SYLLABUS DEVELOPMENT GUIDE

AP® Physics 2

The guide contains the following 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 2: 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.

Samples of Evidence

For each curricular requirement, two to 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. In some samples, the specific language that addresses the required evidence is highlighted in **bold** text.

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.	*See page:* 3
CR2	The course provides opportunities to develop student understanding of the required content outlined in each of the units described in the AP Physics 2 Course and Exam Description.	*See page:* 4
CR3	The course provides opportunities for students to develop the skills related to Science Practice 1: Creating Representations.	*See page:* 6
CR4	The course provides opportunities for students to develop the skills related to Science Practice 2: Mathematical Routines.	*See page:* 7
CR5	The course provides opportunities for students to develop the skills related to Science Practice 3: Scientific Questioning & Argumentation.	*See page:* 8
CR6	Students spend a minimum of 25% of instructional time engaged in hands-on laboratory investigations.	*See page:* 9
CR7	Students engage in hands-on laboratory investigations representative of the topics outlined in the AP Physics 2 Course and Exam Description.	*See page:* 10
CR8	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).	*See page:* 13

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 outlined in each of the units described in the AP Physics 2 Course and Exam Description.

Required Evidence

- ☐ The syllabus must include an outline of course content by unit title to demonstrate the inclusion of the required course content listed in the current AP Physics 2 Course and Exam Description.

  Note: If the syllabus demonstrates a different sequence than the units outlined in the current AP Physics 2 Course and Exam Description, the teacher must include the following specific statement: All the content in the current AP Physics 2 Course and Exam Description will be covered in this course.

Samples of Evidence

1. The course will follow the units listed below from the current AP Physics 2 Course and Exam Description:

   Unit 9: Thermodynamics

   Unit 10: Electric Force, Field, and Potential

   Unit 11: Electric Circuits

   Unit 12: Magnetism and Electromagnetism

   Unit 13: Geometric Optics

   Unit 14: Waves, Sound, and Physical Optics

   Unit 15: Modern Physics

2. All the content in the current AP Physics 2 Course and Exam Description will be covered in this course.

   We will cover these chapters of our algebra-based, college-level textbook:

   Chapter 12: Waves and Sound

   Chapter 13: Temperature, Kinetic Theory, and Gas Laws

   Chapter 14: Heat and Heat Transfer Methods

   Chapter 15: Thermodynamics

   Chapter 18: Electric Charge and Electric Field

   Chapter 19: Electric Potential and Electric Field

   Chapter 20: Electric Current, Resistance, and Ohm's Law

   Chapter 21: Circuits and DC Instruments

   Chapter 22: Magnetism

   Chapter 23: Electromagnetic Induction, AC Circuits, and Electrical Technologies

   Chapter 24: Electromagnetic Waves

   Chapter 25: Geometric Optics

   Chapter 27: Wave Optics

   Chapter 29: Quantum Physics

   Chapter 30: Atomic Physics

   Chapter 31: Radioactivity and Nuclear Physics

3. All the content in the current AP Physics 2 Course and Exam Description will be covered in this course.

   The following topics will be covered throughout the year:

   1. **Thermodynamics:** Kinetic theory of temperature and pressure, ideal gas law, thermal energy and transfer, thermal conductivity and specific heat, 1st and 2nd laws of thermodynamics
   2. **Electric Circuits:** Current, simple circuits, resistivity and Ohm's law, power, complex circuits, Kirchhoff's loop and junction rules, RC circuits
   3. **Electrostatics:** Electric charge and force, transfer of charge, electric force vs. gravitational force, electric fields, electric permittivity, electric potential, capacitors, conservation of electric energy
   4. **Magnetism and Electromagnetism:** Magnetic field, magnetic dipoles, magnetic permeability, magnetism and moving charges, magnetism and current-carrying wires, electromagnetic induction and Faraday's law
   5. **Waves, Sound, and Physical Optics:** Wave/pulse properties, periodic waves, boundary behavior of waves and polarization, EM waves, Doppler effect, wave interference, diffraction, double-slit interference
   6. **Geometric Optics:** Ray diagrams, reflection, mirrors, refraction, lenses, thin film interference
   7. **Modern Physics:** Quantum theory and wave particle duality, Bohr model, emission and absorption spectra, blackbody radiation, photoelectric effect, Compton scattering, fission-fusion and nuclear decay, types of radioactive decay

Curricular Requirement 3

The course provides opportunities for students to develop the skills related to Science Practice 1: Creating Representations.

