Physics 21S: Mechanics and Heat with Laboratory
Syllabus
June 20 to July 15, 2015
Hewlett 201

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Email policy: I will try to reply to your emails quickly, within 24 hours.
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The Physics 20S summer series comprises two separate courses over 8 weeks equivalent to
taking PH21, PH22, PH23, and PH24. These courses cover mechanics and heat, electricity and
magnetism, and modern physics. Both are algebra based courses and will not use or require
calculus. This year, these two separate courses will have the same instructor and there will be
many logistical similarities among them so that they will be seamless.

Physics 21S is an introduction to Newton’s laws of motion, conservation laws of energy and
momentum, fluid motion, heat, and the laws of thermodynamics.

1. Course Goals
The goals of this course are to understand the major concepts of the physics of particles and
fluids and to be able to summarize and explain these concepts to others. You will practice
explaining your knowledge to others in class, in discussion sections, in labs, and on
assignments and exams. Working in groups is necessary to hone your explanation skills and to
learn from others.

In addition, I hope you will gain an appreciation for the power physics displays in explaining a
swath of physical phenomena through few basic principles. Understanding and being able to
apply these basic principles is the main goal of this course.

In addition to learning the principles and applications of physics, you will also gain valuable
skills that can be transferred to other areas of your learning. I hope you will gain skills of how
to learn more effectively and will understand the value the following life skills: collaboration
with peers, improvement in metacognitive skills (reflecting on how you are learning and
changing), the need for effortful, focused, intense, and extended study time, and repeated
recall and application for assessment. You will regularly use sense-making and explanations
as part of honing your intuitive grasp of physics, and use that in problem solving. Lastly, I hope
you will gain communication skills that enable you to explain a rational stance and defend it clearly.

2. Learning Objectives
These learning objectives will help you understand what you need to know to do well in this course. By the end of the course, you should be able to:

1. demonstrate **critical thinking** as it relates to solving real world problems using physics
2. **model** real world physical systems using physical concepts and **apply** the correct physics equations to **predict** the behavior of the systems. These include ability to:
   a. apply **kinematics equations** to predict the trajectory, velocity, time, and distance for an object experiencing a constant acceleration;
   b. draw **free-body diagrams** depicting all the forces or torques on point objects, extended objects, or fluids;
   c. apply **Newton’s laws** to describe the motion of an object;
   d. determine situations when a particular **conservation law** is applicable and apply the conservation law to determine physical parameters affecting motion;
   e. use **kinetic theory** and microscopic models to explain macroscopic phenomena;
   f. interpret **pressure-volume** (PV) diagrams;
   g. apply the **laws of thermodynamics** to determine whether processes are possible;
   h. **integrate** physics principles from different parts of the course to solve problems.
3. **break** complex real world systems into smaller **subsystems**, analyze those, and combine the results to formulate a **complex solution**
4. do **consistency** and **limiting case** checks on solutions
5. work with **dimensionally consistent** quantities and use **appropriate units**
6. describe solutions to problems using **clear logic, diagrams, and graphs**

3. Course Philosophy
The best way to master new material is by practicing it. All parts of the course will therefore be taught interactively. Since this is a fast-paced summer course, it is essential to keep up with the material by coming prepared, reviewing lectures daily, and keeping up with assignments.

4. Math Concepts You’ll Need
It is absolutely important that you are able to do the following mathematical manipulations. Even though we will summarize vectors, we do not have time in class to teach all the math background you need.

- Ratios and proportions
- Solving systems of equations (e.g. 2 (or 3) equations and 2 (or 3) unknowns)
- Quadratic equations and their solutions
- Pythagoras’ theorem
- Basic trigonometry (sin, cos, tan, and rules associated with them)
- Vectors – addition, subtraction, decomposing vectors (see Giancoli Chapter 3.1 to 3.4)
- Simple concepts of pre-calculus: slopes, positive and negative slopes, minima/maxima of functions, and areas as integrals.
5. Textbook
You do not need the version with any supplemental materials, such as Mastering Physics. If you have an older edition, you will need to make sure to look up page numbers and problem numbers in the seventh edition. You can find a copy in the Huang Engineering Library, or borrow a copy from a friend.

