

La Cañada High School

Proposed Course Outline – Physics 1 P: Advanced

- I. **Course Title – Physics 1 P: Advanced**
- II. **Grade Level(s) – Grade 9**
- III. **Length/Credit – 1 Year - 10.0 units Satisfies One Year of Science for Graduation Credit**
- IV. **Preparations – 8th grade science teacher recommendation, grade of an A in grade 8 science, grade of B or higher in Math 8 advanced or grade of A in Math 8.**
- V. **Course Description**

Physics 1 P Advanced is a conceptual physics course that introduces students to the subjects of Forces and Motion, Forces at a Distance, Energy Conversion and Renewable Energy, Nuclear Processes and Earth History, Waves and Electromagnetic Radiation, and Stars and the Origins of the Universe. As the first high school class in a three course Next Generation Science Standards (NGSS) sequence, Physics 1 P Advanced will employ the NGSS 3D instructional model that asks students to learn core disciplinary ideas related to the field of physics, to examine these content domains through cross-cutting concepts, and to employ the science and engineering practices to explore phenomena related to the topics mentioned above. This advanced class will also require interested students to engage with mathematical thinking at the Algebra level to explore the content domains and bring alive the science and engineering practices.

This course requires that significant instructional time be spent in hands-on laboratory work, with an emphasis on inquiry-based investigations that provide students with opportunities to demonstrate the foundational physics principles and apply all the attributes of the NGSS 3D instructional model and the seven science practices to their learning. This course is proposed as a UC Certified Lab Science.

VI. **Standards/ESLRs Addressed**

Introduction:

Based upon the 2016 California NGSS science framework, the Physics 1 Advanced course framework is organized based upon six instructional segments. These instructional segments are centered upon observations of specific phenomenon. As students achieve the performance expectations (PEs) within each instructional segment, they uncover disciplinary core ideas (DCIs) from Physical Science, Earth and space science, and engineering. Students also focus on one or more crosscutting concepts (CCC) as tools to make sense of their observations and

investigations; the CCCs are ongoing themes in all disciplines of science and engineering and help tie these seemingly disparate fields together. In addition to the exploration of phenomena through DCIs and CCCs, this course is organized based upon eight science and engineering practices (SEPs) which articulate the behaviors in which students need to engage in order to achieve conceptual understanding in the course. The science and engineering practices enable students to establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. Because content, inquiry, and reasoning are equally important in Physics 1 P Advanced, the learning objectives of the course described in the content outline combines content with inquiry and reasoning skills described in the science practices stated below.

SEP 1: Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

SEP 2: Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

SEP 3: Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

SEP 4: Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

SEP 5: Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

SEP 6: Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions.

SEP 7: Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached.

SEP 8: Obtaining, Evaluating and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

VII. Brief Course Outline

Unit 1: Forces and Motion

A. Guiding Questions

- How can Newton's Laws be used to explain how and why things move?
- How can mathematical models of Newton's Laws be used to test and improve engineering designs?

B. Performance Expectations: Students who demonstrate understanding can:

- HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
- HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*
- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

C. Highlighted Science and Engineering Practices

- [SEP-1] Asking Questions and Defining Problems
- [SEP-2] Developing and Using Models
- [SEP-4] Analyzing and Interpreting Data
- [SEP-5] Using mathematics and Computational Thinking
- [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)

D. Highlighted Disciplinary Core Ideas

- PS2.A : Forces and Motion
- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions

E. Highlighted Cross Cutting Concepts

- [[CCC-2] Cause and Effect
- [CCC-4] System and System Models
- [CCC-6] Structure and Function

Unit 2: Forces at a Distance

A. Guiding Questions

- How can different objects interact when they are not even touching?

