AP® Physics 2 Sample Syllabus 4

Curricular Requirements		Page(s)
CR1	Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.	1
CR2a	The course design provides opportunities for students to develop understanding of the foundational principles of thermodynamics in the context of the big ideas that organize the curriculum framework.	2
CR2b	The course design provides opportunities for students to develop understanding of the foundational principles of fluids in the context of the big ideas that organize the curriculum framework.	2
CR2c	The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.	2
CR2d	The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.	2
CR2e	The course design provides opportunities for students to develop understanding of the foundational principles of magnetism and electromagnetic induction in the context of the big ideas that organize the curriculum framework.	3
CR2f	The course design provides opportunities for students to develop understanding of the foundational principles of optics in the context of the big ideas that organize the curriculum framework.	4
CR2g	The course design provides opportunities for students to develop understanding of the foundational principles of modern physics in the context of the big ideas that organize the curriculum framework.	4
CR3	Students have opportunities to apply AP Physics 2 learning objectives connecting across enduring understandings as described in the curriculum framework. These opportunities must occur in addition to those within laboratory investigations.	7
CR4	The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.	7
CR5	Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.	5
CR6a	The laboratory work used throughout the course includes a variety of investigations that support the foundational AP Physics 2 principles.	5
CR6b	The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.	6, 7
CR7	The course provides opportunities for students to develop their communication skills by recording evidence of their research of literature or scientific investigations through verbal, written, and graphic presentations.	5
CR8	The course provides opportunities for students to develop written and oral scientific argumentation skills.	5, 7

Course Description

AP Physics 2 is equivalent to most college-level introductory physics courses with a focus on the following topics: fluid statics and dynamics, thermodynamics, PV diagrams and probability, electrostatics, electrical circuits with capacitors, magnetic fields, electromagnetism, physical and geometric optics, and other topics in modern physics. *AP Physics 1 should be taken before this course, which covers traditional mechanics and other important introductory topics.*

Emphasis will be placed on understanding physical science literacy and applying physics concepts to think critically and solve problems. Algebra and trigonometry are the primary mathematical tools for problem solving. Science literacy is the process of both knowing physics and doing physics. Hands-on laboratory and the scientific notebook will be emphasized. This course will prepare the student for the AP exam in May. This class is scheduled for 90 minutes every other day from the end of August until the end of May.

Resources

Text

Walker, James S. *Physics, AP® Edition*. 5th Edition. Upper Saddle River, New Jersey: Prentice Hall, 2016. **[CR1]**

CR1— Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.

Teaching Strategies

The course consists of the units listed in the course outline (see below), with a test at the completion of each unit. Most units begin with an overview of the content with leading questions or a "quick-discovery" student "hands-on" session, which are designed to help students discover and explore physical relationships.

Homework is assigned regularly and recorded in a student notebook which is peer reviewed regularly. Labs are provided with each unit at a time that will best reinforce the concepts of the unit. Informal, formative, and summative evaluation will be used to provide timely feedback to students regarding their progress and level of understanding of the content. Student "clickers" (Classroom Response System) will be used to provide "live" feedback to students and the teacher to maximize course effectiveness.

Students will gain experience using the TI-84 family of calculators and Calculator Based Lab (CBL) collection materials as the course progresses.

Physics Outline of Units with Timelines

** Notations are the links to the AP Physics 2 Enduring Understandings*

I. Introduction - Weeks 1–2
Big Ideas: 3 and 5
* 3.A, 3.B, and 5.D

- A. Review of physical quantities (Chapter 1)
- B. Algebra and trigonometry review
- C. Newton's biggest hits (review of important Physics 1 topics)

II. Fluid Mechanics (Chapter 15) - Weeks 3–4
Big Ideas: 1, 3, and 5 **[CR2b]**
*1.E, 3.C, 5.B, and 5.F

- A. Density and Pressure
  1. Density and specific gravity
  2. Pressure as a function of depth
  3. Pascal's principle
- B. Buoyancy
  1. Buoyant force
  2. Archimedes' principle
- C. Fluid flow continuity
- D. Bernoulli's Equation

> CR2b— The course design provides opportunities for students to develop understanding of the foundational principles of fluids in the context of the big ideas that organize the curriculum framework.