6. Course Components
6.1. Pre-lecture Reading Quizzes
I will post pre-lecture reading quizzes on Coursework that you should be able to answer after reading the relevant sections of the text. **Reading quizzes must be completed by 8 am of the day of the lecture in order to receive credit.** Reading quizzes, as a whole, will count towards 5% of the course grade. The two lowest reading quizzes will be dropped.

6.2 Lecture
Monday to Friday, 9:30 - 10:50 am, Hewlett 201. And Mondays 1:30 - 2:50 pm, Hewlett 201.
The exceptions to this rule are the Mondays of the second and third week, when we will give the two midterms from 9:30 - 10:50 am. **Monday lecture for these days will be 1:30pm - 2:50pm,** which should be listed in Axess as the nominal exam time. The reason for this switch is so that students are not distracted by the midterm during lecture. The final exam will be during class on the last Friday of each course. Therefore, we will only have 21 lectures.

Your responses in the reading quizzes will, for the most part, shape the focus of the lecture for the day. Mini-lectures will be interspersed between collaborative conceptual and problem-solving sessions. As we move along the course, you should be prepared to integrate what we have covered earlier and apply it to newer problems. In-class collaborative problems and questions will be a normal part of the course. This is your opportunity to really understand concepts covered in that particular lecture. **Active participation accounts for 5% of your grade.** Participation means different things for different personalities and includes: (a) asking or answering questions during or after lectures; (b) contributing to the group for instance, by explaining concepts that you understand or asking for clarification when a concept is unclear; or (c) describing your group’s solution or acting as “group spokesperson.” Participating in clicker questions during class (see the section below) is a major part of your class participation grade.

6.3 Clickers
We are providing clickers (devices to anonymously submit answers to questions in class) on daily loan to students. The clickers have unique numbers. Pick up your assigned clicker at the beginning of lecture and return it at the end of each day’s lecture. These are not used to take attendance or to grade your responses. We will use “clicker questions” so that we all can see how much the class understands the topics in class. If a significant portion of the class does not get the right answer, you will talk with your neighbors to try to figure out the right answer. This exercise provides great practice for the course goal of being able to explain your knowledge to
6.4 Discussion Sections
T,W,Th afternoons (see the timetable below). Room S15.
Discussion section will allow you to explore a concept or problem in greater depth while working in groups of three or four. Material for section will come from old exam problems, problems that augment ideas presented in lecture, or tutorial style worksheets. You will turn in your pre-lab assignments at the beginning of the discussion section. **Pre-labs are graded and account for 10% of the course grade.** No late pre-labs accepted. The lowest pre-lab score will be dropped. Section sign-ups for discussion sections MUST be done on Axess and not on Coursework. There are 2 discussion sections for PH21S. Make sure you click on “View All” to see all available sections.

6.5 Labs
T,Th afternoons (exact time depends on the section). Labs will be held in the sub-basement of the Physics and Astrophysics Building. There will be no makeup labs. Lab experiments will complement material presented in lecture or discussion section and will provide an opportunity to apply what you are learning in lecture. Lab will be collaborative and guided so you will often be designing your experiments or deciding on how best to analyze your data. **Lab write-ups are graded and account for 10% of the course grade.** The lowest lab score will be dropped. You MUST attend the discussion and lab that you are enrolled in.

**Discussion and Lab Schedule**

<table>
<thead>
<tr>
<th></th>
<th>Discussion Sec. 2</th>
<th>Lab Sec. 2</th>
<th>Discussion Sec. 3</th>
<th>Lab Sec. 3</th>
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</thead>
<tbody>
<tr>
<td>Tuesday</td>
<td>1:15 - 2:05</td>
<td>2:15 - 4:05</td>
<td>3:15 - 4:05</td>
<td>4:15 - 6:05</td>
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<tr>
<td>Wednesday</td>
<td>1:15 - 2:05</td>
<td>None</td>
<td>3:15 - 4:05</td>
<td>None</td>
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<tr>
<td>Thursday</td>
<td>1:15 - 2:05</td>
<td>2:15 - 4:05</td>
<td>3:15 - 4:05</td>
<td>4:15 - 6:05</td>
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7. Grading