- How do interactions between matter at the microscopic scale affect the macroscopic properties of matter that we observe?
 - How do satellites stay in orbit?
- B. Performance Expectations: Students who demonstrate understanding can:
- HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
 - HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
 - HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
- C. Highlighted Science and Engineering Practices
- [SEP-1] Asking Questions and Defining Problems
 - [SEP-2] Developing and Using Models
 - [SEP-3] Planning and Carrying Out Investigations
 - [SEP-4] Analyzing and Interpreting Data
 - [SEP-5] Using mathematics and Computational Thinking
 - [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)
 - [SEP-7] Engaging in Argument from Evidence
 - [SEP-8] Obtaining, Evaluating, and Communicating Information
- D. Highlighted Disciplinary Core Ideas
- PS2.A: Forces and Motion
 - ETS1.A: Defining and Delimiting Engineering Problems
 - ETS1.B: Developing Possible Solutions
- E. Highlighted Cross Cutting Concepts
- [CCC-1] Patterns
 - [CCC-2] Cause and Effect
 - [CCC-3] Scale, Proportion, and Quantity
 - [CCC-4] System and System Models
 - [CCC-5] Energy and Matter: Flows, Cycles, and Conservation
 - [CCC-7] Stability and Change

Unit 3: Energy Conversion and Renewable Energy

A. Guiding Questions

- How do power plants generate electricity?
- What engineering designs can help increase the efficiency of our electricity production and reduce the negative impacts of using fossil fuels?

B. Performance Expectations: Students who demonstrate understanding can:

- HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
- HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
- HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
- HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

C. Highlighted Science and Engineering Practices

- [SEP-1] Asking Questions and Defining Problems
- [SEP-2] Developing and Using Models
- [SEP-3] Planning and Carrying Out Investigations
- [SEP-4] Analyzing and Interpreting Data
- [SEP-5] Using mathematics and Computational Thinking
- [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)
- [SEP-7] Engaging in Argument from Evidence
- [SEP-8] Obtaining, Evaluating, and Communicating Information

D. Highlighted Disciplinary Core Ideas

- PS3.D: Energy in Chemical Processes and Everyday Life
- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces

E. Highlighted Cross Cutting Concepts

- [CCC-2] Cause and Effect
- [CCC-3] Scale, Proportion, and Quantity
- [CCC-4] System and System Models
- [CCC-5] Energy and Matter: Flows, Cycles, and Conservation

Unit 4: Nuclear Processes and Earth History

A. Guiding Questions

- *What does $E=mc^2$ mean?*
- *How do nuclear reactions illustrate conservation of energy and mass?*
- *How do we determine the age of rocks and other geologic features?*

B. Performance Expectations: Students who demonstrate understanding can:

- HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
- HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
- HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

C. Highlighted Science and Engineering Practices

- [SEP-1] Asking Questions and Defining Problems
- [SEP-2] Developing and Using Models
- [SEP-4] Analyzing and Interpreting Data
- [SEP-5] Using mathematics and Computational Thinking
- [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)
- [SEP-7] Engaging in Argument from Evidence
- [SEP-8] Obtaining, Evaluating, and Communicating Information

D. Highlighted Disciplinary Core Ideas

- PS1.C: Nuclear Processes
- PS1.A Structure and Properties of Matter
- ESS1.C: The History of Planet Earth
- ESS2.B: Plate Tectonics and Large-Scale System Interactions

- E. Highlighted Cross Cutting Concepts
- [CCC-1] Patterns
 - [CCC-2] Cause and Effect
 - [CCC-3] Scale, Proportion, and Quantity
 - [CCC-4] System and System Models
 - [CCC-5] Energy and Matter: Flows, Cycles, and Conservation
 - [CCC-6] Structure and Function
 - [CCC-7] Stability and Change

Unit 5: Waves and Electromagnetic Radiation

- A. Guiding Questions
- How do we know what is inside the Earth?
 - Why do people get sunburned by UV light?
 - How do can we transmit information over wires and wirelessly?
- B. Performance Expectations: Students who demonstrate understanding can:
- HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
 - HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
 - HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
 - HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*
 - HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.
 - HS-ESS2-1. Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

