

# AP<sup>®</sup> Physics 2: Algebra-Based

## About the Advanced Placement Program<sup>®</sup> (AP<sup>®</sup>)

The Advanced Placement Program<sup>®</sup> has enabled millions of students to take college-level courses and earn college credit, advanced placement, or both, while still in high school. AP Exams are given each year in May. Students who earn a qualifying score on an AP Exam are typically eligible, in college, to receive credit, placement into advanced courses, or both. Every aspect of AP course and exam development is the result of collaboration between AP teachers and college faculty. They work together to develop AP courses and exams, set scoring standards, and score the exams. College faculty review every AP teacher's course syllabus.

## AP Physics Program

The AP Program offers four physics courses:

**AP Physics 1: Algebra-Based** is a full-year course that is the equivalent of a first-semester introductory college course in algebra-based physics.

**AP Physics 2: Algebra-Based** is a full-year course, equivalent to a second-semester introductory college course in physics.

**AP Physics C: Mechanics** is a half-year course equivalent to a semester-long, introductory calculus-based college course.

**AP Physics C: Electricity and Magnetism**, a half-year course following Physics C: Mechanics, is equivalent to a semester-long, introductory calculus-based college course.

## AP Physics 2 Course Overview

AP Physics 2 is an algebra-based, introductory college-level physics course. Students cultivate their understanding of physics through inquiry-based investigations as they explore these topics: fluids; thermodynamics; electrical force, field, and potential; electric circuits; magnetism and electromagnetic induction; geometric and physical optics; and quantum, atomic, and nuclear physics.

### PREREQUISITES

Students should have completed AP Physics 1 or a comparable introductory physics course and should have taken or be concurrently taking pre-calculus or an equivalent course.

### LABORATORY REQUIREMENT

This course requires that 25% of 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 the science practices. Colleges may require students to present their laboratory materials from AP science courses before granting college credit for laboratory work, so students are encouraged to retain their notebooks, reports, and other materials.

## AP Physics 2 Course Content

The course content is organized into seven commonly taught units, which have been arranged in the following suggested, logical sequence:

- **Unit 1:** Fluids

- **Unit 2:** Thermodynamics
- **Unit 3:** Electric Force, Field, and Potential
- **Unit 4:** Electric Circuits
- **Unit 5:** Magnetism and Electromagnetic Induction
- **Unit 6:** Geometric and Physical Optics
- **Unit 7:** Quantum, Atomic, and Nuclear Physics

Each unit is broken down into teachable segments called topics. In addition, the following big ideas serve as the foundation of the course, enabling students to create meaningful connections among concepts and develop deeper conceptual understanding:

- **Systems:** Objects and systems have properties such as mass and charge.
- **Fields:** Fields existing in space can be used to explain interactions.
- **Force Interactions:** The interactions of an object with other objects can be described by forces.
- **Change:** Interactions between systems can result in changes in those systems.
- **Conservation:** Changes that occur as a result of interactions are constrained by conservation laws.
- **Waves:** Waves can transfer energy and momentum from one location to another without the permanent transfer of mass.
- **Probability:** The mathematics of probability can be used to describe the behavior of complex systems.

## AP Physics 2 Science Practices

The following science practices describe what skills students should develop during the course:

- **Modeling:** Use representations and models to communicate scientific phenomena and solve scientific problems.
- **Mathematical Routines:** Use mathematics appropriately.
- **Scientific Questioning:** Engage in scientific questioning to extend thinking or guide investigations.
- **Experimental Methods:** Plan and implement data collection strategies in relation to a particular scientific question.
- **Data Analysis:** Perform data analysis and evaluation of evidence.
- **Argumentation:** Work with scientific explanations and theories.
- **Making Connections:** Connect and relate knowledge across various scales, concepts, and representations in and across domains.

## AP Physics 2 Exam Structure

AP PHYSICS 2 EXAM: 3 HOURS

### Assessment Overview

The AP Physics 2 Exam assesses student application of the science practices and understanding of the course learning objectives outlined in the course framework. The exam is 3 hours long and includes 50 multiple-choice questions and 4 free-response questions. The four free-response questions may appear in any order. A four-function, scientific, or graphing calculator is allowed on both sections of the exam.

### Format of Assessment

**Section I:** Multiple-choice | 50 Questions | 90 Minutes | 50% of Exam Score

- 45 single-select multiple-choice questions (discrete or in sets).
- 5 multiple-select multiple-choice items (all discrete).

**Section II:** Free-response | 4 Questions | 90 Minutes | 50% of Exam Score

- Question 1: Experimental Design (**12 points**).
- Question 2: Qualitative/Quantitative Translation (**12 points**).
- Question 3: Paragraph Argument Short Answer (**10 points**).
- Questions 4: Short Answer Question (**10 points each**).

## Exam Components

### Sample Multiple-Choice Question

A student writes the following information for a process that involves a fixed quantity of ideal gas.

$$W = -P\Delta V$$

$$\Delta U = Q + W$$

$$P = 2.0 \times 10^5 \text{ Pa}$$

$$\Delta V = -2.0 \times 10^{-3} \text{ m}^3$$

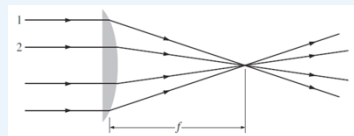
$$\Delta U = -600 \text{ J}$$

Which of the following descriptions best represents the process?

- (A) The gas expands at a constant pressure of 200 kPa.
- (B) The gas is cooled at constant volume until its pressure falls to 200 kPa.
- (C) The gas is compressed at a constant pressure of 200 kPa.
- (D) The gas is heated and its pressure increases at constant volume.

Correct Answer: C

### Sample Free-Response Question: Experimental Design



**Quantitative/Qualitative Translation:** The figure at left represents a glass lens that has one flat surface and one curved surface. After incoming parallel rays pass through the lens, the rays pass through a focal point.

- (A) The rays undergo refraction and change direction at the right surface of the lens, as shown. Explain why the angle of refraction of ray 1 is greater than that of ray 2.
- (B) The index of refraction of the glass is  $n_{\text{glass}}$ , and the radius of curvature of the lens's right edge is  $R$ . (The radius of curvature is the radius of the sphere of which that edge is a part. A smaller  $R$  corresponds to a lens that curves more). A teacher who wants to test a class's understanding about lenses asks the students if the equation  $f = n_{\text{glass}}R$  makes sense for the focal length of the lens in air. Is the teacher's equation reasonable for determination of the focal length? Qualitatively explain your reasoning, making sure you address the dependence of the focal length on both  $R$  and  $n_{\text{glass}}$ .
- (C) An object is placed a distance  $f/2$  (half of the focal length) to the left of the lens. On which side of the lens does the image form, and what is its distance from the lens in terms of  $f$ ? Justify your answer. (Assume this is a thin lens.)
- (D) The lens is now placed in water, which has an index of refraction that is greater than air but less than the glass. Indicate below whether the new focal length is greater than, less than, or equal to the focal length  $f$  in air.

- \_\_\_ Greater than in air
- \_\_\_ Less than in air
- \_\_\_ The same as in air

Justify your answer qualitatively, with no equations or calculations.