AP® Physics 2 Syllabus

Curricular Requirements		Page
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 an 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 an understanding of the foundational principles of thermodynamics in the context of the big ideas that organize the curriculum framework.	2
CR2c	The course design provides opportunities for students to develop an 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 an 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 an understanding of the foundational principles of magnetism and electromagnetic induction in the context of the big ideas that organize the curriculum framework.	2
CR2f	The course design provides opportunities for students to develop an understanding of the foundational principles of optics in the context of the big ideas that organize the curriculum framework.	2
CR2g	The course design provides opportunities for students to develop an understanding of the foundational principles of modern physics in the context of the big ideas that organize the curriculum framework.	2
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.	3
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.	4
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.	3
CR6a	The laboratory work used throughout the course includes a variety of investigations that support the foundational AP Physics 2 principles.	3, 4, 5, 6
CR6b	The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.	3, 4, 5, 6
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.	3
CR8	The course provides opportunities for students to develop written and oral scientific argumentation skills.	3

Course Introduction

AP® Physics 2 is an algebra-based course in general physics that meets for 60 minutes each day for the entire school year, with 25% of instructional time allotted for laboratory investigations. General physics topics presented during the course closely follow those outlined by the College Board and also mirrors an introductory level university physics course. AP® Physics 2 is organized around six big ideas that bring together the fundamental science principles and theories of general physics. These big ideas are intended to encourage students to think about physics concepts as interconnected pieces of a puzzle. The solution to the puzzle is how the real world around them actually works. The students will participate in inquiry-based explorations of these topics to gain a more conceptual understanding of these physics concepts. Students will spend less of their time in traditional formula-based learning and more of their effort will be directed to developing critical thinking and reasoning skills.

Textbook

Serway, Raymond A., and Vuille, Chris. *College Physics*. Tenth Edition. Stamford, CT: Cengage Learining, 2014. **[CR1]**

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

Additional Resources/Materials

1. OpenStax College, *College Physics*. OpenStax College. 21 June 2012. **[CR1]**
2. Lewin, Walter. *8.01 Physics I: Classical Mechanics*, *Fall 1999*. (MIT OpenCourseWare: Massachusetts Institute of Technology), http://ocw.mit.edu/courses/physics/8-01-physics-i-classical-mechanics-fall-1999. License: Creative Commons BY-NC-SA. **[CR1]**
3. Data Studio Software v. 1.7. Pasco Scientific. Roseville, CA. **[CR1]**
4. PhET Interactive Simulations. University of Colorado Bolder. @ phet.colorado.edu. **[CR1]**

Big Ideas for AP® Physics 2

- Big Idea 1: Objects and systems have properties such as mass and charge. Systems may have internal structure.
- Big Idea 2: Fields existing in space can be used to explain interactions.
- Big Idea 3: The interactions of an object with other objects can be described by forces.
- Big Idea 4: Interactions between systems can result in changes in those systems.
- Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.
- Big Idea 6: Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.
- Big Idea 7: The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems.

The big ideas for AP® Physics 2 are correlated to the content of the course and to the lab and inquiry-based investigations done throughout the school year in the following table.

Outline of AP® Physics 2 Principles and Correlation to Big Ideas (BI):