- C. Highlighted Science and Engineering Practices
- [SEP-1] Asking Questions and Defining Problems
 - [SEP-2] Developing and Using Models
 - [SEP-3] Planning and Carrying Out Investigations
 - [SEP-4] Analyzing and Interpreting Data
 - [SEP-5] Using mathematics and Computational Thinking
 - [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)
 - [SEP-7] Engaging in Argument from Evidence
 - [SEP-8] Obtaining, Evaluating, and Communicating Information
- D. Highlighted Disciplinary Core Ideas
- PS4.A: Wave Properties
 - PS4.B: Electromagnetic Radiation
 - PS4.C: Information Technologies and Instrumentation
 - PS3.D: Energy in Chemical Reactions
 - ETS1.A: Defining and Delimiting Engineering Problems
- E. Highlighted Cross Cutting Concepts
- [CCC-1] Patterns
 - [CCC-3] Scale, Proportion, and Quantity
 - [CCC-5] Energy and Matter: Flows, Cycles, and Conservation
 - [CCC-7] Stability and Change

Unit 6: Stars and the Origins of the Universe

- A. Guiding Questions
- How do we know what are stars made out of?
 - What fuels our Sun? Will it ever run out of that fuel?
 - Do other stars work the same way as our Sun?
 - How do patterns in motion of the stars tell us about the origin of our Universe?
- B. Performance Expectations: Students who demonstrate understanding can:

- HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.
- HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
- HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

C. Highlighted Science and Engineering Practices

- [SEP-1] Asking Questions and Defining Problems
- [SEP-2] Developing and Using Models
- [SEP-3] Planning and Carrying Out Investigations
- [SEP-4] Analyzing and Interpreting Data
- [SEP-5] Using mathematics and Computational Thinking
- [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)
- [SEP-7] Engaging in Argument from Evidence
- [SEP-8] Obtaining, Evaluating, and Communicating Information

D. Highlighted Disciplinary Core Ideas

- ESS1.A: The Universe and Its Stars
- PS1.C: Nuclear Processes

E. Highlighted Cross Cutting Concepts

- [CCC-1] Patterns
- [CCC-2] Cause and Effect
- [CCC-3] Scale, Proportion, and Quantity
- [CCC-4] System and System Models
- [CCC-5] Energy and Matter: Flows, Cycles, and Conservation
- [CCC-6] Structure and Function
- [CCC-7] Stability and Change

VIII. Methods of Assessment

Grades and Class Participation:

All work will be assessed and the students will receive points. Overall grades in the class will be by total percentage: A=90+ B=80-89 C=70-79 D=60-69

Grades will be based on daily class assignments, homework, notebook checks, projects, quizzes and tests. Class participation is essential to the learning process; therefore, daily student attendance is essential for course success.

Grades for this class will derive from the following sources:

Exams	75%
Labs/Homework/Projects	25%

Attendance Policy: Attendance in this course will be treated the same way as it would be treated at a place of employment. If a student is absent, it is the student's responsibility to see the instructor to get "make-up" or "missed" information. Also, if a student is behind, he/she can set up appointment to use the computer lab before or after school, or during STEP, as is mutually agreeable to teacher and student.

Academic Honesty:

Students are expected to demonstrate honesty and integrity at all times. Each student is responsible for his or her own work, which includes test taking, homework, class assignments, individual contributions to group products, and the original creation of digital art, web pages, essays, compositions, and research papers. All work submitted by a student should be a true reflection of that student's knowledge, experience, effort and ability. It is unacceptable academic behavior to submit work that is not one's own. Refer to "Academic Honesty & Integrity" section in your student handbook. The consequences laid out in this section will be strictly adhered to in all incidents of cheating or plagiarism.

IX. Materials/Textbook(s) Conceptual Physics, Hewitt, 3rd Student Edition, 2002.

X. Seeking "a-f" Approval – Yes – Yes, this course will be submitted to the University of California for approval for the 2018-19 academic year in the subject domain "D" for Laboratory Science.

XI. Seeking AP Class Approval – No– This course does NOT seek AP approval.