Required Evidence

- ☐ The syllabus must include a section labeled "Science Practice 1" describing one assignment, activity, or lab where students create representations that depict physical phenomena.

Clarifying Terms

The following task verbs are commonly associated with Science Practice 1: sketch, draw, or plot.

Samples of Evidence

1. **Science Practice 1**

   A lab activity in which students explore the relationship between voltage and current for a particular resistor.

   a) **Draw a circuit diagram** with proper symbols for different circuit elements.

   b) **Graph voltage vs. current** with proper units, scale, and axes labels.

2. **SP1**

   In this magnetism activity, students will work in small groups to **create a representation** of the magnetic field due to a current-carrying wire. Students will discuss their representations and then describe them to their peer groups.

3. **Science Practice 1**

   What is the index of refraction of an acrylic block? Students will measure the angle of refraction for different angles of incidences. Students will **plot the data** and use the graph to experimentally determine the index of refraction of an acrylic block.

Curricular Requirement 4

The course provides opportunities for students to develop the skills related to Science Practice 2: Mathematical Routines.

Required Evidence

- ☐ The syllabus must include a section labeled "Science Practice 2" describing one assignment, activity, or lab where students use mathematical routines.

Clarifying Terms

The following task verbs are commonly associated with Science Practice 2: calculate, compare, derive, determine, estimate, or show.

Samples of Evidence

1. **Science Practice 2**

   A problem-solving activity where students are asked to conceptualize the existence of two types of charges by doing the tape activity.

   1. **Derive** the correct expression for the charge transferred from tape A to B.
   2. **Calculate** the amount of charge transferred quantitatively.
   3. **Compare** charge transferred from one tape to the other for multiple situations.

2. **SP2**

   Lab Investigation:

   During lens labs, students will use mathematical routines to **calculate the focal length** of a lens using the object distance and the image distance.

3. **Science Practice 2**

   What is the relationship between currents and potential difference? Students will investigate the behavior of resistors in series, parallel, and series-parallel DC circuits. Students will use Ohm's law to **calculate** resistances from the current and potential difference measurements.

Curricular Requirement 5

The course provides opportunities for students to develop the skills related to Science Practice 3: Scientific Questioning & Argumentation.

Required Evidence

- ☐ The syllabus must include a section labeled "Science Practice 3" describing one assignment, activity, or lab where students design experimental procedures, and make and justify claims.

Clarifying Terms

The following terms are commonly associated with Science Practice 3: claim, describe, design, explain, indicate, justify, predict, or state.

Samples of Evidence

1. **Science Practice 3**
    1. **Design an experiment** to verify Kirchhoff's voltage and junction rules.
    2. Analyze the experimental data for a complex circuit that includes voltage and current calculations leading a specific relationship in relation to Kirchhoff's rules.
    3. **Predict** the direction of a current in part of a complex circuit and **justify** using Kirchhoff's rules.
2. **SP3**

    The RC Circuits Lab #3 is a guided three-part inquiry-based investigation in which students **design and perform a series of investigations** of RC circuits in order to observe and analyze the relationships that exist when resistors, capacitors, and emf sources are arranged in different ways (series, parallel, or combinations).
3. **SP3**

    Students will **predict** and determine the direction of an induced current and must **justify** their answer using Lenz's law

Curricular Requirement 6

Students spend a minimum of 25% of instructional time engaged in hands-on laboratory investigations.

Required Evidence

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

Samples of Evidence

1. Students in this course are engaged in the inquiry-based laboratory work for more than 25% of the instructional time.
2. Students in this course are engaged in laboratory work more than 25% of the instructional time.
3. 25% of course time is spent engaged in hands-on labs.

Curricular Requirement 7

Students engage in hands-on laboratory investigations representative of the topics outlined in the AP Physics 2 Course and Exam Description.

Required Evidence

- ☐ The syllabus must include a title and brief description for each laboratory investigation. The labs listed should be representative of the topics outlined in the AP Physics 2 Course and Exam Description.

