

SYLLABUS DEVELOPMENT GUIDE

AP[®] Physics 1: Algebra-Based

The guide contains the following sections and information:

Curricular Requirements

The curricular requirements are the core elements of the course. A syllabus must provide explicit evidence of each requirement based on the required evidence statement(s). The Unit Guides and the “Instructional Approaches” section of the *AP[®] Physics 1: Algebra-Based Course and Exam Description (CED)* may be useful in providing evidence for satisfying these curricular requirements.

Required Evidence

These statements describe the type of evidence and level of detail required in the syllabus to demonstrate how the curricular requirement is met in the course.

Note: Curricular requirements may have more than one required evidence statement. Each statement must be addressed to fulfill the requirement.

Clarifying Terms

These statements define terms in the Syllabus Development Guide that may have multiple meanings.

Samples of Evidence

For each curricular requirement, three separate samples of evidence are provided. These samples provide either verbatim evidence or clear descriptions of what acceptable evidence could look like in a syllabus.

Curricular Requirements

CR1	Students and teachers have access to college-level resources including a college-level textbook and reference materials in print or electronic format.	<i>See page:</i> 3
CR2	The course provides opportunities to develop student understanding of the required content and related big ideas outlined in each of the units described in the AP Course and Exam Description (CED).	<i>See page:</i> 4
CR3	The course provides opportunities for students to develop the skills related to Science Practice 1: Modeling.	<i>See page:</i> 6
CR4	The course provides opportunities for students to develop the skills related to Science Practice 2: Mathematical Routines.	<i>See page:</i> 7
CR5	The course provides opportunities for students to develop the skills related to Science Practice 3: Scientific Questioning.	<i>See page:</i> 8
CR6	The course provides opportunities for students to develop the skills related to Science Practice 4: Experimental Methods.	<i>See page:</i> 9
CR7	The course provides opportunities for students to develop the skills related to Science Practice 5: Data Analysis.	<i>See page:</i> 10
CR8	The course provides opportunities for students to develop the skills related to Science Practice 6: Argumentation.	<i>See page:</i> 11
CR9	The course provides opportunities for students to develop the skills related to Science Practice 7: Making Connections.	<i>See page:</i> 12
CR10	The course provides students with opportunities to apply their knowledge of AP Physics concepts to real-world questions or scenarios to help them become scientifically literate citizens.	<i>See page:</i> 13
CR11	Students spend a minimum of 25 percent of instructional time engaged in a wide range of hands-on laboratory investigations with an emphasis on inquiry-based labs to support the learning of required content and development of science practice skills throughout the course.	<i>See page:</i> 14
CR12	The course provides opportunities for students to record evidence of their scientific investigations in a portfolio of lab reports or a lab notebook (print or digital format).	<i>See page:</i> 16

Curricular Requirement 1

Students and teachers have access to college-level resources including a college-level textbook and reference materials in print or electronic format.

Required Evidence

- The teacher must provide the title, author, and publication date of an algebra-based, college-level textbook on their course audit form.

Samples of Evidence

1. The teacher selects an approved college-level textbook on their course audit form.
2. The teacher provides the title, author, and publication date of an algebra-based, college-level textbook on their course audit form.

Curricular Requirement 2

The course provides opportunities to develop student understanding of the required content and related big ideas outlined in each of the units described in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include an outline of course content by unit title or topic using any organizational approach to demonstrate the inclusion of required course content and associated big ideas listed in the AP Physics 1 Course and Exam Description (CED).

