# AP® Physics C: Electricity and Magnetism

## About the Advanced Placement Program® (AP®)

The Advanced Placement Program® 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 C: Electricity and Magnetism Course Overview

AP Physics C: Electricity and Magnetism is a calculus-based, college-level physics course, especially appropriate for students planning to specialize or major in physical science or engineering. The course explores topics such as electrostatics; conductors, capacitors, and dielectrics; electric circuits; magnetic fields; and electromagnetism. Introductory differential and integral calculus are used throughout the course.

**PREREQUISITES**

Students should have taken or be concurrently taking calculus.

**LABORATORY REQUIREMENT**

AP Physics C: Electricity and Magnetism should include a hands-on laboratory component comparable to a semester-long introductory college-level physics laboratory. Students should spend a minimum of 25% of instructional time engaged in hands-on laboratory work. Students ask questions, make observations and predictions, design experiments, analyze data, and construct arguments in a collaborative setting, where they direct and monitor their progress. Each student should complete a lab notebook or portfolio of lab reports.

## AP Physics C: Electricity and Magnetism Course Content

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

- **Unit 1:** Electrostatics
- **Unit 2:** Conductors, Capacitors, Dielectrics
- **Unit 3:** Electric Circuits
- **Unit 4:** Magnetic Fields
- **Unit 5:** Electromagnetism

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:

- **Change:** Interactions produce changes in motion.
- **Force Interactions:** Forces characterize interactions between objects or systems.
- **Fields:** Fields predict and describe interactions.
- **Conservation:** Conservation laws constrain interactions.

## AP Physics C: Electricity and Magnetism Science Practices

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

- **Visual Representations:** Analyze and/or use [nonnarrative/non-mathematical] representations of physical situations, excluding graphs.
- **Question and Method:** Determine scientific questions and methods.
- **Representing Data and Phenomena:** Create visual representations or models of physical situations.
- **Data Analysis:** Analyze quantitative data represented in graphs.
- **Theoretical Relationships:** Determine the effects on a quantity when another quantity or the physical situation changes.
- **Mathematical Routines:** Solve problems of physical situations using mathematical relationships.
- **Argumentation:** Develop an explanation or scientific argument.

## AP Physics C: Electricity and Magnetism Exam Structure

AP PHYSICS C: ELECTRICITY AND MAGNETISM EXAM:
1 HOUR, 30 MINUTES

### Assessment Overview

The AP Physics C: Electricity and Magnetism Exam assesses student application of the science practices and understanding of the learning objectives outlined in the course framework. The exam is 1 hour and 30 minutes long and includes 35 multiple-choice questions and 3 free-response questions. A four-function, scientific, or graphing calculator is allowed on both sections of the exam.

### Format of Assessment

**Section I:** Multiple-choice | 35 Questions | 45 Minutes | 50% of Exam Score

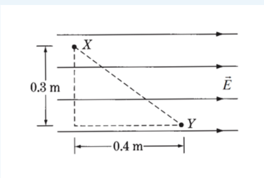
- Science Practices 1, 2, 4, 5, 6, and 7 are assessed.
- Science Practice 3 is not assessed.

**Section II:** Free-response | 3 Questions | 45 Minutes | 50% of Exam Score

- All Science Practices are assessed.
- One of the three questions will include an experimental or lab-based component.

## Exam Components

### Sample Multiple-Choice Question

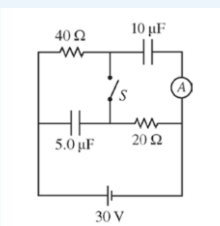



A uniform electric field **E** of magnitude 6,000 V/m exists in a region of space as shown above. What is the electric potential difference, $V_X - V_Y$, between points $X$ and $Y$?

(a) -12,000 V
(b) 0 V
(c) 1,800 V
(d) 2,400 V
(e) 3,000 V

Correct Answer: D

### Sample Free-Response Question




In the circuit illustrated above, switch $S$ is initially open and the battery has been connected for a long time.

(a) What is the steady-state current through the ammeter?
(b) Calculate the charge on the 10 μF capacitor.
(c) Calculate the energy stored in the 5.0 μF capacitor. The switch is now closed, and the circuit comes to a new steady state.
(d) Calculate the steady-state current through the battery.
(e) Calculate the final charge on the 5.0 μF capacitor.
(f) Calculate the energy dissipated as heat in the 40 ohm resistor in one minute once the circuit has reached steady state.