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<tbody>
<tr>
<td>Midterm 1</td>
<td>20%</td>
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<tr>
<td>Midterm 2</td>
<td>20%</td>
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<tr>
<td>Final Exam</td>
<td>30%</td>
</tr>
<tr>
<td>Lab Write-ups</td>
<td>10%</td>
</tr>
<tr>
<td>Pre-lab assignments</td>
<td>10%</td>
</tr>
<tr>
<td>Pre-lecture assignments</td>
<td>5%</td>
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<tr>
<td>Class participation</td>
<td>5%</td>
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No letter grades will be assigned to the exams. Final grades will be determined from the final
weighted scores using the above weightings. Tentative letter grade cutoffs are listed below. They may be lowered (made easier) but they will not be raised. Distinctions between A+, A, and A- (and the equivalents for B, C, D, F) will not be determined until the end of the course.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
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<tbody>
<tr>
<td>A</td>
<td>90</td>
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<tr>
<td>B</td>
<td>75</td>
</tr>
<tr>
<td>C</td>
<td>63</td>
</tr>
<tr>
<td>D</td>
<td>50</td>
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</tbody>
</table>

7.1 Exam Schedule
There will be no makeups, early or late, for anything, so you must be present for the three exams on June 27th, July 5th, and July 15th from 9:30 - 10:50 am.

7.2 Midterm Exams
Two exams will be held in-class on the Monday of the second week and Tuesday of the third week (June 25 & July 5), from 9:30 - 10:50 am. Monday lecture for the second week will be 1:30 - 2:50 pm, which should be listed in Axess as the nominal exam time. The reason for this switch is so that students are not distracted by the midterm during lecture.

Material covered in the lectures, required reading, practice problems, in-class demos, labs, and discussion section are all fair for the exams. Questions could be short or long answer, problem solving, multiple choice, fill-in-the-blanks, or true-false. With multiple-choice or true-false questions, you may be asked to explain your response. Equation sheets will be given out for each exam. These exams account for 40% of the course grade. There are no makeup exams.

7.3 Final Exam
Friday, July 15, 9:30 am to 10:50 am in class. The comprehensive final accounts for 30% of the course grade. There are no makeups for the final exam.

Review Sessions
Optional review sessions for the midterms will be held on Friday afternoons.

7.4 Homework
Practice problems will be posted on Coursework on Mondays; solutions will be posted by the following Saturday. Practice problems will not be collected or graded but at least one homework problem is will appear in some form in each of the exams. Therefore, do the practice problems and make sure you understand the concepts being covered; work in study groups; and take advantage of office hours to clarify concepts before the exams.
8. Useful Resources
In addition to our office hours, CTL provides free Peer Tutoring Services in Florence Moore.

**Summer Tutor Program:** [https://sarc.stanford.edu/tutoring](https://sarc.stanford.edu/tutoring)
On the Internet, you may also find the HyperPhysics and Khan Academy websites quite useful.

9. Office Hours
TAs will have office hours either directly after or before section, and they will be in the Physics Tutoring Center, the big room next to the labs and discussion rooms. The instructor’s office hours will be announced by the first day of class. You are more than welcome to email the instructor to find a separate time if you can’t make the standard office hours.

10. Calculator Policy
Calculators with the ability to compute trigonometric functions, square roots, and exponents will not be needed for the assignments and exams. Points will be awarded for showing correct steps and for understanding the concepts, not for the final numeric answer. This emphasizes that physics is not about plugging in numbers.

11. Students with Documented Disabilities
Students who have a disability that may necessitate an academic accommodation or the use of auxiliary aids and services in a class must initiate the request to the Office of Accessible Education (OAE). The OAE will evaluate the request with required documentation, recommend appropriate accommodations, and prepare a verification letter dated in the current academic term in which the request is being made. Please contact the OAE as soon as possible; timely notice is needed to arrange appropriate accommodations. The OAE website is [http://studentaffairs.stanford.edu/oae/info](http://studentaffairs.stanford.edu/oae/info); their office is located at 563 Salvatierra Walk (phone 723-1066, TTY 725-1067).