Samples of Evidence

1. Unit 1: Kinematics (Big Ideas 3 and 4)
Unit 2: Dynamics (Big Ideas 1, 2, 3, and 4)
Unit 3: Circular Motion and Gravitation (Big Ideas 1, 2, 3, and 4)
Unit 4: Energy (Big Ideas 3, 4, and 5)
Unit 5: Momentum (Big Ideas 3, 4, and 5)
Unit 6: Simple Harmonic Motion (Big Ideas 3 and 5)
Unit 7: Torque and Rotational Motion (Big Ideas 3, 4, and 5)
2. Unit 1: Kinematics - INT and CHA
 - ♦ Position, Velocity, and Acceleration
 - ♦ Representations of MotionUnit 2: Dynamics - SYS, FLD, INT, and CHA
 - ♦ Systems
 - ♦ The Gravitational Field
 - ♦ Contact Forces
 - ♦ Newton's First Law
 - ♦ Newton's Third Law and Free-Body Diagrams
 - ♦ Newton's Second LawUnit 3: Circular Motion and Gravitation - SYS, FLD, INT, and CHA
 - ♦ Vector Fields
 - ♦ Fundamental Forces
 - ♦ Gravitational and Electric Forces
 - ♦ Gravitational Field/Acceleration Due to Gravity on Different Planets
 - ♦ Inertial vs. Gravitational Mass
 - ♦ Centripetal Acceleration and Centripetal Mass
 - ♦ Free-Body Diagrams for Objects in Uniform Circular Motion
 - ♦ Applications of Circular Motion and GravitationUnit 4: Energy - INT, CHA, CON
 - ♦ Open and Closed Systems: Energy
 - ♦ Work and Mechanical Energy
 - ♦ Conservation of Energy, the Work-Energy Principle, and Power

Unit 5: Momentum - INT, CHA, CON

- ♦ Momentum and Impulse
- ♦ Representations of Changes in Momentum
- ♦ Open and Closed Systems: Momentum
- ♦ Conservation of Linear Momentum

Unit 6: Simple Harmonic Motion - INT and CON

- ♦ Period of Simple Harmonic Oscillators
- ♦ Energy of a Simple Harmonic Oscillator

Unit 7: Torque and Rotational Motion - INT, CHA, CON

- ♦ Rotational Kinematics
- ♦ Torque and Angular Acceleration
- ♦ Angular Momentum and Torque
- ♦ Conservation of Angular Momentum

3. Kinematics - Big Idea 3: Force Interactions (INT); Big Idea 4: Change (CHA)

Dynamics - Big Idea 1: Systems (SYS); Big Idea 2: Fields (FLD); Big Idea 3: Force Interactions (INT); Big Idea 4: Change (CHA)

Circular Motion and Gravitation - Big Idea 1: Systems (SYS); Big Idea 2: Fields (FLD); Big Idea 3: Force Interactions (INT); Big Idea 4: Change (CHA)

Energy - Big Idea 3: Force Interactions (INT); Big Idea 4: Change (CHA); Big Idea 5: Conservation (CON)

Momentum - Big Idea 3: Force Interactions (INT); Big Idea 4: Change (CHA); Big Idea 5: Conservation (CON)

Simple Harmonic Motion - Big Idea 3: Force Interactions (INT); Big Idea 5: Conservation (CON)

Torque and Rotational Motion - Big Idea 3: Force Interactions (INT); Big Idea 4: Change (CHA); Big Idea 5: Conservation (CON)

Curricular Requirement 3

The course provides opportunities for students to develop the skills related to Science Practice 1: Modeling, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include one assignment, activity, or lab describing how students use representations and models to communicate scientific phenomena and solve scientific problems.
- The assignment, activity, or lab must be labeled with the relevant practice(s) (e.g., “1.2”) associated with Science Practice 1. As long as one practice under Science Practice 1 is represented, evidence is sufficient.