III. Thermal Physics (Chapters 16, 17, and 18) - Weeks 5–9
Big Ideas: 1, 4, 5, and 7 **[CR2a]**
*1.E, 4.D, 4.E, 5.B, 7.A, and 7.B

- A. Temperature and Heat
  1. Mechanical equivalent of heat
  2. Heat transfer and thermal expansion
- B. Kinetic Theory
  1. Ideal gases
  2. Gas laws
- C. Thermodynamics
  1. Thermodynamic processes
     - a. Adiabatic
     - b. Isothermal
     - c. Isobaric
     - d. Isochoric
     - e. Cyclic
  2. pV diagrams
     - a. Determining work done
     - b. Interpreting graphs
  3. First Law of Thermodynamics
     - a. Internal energy
     - b. Energy conservation
  4. Second Law of Thermodynamics
     - a. Entropy
     - b. Heat engines
     - c. Carnot cycle

> CR2a— The course design provides opportunities for students to develop understanding of the foundational principles of thermodynamics in the context of the big ideas that organize the curriculum framework.

IV. Electricity (Chapters 19, 20, and 21) - Weeks 10–14
Big Ideas: 1, 2, 3, 4, and 5 **[CR2c] [CR2d]**
*1.E, 2.A, 2.C, 2.D, 2.E, 3.A, 3.C, 3.G, 4.E, 5.B, and 5.C

- A. Electrostatics
  1. Coulomb's Law
  2. Electric Field

> CR2c— The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.

> CR2d— The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.

            a. Force on a test charge
            b. Field diagrams
            c. Motion of particle in an E field
        3. Electric Potential
            a. Due to a group of charges
            b. Potential difference
            c. Work on a charge
            d. Between parallel plates
        4. Electrostatics with Conductors
            a. Absence of E field in conductor
            b. Equipotential
            c. Charging by induction
    B. Capacitors
        1. Capacitance
        2. Energy and charge stored
        3. Parallel plates
    C. Electric Current
        1. Definition of direction of current
        2. Ohm's Law
        3. Resistance and Resistivity
        4. Power
    D. DC Circuits
        1. Schematic diagrams/Kirchhoff's Laws
        2. Resistors
            a. In series
            b. In parallel
        3. Capacitors
            a. In series
            b. In parallel
        4. Terminal voltage and internal resistance
        5. Steady-state RC circuits

V. Magnetism (Chapters 22 and 23) - Weeks 15–16
Big Ideas: 2, 3, and 4 **[CR2e]**
*1.E, 2.A, 2.B, 2.E, 3.G, 4.E, and 5.B
    A. Magnetostatics
        1. Magnetic field
        2. Forces on moving charges
        3. Forces on a current-carrying wire
        4. Magnetic field of current-carrying wires
    B. Electromagnetism
        1. Magnetic flux
        2. Faraday's Law and Lenz's Law
        3. Induced emf and induced current

CR2e— The course design provides opportunities for students to develop understanding of the foundational principles of magnetism and electromagnetic induction in the context of the big ideas that organize the curriculum framework.

VI. Optics (Chapters 25, 26, 27, and 28) - Weeks 17–22

Big Idea 6 **[CR2f]**
*1.D, 5.D, 6.A, 6.B, 6.C, 6.D, 6.E, 6.F, and 6.G

- A. Physical Optics
  1. The electromagnetic spectrum
  2. Interference
     a. Two-source interference
  3. Diffraction
     a. Diffraction grating
  4. Thin films
- B. Geometric Optics
  1. Reflection and refraction
     a. Snell's Law
     b. Total internal reflection
  2. Images formed by mirrors
     a. Ray diagrams
     b. Thin lens/mirror equation
  3. Images formed by lenses
     a. Ray diagrams
     b. Thin lens/mirror equation

CR2f— The course design provides opportunities for students to develop understanding of the foundational principles of optics in the context of the big ideas that organize the curriculum framework.