Physics Principles	**Correlation to BI**
Thermodynamics [CR2a]	
Chap 10: Ideal Gases—Macroscopic & Kinetic Theories	1, 4, 5, and 7
Chap 11: Heat & Internal Energy, Specific Heat, Latent Heat	1, 4, 5, and 7
Chap 12: Thermal Energy Transfer by Conduction and Radiation, Laws of Thermodynamics, Heat Engines	1, 4, 5, and 7
Fluids [CR2b]	
Chap 9: Density & Pressure, Buoyant Forces, Bernoulli's Equation, Archimedes' Principle	1, 3, and 5
Chap 9: Fluid Dynamics, Flow Rate & Continuity Principle	1, 3, and 5
Electrostatics [CR2c]	
Chap 15: Electric Force, Field & Potential	1, 2, 3, 4, and 5
Chap 16: Capacitors	1, 2, 3, 4, and 5
Electric Circuits [CR2d]	
Chap 17: emf, Resistance & Current	1, 4, and 5
Chap 18: Analyze DC Circuits Using Ohm's Law & Kirchoff's Laws	1, 4, and 5
Chap 18: DC RC Circuits	1, 4, and 5
Magnetism [CR2e]	
Chap 19: Magnetic Field	2, 3, and 4
Chap 19: Magnetic Force on a Charge & Current Carrying Wire	2, 3, and 4
Chap 20: Induced emf & Magnetic Flux	2, 3, and 4
Chap 20: Electromagnetic Induction—Faraday's Law & Lenz's Law	2, 3, and 4
Chap 20: Motional emf	2, 3, and 4
Optics [CR2f]	
Chap 22: Reflection & Refraction	6
Chap 23: Mirrors & Lenses	6
Chap 24: Interference, Young's Double-Slit Experiment, Phase Changer Due to Reflection, Thin Film Interference & Diffraction	6
Modern Physics [CR2g]	
Chap 27: Blackbody Radiation, Photoelectric Effect, Dual Nature of Light, Wave Function	1, 3, 4, 5, 6, and 7
Chap 28: Models of the Atom, Quantum Mechanics & the Hydrogen Atom, Pauli Exclusion Principle	1, 3, 4, 5, 6, and 7
Chap 29: Nuclear Physics—Properties of the nucleus, binding energy, radioactive decay, nuclear reactions	1, 3, 4, 5, 6, and 7

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

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

AP® Test Review for the time remaining until the AP® Test.
Time after AP® Test will be spent on Relativity, Astronomy, and other topics.

AP® Physics 2 Laboratory and Investigations
[CR6a] [CR6b]

Laboratory work is an integral part of physics and students are introduced to a variety of different laboratory experiences. All labs are hands-on. Some labs are expected to develop a specific skill. Others are open ended; based on a given objective and an equipment list, the students are required to design their own procedure, data gathering, and analysis. Class time is used to introduce the lab; students can design the lab in their own time and then more class time is given to conduct the experiment and record data. The analyses and report generation are completed as homework. Students perform labs either to discover a fundamental concept or to apply a concept previously discussed. Most laboratory experiences are designed to encourage students to develop their own hypothesis, experiments, and conclusions. Labs also provide the opportunity to gather and analyze data, and to hone critical thinking skills. Part of the lab experience will require students to present their findings to their peers for a peer review and critique. Students must use the evidence they found in the lab to defend their conclusions. **[CR8]** Students are engaged in laboratory work, integrated throughout the course, which accounts for 25% of instructional time. **[CR5]**

Each student is required to keep a lab notebook or portfolio documenting the laboratory exercises. The Lab reports are expected to include the following:

- A statement of the problem/question
- A description of the experimental procedure
- Data and/or observations
- Analysis (calculations, graphs and errors) and discussion
- Conclusions. **[CR7]**

Real World Applications:

• Students investigate how the human eye works and conduct experiments to determine which types of lenses are appropriate to correct visual eye defects such as myopia and hyperopia. As an extension, the students may investigate how laser eye surgery (LASIK) works. This activity allows students to apply the following learning objectives (LO):

> LO 6.A.1.2: The student is able to describe representations of transverse and longitudinal waves.
>
> LO 6.E.3.3: The student is able to make claims and predictions about path changes for light traveling across a boundary from one transparent material to another at non-normal angles resulting from changes in the speed of propagation.
>
> LO 6.E.5.1: The student is able to use quantitative and qualitative representations and models to analyze situations and solve problems about image formation occurring due to the refraction of light through thin lenses.
>
> LO 6.E.5.2: The student is able to plan data collection strategies, perform data analysis and evaluation of evidence, and refine scientific questions about the formation of images due to refraction for thin lenses. **[CR3]**

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

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

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

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.