Samples of Evidence

1. Describe the trip from home to school in terms of distance, displacement, speed, velocity, and acceleration. Generate a matching velocity-time graph for the motion described. Record in lab book. **(SP 1.1, 1.4)**
2. Activity Meeting Point: To predict where two battery-powered cars will collide if they are released from opposite ends of the lab table at different times.
Science Practice 1.1: Student will create a graphical representation using data collected before and after the collision.
Science Practice 1.2: The student will describe the motion of the battery-powered cars before and after the collision.
3. In Unit 2 – Dynamics, students will create a free-body diagram to determine the net force exerted on an object that will be used to solve for its acceleration. **(SP 1.1, 1.4)**

Curricular Requirement 4

The course provides opportunities for students to develop the skills related to Science Practice 2: Mathematical Routines, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include one assignment, activity, or lab describing how students use mathematics appropriately.
- The assignment, activity, or lab must be labeled with the relevant practice(s) associated with Science Practice 2. As long as one practice under Science Practice 2 is represented, evidence is sufficient.

Samples of Evidence

1. Desktop Experiment Task: Find the acceleration of a yo-yo as it falls and unwinds, given only a meter stick and stopwatch. Then draw (using correct shapes and scales) distance, speed, and acceleration versus time graphs.
Science Practice 2.1: The student will justify through data collection the necessary features of a graph needed to determine speed and acceleration.
Science Practice 2.2: The student will be able to apply the correct mathematical meanings of the slope and area under the curve of the various graphs (d vs. t , v vs. t) in order to draw graphs related to the motion of the yo-yo.
2. A description of a class activity is given in which a physical problem is solved using one or more skills from **SP 2.2**.
3. Lab Investigation: Determine the speed of a mass moving as a conical pendulum using two methods: kinematics of uniform circular motion and by summing forces. Compare the results obtained by both methods. (**SP 2.2**)

Curricular Requirement 5

The course provides opportunities for students to develop the skills related to Science Practice 3: Scientific Questioning, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include one assignment, activity, or lab describing how students engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
- The assignment, activity, or lab must be labeled with the relevant practice(s) associated with Science Practice 3. As long as one practice under Science Practice 3 is represented, evidence is sufficient.

Samples of Evidence

1. Students will design a series of experiments based on their questions about Newton's second law to determine if there is an optimum value for any of the variables. Students will use their graphing skills to determine the relationship between the variables and percent error. **(SP 3.1)**
2. Discovery Lab: Given a ramp, a pulley, a string, unequal masses, a meter stick, a timer, and a spring scale, design a series of experiments to determine the coefficients of static and kinetic friction. In addition, determine the acceleration of the object when forces are unbalanced. **(Scientific Questioning – SP 3.1)**
3. Desktop Experiment Task: Have two carts with different masses collide in a nonstick collision. Film the carts with a phone camera from above with a meter stick next to the track. Use frame-by-frame to determine each cart's initial and final speeds, whether the total momentum of the system is constant, and whether the collision was elastic.
Science Practice 3.1: Before conducting the experiment, students will pose a scientific question about the initial and final velocities in the nonstick collision.
Science Practice 3.2: After collecting and analyzing the data, the student will refine the scientific question.

Curricular Requirement 6

The course provides opportunities for students to develop the skills related to Science Practice 4: Experimental Methods, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include one assignment, activity, or lab describing how students plan and implement data collection strategies in relation to a particular scientific question.
- The assignment, activity, or lab must be labeled with the relevant practice(s) associated with Science Practice 4. As long as one practice under Science Practice 4 is represented, evidence is sufficient.

Samples of Evidence

1. Desktop Experiment: Students use long springs to create standing waves. The students make measurements necessary to find the wave speed (wavelength and period data) and the maximum speed attained at an antinode point (amplitude and period data). Students calculate the wave speed and maximum “particle speed” and see that they are different.

Science Practice 4.2: Students will design a plan to collect the data in order to determine the difference between wave speed and particle speed.

Science Practice 4.3: Students will collect the data (wavelength and period of wave and amplitude and period of particle) in order to determine the difference between wave speed and particle speed.