VII. Atomic and Nuclear Physics (Chapters 30, 31, and 32) - Weeks 25–28
Big Ideas: 1, 3, 4, 5, 6, and 7 **[CR2g]**
* 1.A, 1.B, 1.C, 1.D, 3.G, 4.C, 5.B, 5.D, 5.G, and 7.C

- A. Atomic Physics and Quantum Effects
  1. Discovery of the Electron and Atomic Nucleus
     a. Cathode ray tube
     b. Millikin's Oil Drop Experiment
     c. Rutherford scattering
  2. Photons and the Photoelectric Effect
     a. Energy of a photon
     b. Intensity and number of photons
     c. Stopping potential
  3. Bohr Model
     a. Energy levels
     b. Emission and absorption spectra
     c. Transition between energy levels
  4. DeBroglie Wavelength
     a. Wavelength of Particles
  5. Production of X-rays
  6. Compton Scattering
- B. Nuclear Physics
  1. Atomic number, mass number, and atomic mass
  2. Nuclear processes
     a. Radioactive decay (alpha, beta, and gamma)
     b. Fusion
     c. Fission

CR2g— The course design provides opportunities for students to develop understanding of the foundational principles of modern physics in the context of the big ideas that organize the curriculum framework.

3. Mass-Energy equivalence

VIII. Modern Physics and Review for AP Exams - Weeks 29–32

Laboratory

Labs are done throughout the school year when they best fit in the curriculum. One class period out of four (25% of the scheduled instructional time) will be devoted to the hands-on laboratory experience. **[CR5]**

CR5— Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.

Students are required to keep a portfolio (in the form of a scientific notebook) of their work. The labs incorporate a variety of skills and learning experiences for the students. During the lab, students work in pairs or small groups, but they are required to turn in individual work. **[CR7]** Generally, labs follow the following format:

CR7— The course provides opportunities for students to develop their communication skills by recording evidence of their research of literature or scientific investigations through verbal, written, and graphic presentations.

1) Objective: An objective is presented at the beginning of the laboratory period to communicate the goal of the lab to the students. For some labs, students are given equipment and asked to design an experiment to test a particular physical concept. For other labs, students collect data from a specified set of equipment.
2) Pre-Lab Open-Ended Questions: Students are required to demonstrate a basic understanding of the skills and physical concepts of the lab before engaging in any lab work.
3) Procedure: For student-designed labs, students are required to submit their procedure to the teacher for approval before doing the procedure. For pre-designed labs, students follow a given procedure.
4) Data: Each student is required to record their data set. Students are required to analyze their data qualitatively, graphically, statistically, or mathematically, depending on what the lab necessitates. Graphs may be done by hand on graph paper, or on a graphing program such as Excel. Statistical analysis may be done using a calculator or Excel. All work will be recorded in the student write-up.
5) Extension Questions: These are open-ended questions that require the student to think critically about the lab and to reflect on their real-world experiences.

Laboratory List [CR6a]

These laboratory experiences have two versions: one is a guided-inquiry, formative student exploration of the topic; the other is a traditional approach, which is summative in nature. For all the guided-inquiry labs, students will be required to present their data and calculations to the class and be prepared to defend their analysis and conclusions. Labs may need to be redesigned and re-run. **[CR8]**

CR6a— The laboratory work used throughout the course includes a variety of investigations that support the foundational AP Physics 2 principles.

CR8— The course provides opportunities for students to develop written and oral scientific argumentation skills.

1) Measurement and Propagation of Uncertainty
- Objective: Students will use a pendulum to take scientific measurements and estimate and calculate the amount of uncertainty of those measurements.
- Science Practices 2 and 5