Samples of Evidence

1. Students are given a challenge. They design the experimental procedure, conduct the experiment, and analyze the experimental data. The course will include the following labs:
   - Thermal Conductivity Lab: Students design and conduct an experiment to determine the thermal conductivity of a material.
   - Static Electricity Interactions: Students investigate the behavior of electric charges, charging processes, and the distribution of charge on a conducting object.
   - Electric Field and Equipotential: Students 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.
   - Brightness Investigation: Students make predictions about the brightness of light bulbs in a variety of DC circuit configurations (series, parallel, and series-parallel) when some of the bulbs are removed.
   - Resistance and Resistivity: Students explore the microscopic factors that influence the electrical resistance of conducting materials. Students will investigate how geometry affects the resistance of ionic conductors.
   - Series and Parallel Circuits: Students wire three identical resistors in series, in parallel, and in a series-parallel combination to investigate the current and power generated in each combination.
   - Magnetic Field of Earth: Students measure the horizontal component of the Earth's magnetic field using solenoid and a compass.
   - Electromagnetic Induction: Students move a bar magnet in and out of a solenoid and observe the deflection of a galvanometer. They will examine the effects of a changing magnetic field by observing currents induced in a solenoid and determine whether the observations agree with the theory of electromagnetic induction and Lenz's law.
   - Lenses Exploration: Students measure the focal length of convex lenses and the focal length of concave lenses by combining them with a convex lens.
   - Mirrors Exploration: Students measure the focal length of various concave mirrors, and then calculate the magnification of the images.
   - Diffraction Lab: Students determine the width of a human hair with a laser pointer.
   - Rayleigh Scattering: Students investigate why the sky has a bluish tint, but at sunrise/sunset the sky is reddish.
   - Quantum Wave Interference: Students observe diffraction of light through both a single slit and a double slit and observe patterns of maxima and minima.
   - Photoelectric Effect: Students determine Planck's constant from data collected from a circuit with an LED color strip.
   - Radioactive Candy: Students simulate radioactive decay and determine half-life.

2. The labs are listed and described below. In these labs, students are given a general question to answer and will work in small groups of 2 or 3 to develop their own procedures. Students will have their procedures approved by the instructor before they begin.
    - Conservation of Charge: Charge an electroscope by induction and conduction
    - Coulomb's Law: Determine the charge on 2 charged mylar balloons
    - Electric Field: Investigate electric field using conductive paper and different charge distributions
    - Galvanometer/Ohm's Law: Make a tangential galvanometer, convert a galvanometer to an ammeter and calibrate it, convert a galvanometer to a voltmeter and calibrate it, and investigate Ohm's law to determine the resistance of an unknown resistor
    - Magnetic Field: Map the magnetic field of a magnet
    - Complex Circuits: Measure the equivalent resistance of multiple circuits
    - Wheatstone Bridge: Determine the resistivity of a wire and investigate a Wheatstone bridge
    - RC Circuits: Predict and experimentally determine the time constant for an RC circuit
    - Electric Motors: Construct a motor using a battery, a magnet, and a wire
    - Thermal Conductivity: Determine thermal conductivity of a material
    - Half-Life: Investigate half-lives with Skittles
    - Photelectric Effect: Determine the work function for different surfaces
    - Lens Lab: Investigate lenses and their image formation using an optical bench and various concave and convex lenses
    - Diffraction Lab: Determine the spacing between the lines on CDs, DVDs, and Blu-ray disks
    - Speed of Sound Lab: Determine the speed of sound using 2 different methods
    - Standing Waves: Determine the relationship between tension in a string and the wave speed
3.

    Unit 9: Thermodynamics

    Thermal Conductivity: Students will determine the thermal conductivity of a material by comparing the difference in temperature across one material to the difference in temperature across a second material of known thermal conductivity.

    Unit 10: Electric Force, Field, and Potential

    Investigate the relationship between potential difference across a charge capacitor and the number of revolutions made by a genecon.

    Unit 11: Electric Currents

    Investigate the relationship between currents and potential difference. Students will investigate the behavior of resistors in series, parallel, and series-parallel DC circuits. Students will use Ohm's law to calculate resistances from the current and potential difference measurements.

    Unit 12: Magnetism and Electromagnetism

    Magnetic Field of the Earth: Students will measure the horizontal component of the Earth's magnetic field using a solenoid and a compass.

Unit 13: Geometric Optics

What is the index of refraction of an acrylic block? Students will measure the angle of refraction for different given angles of incidences.

Unit 14: Waves, Sound, and Physical Optics

Speed of Sound: Determine the speed of sound with PVC pipes and graduated cylinders.

Unit 15: Modern Physics

Photoelectric Effect: Students will determine Planck's constant from data collected from a circuit with an LED color strip.

Curricular Requirement 8

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 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. After performing the lab, students are expected to submit a lab report electronically or maintain the lab notebook for each experimental activity.
2. Students are expected to keep a lab notebook where they will maintain a record of their laboratory work.
3. All investigations are reported in a laboratory journal. Students are expected to record their observations, data, and data analyses. Data analyses include identification of the sources and effects of experimental uncertainty, calculations, results and conclusions, and suggestions for further refinement of the experiment as appropriate.