2. The Impulse and Momentum Lab #5 is a multipart investigation in which students investigate concepts of impulse and momentum both qualitatively and quantitatively. After exploring the basic concepts of momentum, students:
 - Design experiments to gather the data necessary to answer their scientific question (**SP 4.2**)
 - Gather the data needed to calculate changes in momentum and impulse (**SP 4.3**)
 - Evaluate sources of data using the results of their experiment (comparing momenta before and after a collision) with the goal of demonstrating that the linear momentum of the system is constant. (**SP 4.4**)

3. Design an experiment to determine the factors that change the period of a simple pendulum.

Science Practice 4.1: In a written lab notebook, students will justify the selection of the data needed to answer the question about factors that change the period of a pendulum.

Science Practice 4.2: The student will design an experiment for collecting the data to determine the factors that change the period of a pendulum.

Science Practice 4.3: The student will collect the data needed to determine the factors that change the period of a pendulum.

Curricular Requirement 7

The course provides opportunities for students to develop the skills related to Science Practice 5: Data Analysis, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include one assignment, activity, or lab describing how students perform data analysis and evaluation of evidence.
- The assignment, activity, or lab must be labeled with the relevant practice(s) associated with Science Practice 5. As long as one practice under Science Practice 5 is represented, evidence is sufficient.

Samples of Evidence

1. Guided Inquiry: Design an experiment. Given a track (capable of being inclined to a measurable angle), a low-friction cart, a meter stick, and a timing device, students will design a lab to determine the acceleration of the cart. Students will describe the observed motion qualitatively, organize the data into a meaningful table, and construct a graph that can be used to determine the acceleration of the object.
Science Practice 5.1: The student will analyze distance and time data to determine the acceleration of the cart.
2. Students will design a series of experiments on Newton's second law to determine if there is an optimum value for any of the variables. Students will use their graphing skills to determine the relationship between the variables and percent error. Students will potentially address the latter with refinements to the experimental procedure. **(SP 5.1, 5.2)**
3. Lab #X, [Guided-Inquiry] Hooke's law and oscillations: Students will design a two-part lab. In the first part, they will determine the relationship between a spring's restoring force, spring constant, and displacement. In the second part of the lab, students will examine the oscillation of the spring, determining the period of the oscillation, the energy of the system, and the force and speed acting on the mass at various locations during the oscillation. **(Science Practice 5.1)**

Curricular Requirement 8

The course provides opportunities for students to develop the skills related to Science Practice 6: Argumentation, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include one assignment, activity, or lab describing how students work with scientific explanations and theories.
- The assignment, activity, or lab must be labeled with the relevant practice(s) associated with Science Practice 6. As long as one practice under Science Practice 6 is represented, evidence is sufficient.

Samples of Evidence

1. Students will include an error analysis in every laboratory report. The error analysis section will include information on sources of error, important information about data collection, and the effects these errors might have on the data collected. **(SP 6.3)**
2. Construct an Argument: Object 1 is fixed in place and object 2 is free to move; both are charged and both have the same (or different) sign charges. State how the velocity and acceleration of object 2 are changing (increasing or decreasing) as object 2 moves toward (or away from) object 1.
Science Practice 6.1: The student can justify a claim about the velocity and acceleration with evidence about the charge on the object.
Science Practice 6.4: The student can make claims about what happens to motion of an object when the objects have opposite or like charges.
3. Introductory Circular Motion Lab:
Explain the connection between the radius of circular motion and the period of circular motion when velocity is held constant. **(SP 6.2)**

Curricular Requirement 9

The course provides opportunities for students to develop the skills related to Science Practice 7: Making Connections, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- The syllabus must include one assignment, activity, or lab describing how students connect and relate knowledge across various scales, concepts, and representations in and across domains.
- The assignment, activity, or lab must be labeled with the relevant practice(s) associated with Science Practice 7. As long as one practice under Science Practice 7 is represented, evidence is sufficient.