2) Fluids: Archimedes' Principle (Guided-Inquiry)
   - Objective: Students will determine the density of an unknown fluid and an unknown solid using a fluid of known density and other standard equipment.
   - Science Practices 1, 2, 4, 5 and 6
3) Relationship between pressure and volume (Guided-Inquiry)
   - Objective: Use the pressure/volume syringe or the Pasco pressure/volume interface to design an experiment related to the ideal gas equation.
   - Science Practices 1, 2, 4 and 5
4) Gas Properties PhET Simulation
   - Objective: The students will explore the relationships between pressure volume, temperature, and number of moles for an ideal gas using the "Gas Properties" simulation.
   - Science Practices 1, 2, 3, 4, 5, and 6
5) Investigating Equipotential Lines and Electric Fields (Guided-Inquiry) **[CR6b]**
   - Objective: Students will draw lines of equal electrostatic potential and electric field lines for various charge configurations and determine the dependence of the electrostatic potential on the distance from a point charge.
   - Science Practices 1, 2, 3, 4, and 5
6) Understanding Ohm's Law (Guided-Inquiry) **[CR6b]**
   - Objective: Students will analyze the relationship among current, voltage, and resistance by designing circuits with different resistors and resistor combinations.
   - Science Practices 1, 2, 3, 4, and 7
7) Investigating Magnetic Fields (Guided-Inquiry) **[CR6b]**
   - Objective: Students will determine the magnetic field around magnets and represent this information as magnetic field lines.
   - Science Practices 1, 2, and 4
8) Measurement of the Earth's Magnetic Field (Guided-Inquiry) **[CR6b]**
   - Objective: Students will apply Ampere's Law to measure the strength of the horizontal component of the earth's magnetic field in the lab room.
   - Science Practices 1, 2, 3, and 4
9) Electromagnetic Induction (Guided-Inquiry) **[CR6b]**
   - Objective: Students will qualitatively observe the transfer of energy between two coils. Determine how the ratio of number of coils affects the voltage and current in each coil.
   - Science Practices 1, 2, 4, and 5
10) Using Snell's Law (Guided-Inquiry) **[CR6b]**
   - Objective: Students will use Snell's Law to design an experiment to determine the index of refraction of an unknown substance.
   - Science Practices 1, 2, 3, and 4
11) Understanding Geometric Optics (Guided-Inquiry) **[CR6b]**
   - Objective: Students will design a lab to gain understanding of the types of images formed by various mirrors and lenses.
   - Science Practices 1, 2, and 5
12) Focal Length of a Lens (Guided-Inquiry) **[CR6b]**

CR6b— The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.

- Objective: Students will design an experiment to measure the length of a converging lens and a diverging lens.
- Science Practices 1, 2, and 4

13) Double-Slit Interference (Guided-Inquiry) **[CR6b]**
    - Objective: Students will design an experiment to determine the spacing between two narrow slits based upon an analysis of the interference pattern from monochromatic light.
    - Science Practices 1, 2, and 4
14) Analyzing Emission Spectra
    - Objective: Students will compare and contrast the emission spectra of various gases, and investigate quantitatively the emission spectrum of hydrogen and relate it to Bohr's theory of atomic structure.
    - Science Practices 1, 2, and 3
15) Modeling Radioactive Decay
    - Objective: Students will simulate radioactive decay using various types of dice.
    - Science Practices 1 and 2

CR6b— The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.

Real-World Activity

The students are presented with the following scenario: the local power company wants to build a nuclear reactor in the district. The town council is hearing arguments to decide on whether to pass an ordinance allowing or forbidding the construction of nuclear power plants in city limits. Students will engage in a classroom debate on the merits and drawbacks of nuclear fission reactors. The students will be divided into three groups: one group will argue in favor of the nuclear power plant, one group will argue against the nuclear power plant, and one group will serve as the town council and hear arguments. Both groups must use scientific-based evidence to construct their arguments [Essential Knowledge 4.C.4] **[CR4] [CR8]**

CR4— The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.

CR8— The course provides opportunities for students to develop written and oral scientific argumentation skills.

Activity to Cross Enduring Understandings [CR3]

Students will design a cardboard boat that will safely allow two passengers to cross a pool and come back. Students must include boat design features and calculations to show how their boat design should float. [LO 1.E.11, 1.E.1.2, 3.A.4.1, 3.A.4.2, 3.A.4.3, 3.B.1.4]

CR3— Students have opportunities to apply AP Physics 2 learning objectives connecting across enduring understandings as described in the curriculum framework. These opportunities must occur in addition to those within laboratory investigations.