The Physics 20s summer series comprises **three separate courses** over nine weeks equivalent to a full year (three quarters) of introductory physics. These courses cover mechanics and heat, electricity and magnetism, and modern physics. We will focus on the physical concepts, and calculus will not be used. These three separate courses will have different instructors for each, but there will be many logistical similarities among the three courses so that the three courses will be as seemless as possible.

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**Office Hours:** TBA, or by appointment

**TAs**
**Number 1**  
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**Email policy:**

**Undergraduate Coordinator:** Elva Carbajal; elva@stanford.edu; 650-723-4362

**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 sixth edition. You can find a copy in the Huang Library, or borrow a copy from a friend.

**Exam Schedule**
There will be **no makeups**, early or late, for **anything**, so you must be present for the three exams on Aug. 12th, 19th, and 23rd from 9:00 - 11:00 am.

**Grading**

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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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>25%</td>
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<tr>
<td>Lab Write-ups</td>
<td>15%</td>
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<tr>
<td>Pre-labs</td>
<td>10%</td>
</tr>
<tr>
<td>Pre-lecture assignments</td>
<td>5%</td>
</tr>
<tr>
<td>In-class collaborative problems</td>
<td>5%</td>
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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.

What is Modern Physics?
“Modern Physics” is a phrase that generally refers to the most significant developments in physics in the past century: special relativity (appropriate for describing really fast stuff); quantum mechanics (necessary for describing really small stuff); atomic, molecular, and laser physics; electronic materials (semiconductors); the elementary particles and the fundamental forces (the electromagnetic, weak, and strong interactions); nuclear physics (fission, fusion, and radioactivity); and astrophysics and cosmology (the contents and evolution of the universe). I will introduce you to amazing insights we have about the universe on length and time scales that span many orders of magnitude. As well as emphasizing the progress that has been made in our understanding of the universe, I will also point out the questions that remain open – questions that are currently the subject of active research at Stanford and elsewhere. I will describe how many of these seemingly esoteric topics touch on your everyday life and have led to most of the technological developments of the past century. Your view of the world will never be the same!

Here is a sampling of the questions we will address:

- How does Einstein’s theory of special relativity lead to the conclusion that clocks appear to run slow and objects appear to be shorter when moving with respect to the observer?
- How does quantum mechanics explain the structure of the periodic table?
- How do fluorescent bulbs work, and why are they more efficient? Why do they contain mercury?
- How do LEDs (light emitting diodes) work, and why are they even more efficient?
- How do solar cells turn light into electricity?
- How does a laser work? What is special about laser light?
- How is mass turned into energy in the sun and in a nuclear reactor? What is the difference between fusion and fission?
- How do we explain why some isotopes are stable and others undergo radioactive decay?
- What is radiation? How is it used for cancer therapy?
- What is the evidence that most of the energy density in the universe is in the form of dark matter and dark energy?
- What is the cosmic microwave background radiation, and what does it tell us about the Universe?

Course Goals
The goals of this course are to understand the major concepts of modern physics 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 physics and how it demystifies the world around us.
Math Concepts You'll 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.

Course Components

Lecture
Monday to Friday, 10:00 - 11:50 am, Hewlett 201.

Note this is a different room from 21S and 23S. The exceptions to this rule are the Mondays of the second and third week, when we will give the two midterms from 10:00 - 11:30 am.

Monday lecture for these days will be 2:15pm - 4:05pm, 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 14 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.

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
others.

Discussion Section
T,W,Th afternoons (exact time depends on the section). 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 3 discussion sections for PH25S. Make sure you click on “View All” to see all available sections.

Labs
T,W,Th afternoons (exact time depends on the section). Labs will be held in S16 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 15% 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

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<thead>
<tr>
<th>Section</th>
<th>T,W,Th</th>
<th>Discussion</th>
<th>Lab</th>
<th>Total</th>
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<tbody>
<tr>
<td>1</td>
<td>1:00 - 2:00</td>
<td>2:00 - 4:00</td>
<td>1:00 - 4:00</td>
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<tr>
<td>2</td>
<td>3:00 - 4:00</td>
<td>4:00 - 6:00</td>
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<td>3</td>
<td>6:00 - 7:00</td>
<td>7:00 - 9:00</td>
<td>6:00 - 9:00</td>
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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.

Midterm Exams
Two exams will be held in-class on the Mondays of the second and third week (Aug. 12 & 19), from 10:00 - 11:30 am. Monday lecture for these days will be 1:00 - 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/justify 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.

Final Exam
Friday, August 23, 10:00 am to 11:50 am in class. The comprehensive final accounts for 25% 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.

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 may show up in some form in 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.

Useful Resources
In addition to our office hours, CTL provides free Peer Tutoring Services in Florence Moore. 
**CTL Peer Tutors:** sututor.stanford.edu
On the Internet, you may also find the HyperPhysics and Khan Academy websites quite useful.

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.

Calculator Policy
Calculators with the ability to compute trigonometric functions, square roots, and exponents will be needed for most assignments and all exams. However, the majority of points will be awarded for showing your work and for understanding the concepts, not for the final numeric answer. This emphasizes that physics is not about plugging in numbers.

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; their office is located at 563 Salvatierra Walk (phone 723-1066, TTY 725-1067).

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

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.
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<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Lab</th>
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<tbody>
<tr>
<td>Mon 8/5</td>
<td>Special Relativity</td>
<td>Ch. 26</td>
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<tr>
<td>Tue 8/6</td>
<td>Special Relativity</td>
<td>Ch. 26</td>
<td>Speed of EM waves</td>
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<tr>
<td>Wed 8/7</td>
<td>Early Quantum Mechanics</td>
<td>Ch. 27</td>
<td>Photoelectric effect</td>
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<tr>
<td>Thu 8/8</td>
<td>Atoms</td>
<td>Ch. 28</td>
<td>Interference of light</td>
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<tr>
<td>Fri 8/9</td>
<td>Atoms</td>
<td>Ch. 28</td>
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<tr>
<td>Mon 8/12</td>
<td>Exam; Molecules</td>
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<tr>
<td>Tue 8/13</td>
<td>Nuclear Physics</td>
<td>Ch. 30</td>
<td>Hydrogen spectrum</td>
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<tr>
<td>Wed 8/14</td>
<td>Nuclear Physics</td>
<td>Ch. 30</td>
<td>Lasers</td>
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<tr>
<td>Thu 8/15</td>
<td>Nuclear Energy</td>
<td>Ch. 31</td>
<td>LEDs</td>
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<td>Fri 8/16</td>
<td>Elementary Particles</td>
<td>Ch. 32</td>
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<tr>
<td>Mon 8/19</td>
<td>Exam; Astrophysics</td>
<td>Ch. 33</td>
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<tr>
<td>Tue 8/20</td>
<td>Astrophysics</td>
<td>Ch. 33</td>
<td>Radioactive decay</td>
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<tr>
<td>Wed 8/21</td>
<td>Cosmology</td>
<td>Ch. 33</td>
<td>Hubble’s law</td>
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<tr>
<td>Thu 8/22</td>
<td>Cosmology</td>
<td>Ch. 33</td>
<td>Electron diffraction</td>
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<tr>
<td>Fri 8/23</td>
<td>Final Exam</td>
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