Samples of Evidence

1. The syllabus includes activities in which students practice connecting phenomena across domains and make generalizations across enduring understandings and big ideas. For example, students apply conservation concepts for energy, charge, and linear momentum to everyday situations. (**Science Practice 7.1**)
2. Making Connections: Consider a cart that rolls from rest down a ramp and then around a vertical loop. For the cart to complete the loop without falling out, the cart must be released at a height higher than the top of the loop. Explain why this is the case using energy and circular motion principles.
Science Practice 7.1: Student will connect force interactions, systems, and conservation in order to explain why the cart must be released at a height higher than the loop.
Science Practice 7.2: The student will connect concepts across enduring understandings and big ideas in order to explain why the cart must be released from a height higher than the loop.
3. Given pictures of common objects in real-world settings, students will identify one object and one system. For each object/system, identify the forces acting on the object and system, identify the action-reaction pair, construct a free-body diagram, and predict the motion of the object and the system. Share the results with another student and critique each other. (**SP 7.1, 7.2**)

Curricular Requirement 10

The course provides students with opportunities to apply their knowledge of AP Physics concepts to real-world questions or scenarios to help them become scientifically literate citizens.

Required Evidence

- The syllabus must label and provide a description of at least one assignment or activity requiring students to apply their knowledge of AP Physics concepts to understand real-world questions or scenarios.

Samples of Evidence

1. In the syllabus, case study review and analyses are included. For example, the syllabus includes the following real-world case study:
Students are hired as consultants in a court case involving a car crash. They are asked to analyze the crash data to determine which driver is at fault and to provide expert testimony with their results.
2. Students will analyze an advertisement and/or product that makes scientific claims. The students write a summary that answers the following questions: What scientific principles are they using? (What is the scientific basis for this product?) What is correct or incorrect about their claims? Explain. What sources are used? Are those sources scientifically credible? Explain.
3. Students design a car that would protect an egg in a collision and relate the features of the car design to the safety features in an automobile. Descriptions include connections to the physics principles used to inform the design of the car.

Curricular Requirement 11

Students spend a minimum of 25 percent of instructional time engaged in a wide range of hands-on laboratory investigations with an emphasis on inquiry-based labs to support the learning of required content and development of science practice skills throughout the course.

Required Evidence

- The syllabus must include an explicit statement that at least 25 percent of instructional time is spent engaged in hands-on laboratory investigations, with an emphasis on inquiry-based labs.

AND

- Laboratory investigation titles must be listed along with a brief description.

Clarifying Terms

Guided-inquiry (G.I.): At this level, students investigate a teacher-presented question using student-designed/selected procedures.

Open-inquiry (O.I.): At this level, students investigate topic-related questions that are formulated through student designed/selected procedures.

See Chapter 4 in the AP Physics 1 and 2 Inquiry-Based Lab Investigations book for more information on levels of inquiry.

Samples of Evidence

1. Students in this course are engaged in laboratory work more than 25% of the instructional time. Labs are done when it is most appropriate for them to be done. Students are given a general question to answer and will work in small groups of two or three to develop their own procedures. Students will have their procedures approved by the instructor before they begin. The course will include the following labs:
 - An investigation of vectors using a vector table
 - The determination of the acceleration due to gravity at the school using a pendulum (G.I.)
 - An investigation of Newton's second law of motion using an air track
 - An investigation of the trajectory of a projectile motion in two dimensions (G.I.)
 - An investigation of Newton's second law of motion applied to circular motion (G.I.)
 - An investigation of conservation of energy using an air track
 - An investigation of nonconservative forces using friction
 - An investigation of conservation of momentum and energy using a ballistic pendulum
 - An investigation of Hooke's law using springs and slotted weights (G.I.)
 - An investigation of rotational kinematics, dynamics, and energy using a wheel and axle
 - An investigation of torque using an Atwood's machine and an investigation of a system in rotational equilibrium (G.I.)
 - An investigation of the speed of sound using a resonance tube (G.I.)
 - An investigation of equivalent resistance of various simple circuits (G.I.)
 - An investigation of charging an electroscope by conduction and induction

