AP® Physics C – Electricity and Magnetism

Syllabus 3

School Calendar and Schedule

The academic year runs from mid-August until late May. The class meets for 53 minutes each day except Wednesday, when it meets for 35 minutes.

Student Prerequisites

All students must have had a prior physics course such as Physics B or general physics and must be co-enrolled in integral calculus, as calculus is used extensively throughout the course. **[C6]**

C6—Introductory differential and integral calculus is used throughout the course.

Textbooks

The textbook distributed to the students is *Physics for Scientists and Engineers* by Serway and Beichner, 5th edition, 2000. A classroom set of Halliday and Resnick, 4th edition, is available for additional problems. Teacher-generated notes are also available.

Technology

An electronic student response system is used for daily review. Laptop computers equipped with data acquisition hardware and software is available for laboratory use. Wireless access to the Internet is provided in the laboratory. The instructor maintains a website for student use from home.

C7—The course utilizes guided inquiry and student-centered learning to foster the development of critical thinking skills.

Assessments

In addition to the assessments detailed in each unit, a summative exam consisting of multiple-choice and free-response components is given at the end of the unit. Frequent quizzes for formative assessment are given.

Homework is graded for completion and spot-checked for correctness.

There is a major emphasis on lab work. Labs are usually designed for the students to discover concepts with a minimum of teacher input. Students are encouraged and guided to develop their own hypotheses, experiments, and conclusions. Results are often shared between students in order to discuss their conclusions and error analysis. **[C7]** Hands-on laboratory experiments comprise 20 percent of class time. Additional time is spent on computer simulation–based laboratories. Lab reports are required for all labs and must be collected by the student in a lab notebook. **[C8]**

C8—The course includes a laboratory component comparable to a semester-long, college-level physics laboratory. Students spend a minimum of 20 percent of instructional time engaged in laboratory work. A hands-on laboratory component is required. Each student should complete a lab notebook or portfolio of lab reports. Note: Online course providers utilizing virtual labs (simulations rather than hands-on) should submit their laboratory materials for the audit. If these lab materials are determined to develop the skills and learning objectives of hands-on labs, then courses that use these labs may receive authorization to use the "AP" designation. Online science courses authorized to use the "AP" designation will be posted on the AP Central® website.

Inquiry-based formative assessment exercises are carried out by small groups of students each week.

In April, students take a full-length practice AP Exam.

Unit 1: The Electric Field (1 week) [C1]

C1—Electrostatics.

Objectives

Charge and Coulomb's Law, the electric field, point charge distributions, continuous charge distributions, motion of charged particles in an electric field

Student Activities

Electroscope lab: Construction and discovery, among other things, of how to charge the electroscope (+ and -).

Simulation lab: Using the E-field plotter program, students construct point charge distributions and examine the resulting computer-generated electric field.

Assessments

- Written procedure and informal assessment of results

Unit 2: Gauss's Law (1 ½ weeks) [C1]

Objectives

Electric flux, Gauss's Law (general), Gauss's Law and various continuous charge distributions

Student Activities

Students derive electric fields associated with charged conductors and non-conductors and produce appropriate graphs.

Assessments

- Worksheet graded

Unit 3: Electric Potential (1 ½ weeks) [C1]

Objectives

Electric potential and potential difference, potential differences in uniform electric fields, potential and point charges, potential and continuous charge distributions

Student Activities

Simulation lab: Using the E-field plotter or another computer program, students construct charge distributions consisting of point charges, and examine the resulting computer-generated potential surfaces.

AP Physics Lab Guide Experiment: Electric Power and Batteries (1 and 2) **[C6]**

C6—Introductory differential and integral calculus is used throughout the course.

Students derive electric potentials for continuous charge distributions and produce appropriate graphs.

Assessments

- Informal assessment and worksheet graded

Unit 4: Capacitance (1 week) [C2]

C2—Conductors, capacitors, and dielectrics.

Objectives

Capacitance, Gauss's Law and capacitance, combination of capacitors, energy stored in capacitors, Dielectrics

Student Activities

The procedure for using Gauss's Law to analyze parallel plate, and cylindrical and spherical capacitors is developed and practiced.

Capacitor lab: Using two identical commercial capacitors and one D-cell, create series and parallel circuits to charge the capacitors. Measure the voltage across the plates of each capacitor when connected to the cell and when disconnected. Discharge the capacitors through lightbulbs for a qualitative assessment of energy stored.

Assessments

- Worksheet completion
- Lab report showing circuits and describing results

Unit 5: DC Circuits (2 weeks) [C3]

C3—Electric circuits.

Objectives

Ohm's Law, resistivity, electrical power, electromotive force and internal resistance, equivalent resistance, Kirchhoff's rules, RC circuits

Student Activities

AP Physics Lab Guide Experiment: Ohm's Law (1 and 2) [C6]

C6—Introductory differential and integral calculus is used throughout the course.

Resistivity lab: In this inquiry-based lab, students construct resistors from carbonized paper. They measure resistance and calculate resistivity given the resistor dimensions.

Multiloop circuit lab: Students construct multiloop circuits or are provided with simulations of such circuits. Programmable calculators are used to solve equations simultaneously to analyze the current in each loop.

AP Physics Lab Guide Experiment:

RC Time Constant: Students construct RC circuits with known resistors and capacitors. Computers with data acquisition hardware and software are used to analyze the circuit. Time constant and amount of charge stored on the capacitor must be obtainable from graphs generated. [C6]

Assessments

- Lab reports with circuit diagrams and calculations

Unit 6: Magnetostatics (2 weeks) [C4]

C4—Magnetic fields.

Objectives

Magnetic force on moving charges and currents, path of moving charge in a magnetic field, Hall effect, Biot–Savart law, parallel conductors, Ampere's law, solenoids and toroids

Student Activities

Magnetic force lab: Students construct a device that shows the existence of a magnetic force on a current-carrying wire using common lab equipment.

Hall effect lab: Students show the Hall effect using computers and data acquisition technology.

Solenoid lab: The measurement of magnetic field inside a solenoid and its variation with current. Students calculate how many layers of wire are wrapped around the solenoid core.

Assessments

- Assessment of student demo and explanation during activity
- Lab reports containing data table and calculations

Unit 7: Magnetic Induction (2 weeks) [C5]

C5—Electromagnetism.

Objectives

Magnetic flux, Gauss's law of magnetism, Faraday's law of induction, Lenz's law, induced *emf* and electric fields, generators and motors, Maxwell's equations

Student Activities

Faraday's Law of Induction lab: Students are provided with two solenoids (one of which fits inside the other), an iron bar, computers, and voltage sensors to illustrate Faraday's Law.

Motor/generator presentation lab: Students dissect a small electric motor or generator and, using digital photographs or other diagrams, produce a PowerPoint presentation describing how it works.

Assessments

- Lab report of data and explanation of results
- Assessment of PowerPoint presentation

Unit: Inductance (1.5 weeks) [C5]

Objectives

Self-inductance, RL circuits, energy in magnetic fields, mutual inductance, electronic oscillations in LC circuits, the RLC circuit

Student Activities

Differential equation worksheet: Differential equations for electronic oscillator; similarities with mechanical oscillators

Synthesized music presentation lab: Students do an Internet investigation and create a PowerPoint lesson describing how electronic music is produced. Alternatively, they may dissect a cheap piece of electronic equipment and describe how it works.

Assessments

- Worksheet completion
- Assessment of presentation