12. The Honor Code
The Honor Code articulates University expectations of students and faculty in establishing and maintaining the highest standards in academic work. Examples of conduct that have been regarded as being in violation of the Honor Code (and are most relevant for this course) include copying from another’s examination paper or allowing another to copy from one’s own paper; collaborating when it has been expressly forbidden; plagiarism; revising and resubmitting a quiz or exam for re-grading, without the instructor’s knowledge and consent; representing as one’s own work the work of another; and giving or receiving aid on an academic assignment under circumstances in which a reasonable person should have known that such aid was not permitted. For more information on the Honor Code, see [http://www.stanford.edu/dept/vpsa/judicialaffairs/guiding/honorcode.htm](http://www.stanford.edu/dept/vpsa/judicialaffairs/guiding/honorcode.htm)

In this course, you are encouraged to discuss physics issues and problem-solving strategies related to assigned problems and labs with your classmates. However, any assignment must be written up independently. All exams are to be completed independently without any discussion with others.
# Tentative Course Schedule

Readings are due before class begins.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Lab</th>
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</thead>
<tbody>
<tr>
<td>Mon 20/6</td>
<td>Introduction, Motion in 1D</td>
<td>Ch. 1.6 - 1.7, 2</td>
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<tr>
<td>Mon 20/6</td>
<td>Motion in 2D, Vectors</td>
<td>Ch. 3.1 – 3.4</td>
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<tr>
<td>Tue 21/6</td>
<td>Motion in 2D, projectile motion</td>
<td>Ch. 3.8, 3.5 – 3.7</td>
<td>Lab 1: Position, Velocity, and Acceleration</td>
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<tr>
<td>Wed 22/6</td>
<td>Dynamics and Forces: Newton’s Laws - Part 1</td>
<td>Ch. 4</td>
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<tr>
<td>Thu 23/6</td>
<td>Dynamics and Forces: Newton’s Laws - Part 2</td>
<td>Ch. 4</td>
<td>Lab 2: Newton’s Laws and Friction</td>
</tr>
<tr>
<td>Fri 24/6</td>
<td>Circular Motion and Gravitational Laws</td>
<td>Ch. 5</td>
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<tr>
<td>Mon 27/6</td>
<td><strong>Midterm Exam 1</strong></td>
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<tr>
<td>Mon 27/6</td>
<td>Work and Energy</td>
<td>Ch. 6.1 - 6.5</td>
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<tr>
<td>Tue 28/6</td>
<td>Conservation of Energy</td>
<td>Ch. 6.6 - 6.10</td>
<td>Lab 3: Work and Energy</td>
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<tr>
<td>Wed 29/6</td>
<td>Linear Momentum</td>
<td>Ch. 7</td>
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<tr>
<td>Thu 30/6</td>
<td>Conservation of momentum</td>
<td>Ch. 7</td>
<td>Lab 4: Collisions, Energy, and Projectiles</td>
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<tr>
<td>Fri 1/7</td>
<td>Rotational motion, conservation of angular momentum</td>
<td>Ch. 8</td>
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<tr>
<td>Fri 1/7</td>
<td>Fluids and gases</td>
<td>Ch. 10</td>
<td>Lab 5: Torque lab</td>
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<tr>
<td>Mon 4/7, Holiday</td>
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<tr>
<td>Tue 5/7</td>
<td><strong>Midterm Exam 2</strong></td>
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<tr>
<td>Wed 6/7</td>
<td>Fluids - Dynamics</td>
<td>Ch. 10</td>
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<tr>
<td>Thu 7/7</td>
<td>Simple Harmonic Motion</td>
<td>Ch. 11</td>
<td>Lab 6: Fluids</td>
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<tr>
<td>Fri 8/7</td>
<td>Simple Harmonic Motion</td>
<td>Ch. 11</td>
<td></td>
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<tr>
<td>Mon 11/7</td>
<td>Temperature, Thermal expansion</td>
<td>Ch. 13.1 - 13.4</td>
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<tr>
<td>Day</td>
<td>Topic</td>
<td>Chapters</td>
<td>Activities</td>
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<tr>
<td>Mon 11/7</td>
<td>Ideal gas and Kinetic Theory</td>
<td>Ch. 13.5 - 13.8</td>
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<td>Tue 12/7</td>
<td>Heat, Work done by gas, PV diagrams</td>
<td>Ch. 14</td>
<td>Lab 7: Latent Heat of Fusion</td>
</tr>
<tr>
<td>Wed 13/7</td>
<td>Laws of Thermodynamics, Entropy, Heat engines, Refrigerators,</td>
<td>Ch. 15.1 - 15.4</td>
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<tr>
<td>Thu 14/7</td>
<td>Review</td>
<td>Ch. 15.5 - 15.9</td>
<td>Lab 8: Adiabatic process</td>
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<tr>
<td>Fri 15/7</td>
<td><strong>Final Exam</strong></td>
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