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.

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.

• Students are required to write two short essays on physics topics to help develop their ability to explain physics concepts. Two possibilities include asking the students to describe the structure, function, and applications of the MRI (Magnetic Resonance Imaging), or asking them to explain how electricity is produced and transported to their house. Essays must include the physics explanations and application. **[CR4]**

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.

Laboratory Exercises & their associated science practices (SP)

Note: The labs, listed below, use "GI" to indicate that the respective lab is a Guided Inquiry Lab.

Lab Title	Lab Topic	Lab Description [CR6a]
1. Density of a Solid (GI) **[CR6b]**	Fluid Statics	Devise two methods to determine the density of a solid, one of which must use buoyancy principles. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
2. Density of a Liquid (GI) **[CR6b]**	Fluid Statics	Use a U-shaped tube to determine the density of a fluid floating on water SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
3. Speed of a wind source (GI) **[CR6b]**	Fluid Dynamics	Use a U-shaped tube filled with water and a compressed air source to determine the speed of the air. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1, 7.1
4. Absolute Zero	Thermodynamics	Determine the value of absolute zero using constant volume containers and pressure meters. SP: 1.2, 1.4, 2.2, 3.3, 4.2, 4.3, 4.4, 5.3, 6.1, 6.2
5. Specific Heat (GI) **[CR6b]**	Thermodynamics	Design an experiment to determine the specific heat of various solids and compare the results to a table of known specific heats. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
6. Index of Refraction (GI) **[CR6b]**	Optics	Use lasers to determine the index of refraction of various fluids and then compare to a table of known indices of refraction to try to determine what the fluid is. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1

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

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

Lab Title	Lab Topic	Lab Description [CR6a]
7. Young's Double-Slit Experiment	Optics	Using lasers, investigate interference caused by a double-slit set-up. SP: 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
8. Curved Mirrors (GI) **[CR6b]**	Optics	Determine the focal length of convex and concave mirrors. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
9. Dispersion & Internal Reflection	Optics	Using Pasco optics kit, investigate the phenomena of dispersion, critical angles, and total internal reflections. SP: 1.4, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
10. Magnetic Field Strength of a Solenoid (GI) **[CR6b]**	Magnetism	Determine the relationship between the magnetic field and current and magnetic field and the number of turns for a solenoid. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
11. Electric Fields	Electrostatics	Map the electric field lines created by point charges and charged plates, using multimeters, conductive paper, and aluminum foil. SP: 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
12. Internal Resistance of Batteries (GI) **[CR6b]**	Electricity	Determine the internal resistance of various batteries. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
13. DC Resistor-Capacitor Circuits	Electricity	Determine the DC characteristics of various circuit configurations of capacitors and resistors in their quiescent states. SP: 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
14. Induced emf	Electromagnetism	Determine how the number of turns on a solenoid and the motion of a magnet affect the induced emf/current. SP: 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1

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

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Lab Title	Lab Topic	Lab Description [CR6a]
15. Measuring Planck's Constant	Quantum Physics	Using an LED, determine Planck's Constant, buy measuring the forward voltage and the wavelength of the emitted light. SP: 1.4, 2.2, 2.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
16. Nuclear Decay	Atomic Physics	Use dice to simulate the nuclear decay of an atom, determine the decay constants for various scenarios. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1
17. Energy Levels of Hydrogen	Atomic Physics	Using spectrum tubes and spectrometers, estimate the wavelengths of the visible portion of the hydrogem spectrum and relate it to the energies associated with the Balmer transitions within the hydrogen atom. SP: 1.1, 1.4, 2.1, 2.2, 2.3, 3.1, 3.3, 4.1, 4.2, 4.3, 4.4, 5.3, 6.1

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