2. The syllabus describes the course as a modeling kind and states that total hands-on lab time will be more than 25 percent of total instructional time, with investigations distributed throughout the course over a majority of the identified units. These investigations are named and include descriptions of what activities students engage in. One-third of them are labeled “guided-inquiry,” and another one-third are labeled “open-inquiry,”
3. Students are engaged in laboratory work, integrated throughout the course, that accounts for at least 25 percent of the course. A typical week will have students conducting lab experiments or discovery labs during one class meeting, with the other two class meetings devoted to lecture, discussion, and problem solving.

Lab # 1: Constant velocity (examine the conditions under which an object moves with constant velocity) (O.I.)

Lab # 2: Free fall (utilize spark generator with free-falling object) (G.I.)

Lab # 3: Projectile motion (range is predicted and then measured for various angles of projection) (G.I.)

Lab # 4: Static equilibrium (meter stick suspended from spring scales and supporting several weights at various points of application, force and torque conditions are tested)

Lab # 5: Elastic and inelastic collisions (air track and gliders used to examine elastic and inelastic 1-D collisions)

Lab # 6: Conical pendulum (“flying pig” used as conical pendulum; vertical and radial forces examined)

Lab # 7: Newton’s second law (motion carts and smart pulleys used to discover Newton’s second law)

Lab # 8: Coefficient of friction (variable inclined plane used to find angle of repose for various pairs of surfaces) (O.I.)

Lab # 9: Torque and rotational motion (horizontal bar rotates about vertical axis using torque produced by string attached to falling mass—Newton’s second law for translation and rotation)

Lab # 10: Hooke’s law and simple harmonic motion (various masses attached to vertically mounted spring, first in equilibrium to determine spring constant, and then in oscillation to determine spring constant by alternate method) (G.I.)

Lab # 11: Pendulum and acceleration of gravity (length of a simple pendulum is varied using different mass bobs to verify period independent of mass and proportional to length) (G.I.)

Lab # 12: Resonance and speed of sound (tuning forks are used with resonant air columns produced by variable water level to obtain wavelength and thus speed of sound in air)

Lab # 13: Ohm’s law (voltmeter and ammeter are used to measure resistance of single resistors) (G.I.)

Lab # 14: Series and parallel circuits (various series and parallel combinations of resistors used in previous lab are constructed; current and voltage measured to determine properties of these combinations) (G.I.)

Curricular Requirement 12

The course provides opportunities for students to record evidence of their scientific investigations in a portfolio of lab reports or a lab notebook (print or digital format).

Required Evidence

- The syllabus must include the components of the written reports required of students for all laboratory investigations.
- AND
- The syllabus must include an explicit statement that students are required to maintain a lab notebook or portfolio (hard copy or electronic) that includes all their lab reports.

Samples of Evidence

1. Students are expected to keep a lab notebook where they will maintain a record of their laboratory work. Lab reports will consist of the following components:
 - Title
 - Object/Problem
 - Design (if applicable): If lab has no set equipment or procedure, what is being done? Why are you doing it this way?
 - Data: All data gathered in the lab will go here.
 - Calculations/Graphs: Calculations are done here. Any graphs that need to be made go here.
 - Conclusion: Data analysis occurs here, and a statement can be made about what was learned in the lab. Error analysis and evaluation of the lab occur here as well.
2. Students will complete a paper lab report for each lab done in class consisting of an abstract, introduction/background section, purpose statement, equipment, procedure, data, sample calculations, results, discussion of results, conclusions, and bibliography.
3. Students are required to keep a lab portfolio. Each lab included in the portfolio must contain claims/questions, hypotheses/predictions, equipment, procedure, data, data analysis, error analysis, statistics, and a conclusion. The portfolio may include reports presented in standard written format, poster format, and/or video format.