10.3, Q10.10; 10.1, 10.5, 10.8, 10.9, 10.59, 10.73 |
| 23 | Ch 10: §*5-7*; Lewin's Lec 20 | Q10.18, Q10.27; 10.20, 10.21, 10.32, 10.69 |
| 24 | Ch 11: §*1-3*; Lewin's Lec 25 | Q10.20, Q10.21, Q10.24, Q10.29; 10.42, 10.43, 10.67, 10.94 |
| 25 | Ch 11: §*4,5*; Lewin's Lec 26 | Q11.4, Q11.5, Q11.7; 11.5, 11.11, 11.14, 11.76 |
| 26 | Ch 12: §*1,2* | Q11.14, Q11.17, Q11.20; 11.25, 11.34, 11.41, 11.86, 11.96 |
| 27 | Ch 12: §*3,4*; Lewin's Lec 27 | Q12.4, Q12.5, Q12.16; 12.5, 12.12, 12.50, 12.59 |
| 28 | Ch 12: §*5,6*; Lewin's Lec 28 | Q12.13, Q12.18, Q12.20; 12.31, 12.37, 12.74, 12.85† |
| 29 | Ch 13: §*1-4*; Lewin's Lec 14 | Q12.23, Q12.25, Q12.29; 12.41, 12.42, 12.91, 12.94 |
| 30 | Ch 13: §*5,6,8*; Lewin's Lecs 22 & 24 | Q13.1, Q13.7, Q13.9, Q13.10; 13.4, 13.5, 13.19, 13.72 |
| 31 | Ch 14: §*1-4*; Lewin's Lec 10 | Q13.14, Q13.17, Q13.21; 13.24, 13.28, 13.37, 13.69, 13.82†, 13.84† |
| 32 | Ch 14: §*5-8*; Lewin's Lecs 24 & 21 | Q14.1, Q14.3; 14.4, 14.9, 14.16, 14.19, 14.30 |
| 33 | Ch 15: §*1-3* | Q14.12; 14.41, 14.53, 14.72, 14.93, 14.97 |
| 34 | Ch 15: §*4,5* | Q15.1, Q15.6; 15.2, 15.3, 15.8, 15.9, 15.12, 15.52 |
| 35 | Ch 15: §*6,7* | Q15.4; 15.15, 15.22, 15.23, 15.26 |
| 36 | Ch 15: §*8*; Lewin's Lec 31 | Q15.15; 15.37, 15.38, 15.70 |
| 37 | Ch 39: §*1*; Ch 40: §*1,2* | 15.40, 15.43, 15.72 |
| 38 | Ch 16: §*1-4* | Q39.1, Q40.1, Q40.2; 39.1, 39.7, 40.11 |
| 39 | Ch 16: §*5-8* | Q16.1, Q16.5, Q16.8; 16.3, 16.8, 16.20, 16.26, 16.30 |
| 40 | | Q16.11, Q16.18; 16.33, 16.35, 16.39, 16.41, 16.59, 16.70 |