AP Physics C: Electricity & Magnetism

Course Description

AP Physics provides a systematic introduction to the main principles of physics at the freshman college level, and follows Physics C format. Physics C provides a systematic introduction to the main principles of Physics and emphasizes the development of problem-solving ability. Strong emphasis is placed on solving a variety of challenging problems, with fundamental calculus use being introduced. The subject matter covers Electricity and Magnetism, both in theory and practice with equal emphasis on these two areas. The laboratory components of the course offer many experiences dealing with advanced topics and skills while using both simple and sophisticated equipment. This course runs sequentially with AP Physics C: Mechanics.

Additionally, other learning opportunities exist for students beyond the classroom. All students participate in our annual Fairfield High School Physics Olympics competition in which students compete in small groups and as a class. We have modeled this event after the AAPT Physics Olympics, but have included experiments of our own design. These activities have been created to provide a fun and safe learning event for students, and will also help them review for final exams. Centered on key physics concepts, the activities will engage students in hands-on, minds-on experiments and provide a culminating experience for the students that they won't soon forget. We also take a group of students to compete at Yale University's annual Physics Olympics. Also, guest lecturers from various institutions have been invited in to speak with students, and field trips to museums have been arranged.

Instructional Materials:

Primary Text: Giancoli; *Physics for Scientists and Engineers with Modern Physics,* Prentice Hall, 4th Edition, 2007

Secondary Text: Cutnell & Johnson, *Physics*, Wiley, 6th Edition, 2004

Technology: Computers equipped with Vernier probes and data acquisition and analysis software; Classic apparatus (e.g. Millikan Oil Drop, Ripple Tanks, Michelson Interferometer, Franck-Hertz); TI Graphing calculators; Department website:

Overview: The course is conducted within a four marking period school year and meets five times per week. Three of those periods are 45 minute classes, and the other two are 90 minute extended lab periods, resulting in approximately 315 minutes of instructional time per week.

Lecture and discussion are used in conjunction with one another to aid in the development of problem-solving skills, as well as an understanding of the placement of concepts within a theoretical framework, and the historical perspective on the science of physics and experimental science.
Guided learning and inquiry, interactive lecture demonstrations, and student-centered instruction, foster the development of critical thinking skills. Developmental problem solving techniques, critical thinking skills, and emphasis on sound experimentation skills are also prominent features of the course.

Students are given the opportunity to investigate fundamental concepts in a laboratory environment through hands-on and student-centered experiments. Two double-lab periods are allotted for lab, and account for over ~~nearly~~half of the instructional time per week.

Students engage in the setup, development, and conduction of experiments. Students conduct investigations utilizing a wide variety of physical material including standard physics equipment as well as more advanced apparatus such as Frank-Hertz and Millikan's Oil Drop devices. Computer probes and other measuring devices like oscilloscopes and meters are used in the collection of data. Their analysis of data is compiled on-site and worked into comprehensive reports with attention to sound scientific procedures. Students keep a record of their lab work in an appropriate lab notebook.

Laboratory List: Two double-lab periods are allotted for lab, and account for over half of the instructional time per week. The following list includes open-ended investigations, physical law confirmation experiments, measurements of fundamental constants, and practical application of theory.

Electricity & Magnetism

1. Ohm's Law

2. Series & Parallel Resistor Combinations
3. Kirchhoff's Laws in Complex Circuits
4. E-Field Mapping
5. Capacitor Dielectric Properties
6. RC-Circuit Behavior
7. q/m ratio of Electron
8. Magnetic Field Strength Near Wires
9. Magnetic Forces: Current Balance
10. Millikan's Oil Drop Experiment
11. Rutherford Gold-Foil Simulation
12. Transformer Ratios

Course Outline of Topics

I. <u>Electrical Physics</u>

a. **Electrostatics (3 weeks)**
   i. Electrostatic Phenomena
      1. Charged Conductor Effects: Franklin's Analysis
      2. Charge Carriers: Thompson's Discovery
   ii. Electrical Forces
      1. Force due to Point Charges: Coulomb's Law
   iii. Electrical Energy
      1. Potential Differences (Voltage)
      2. Potential of Charged Conductors
      3. Capacitors & Dielectrics

b. **Current & Circuitry (3 weeks)**
   i. Ohm's Law
   ii. Kirchhoff's Rules
   iii. RC-Circuits

c. **Electrical Fields (2 weeks)**
   i. Electrostatic Phenomena
      1. Faraday's Analysis of Conductor Fields
   ii. Electrical Forces & Field Strength
      1. Field Strength due to Point Charges
      2. Calculus Analysis of Charge Distributions
      3. Gauss's Law
   iii. Electrical Energy & Potential
      1. Field Potential due to Point Charges
      2. Calculus Analysis of Charge Distributions

3. Equi-potentials
4. Field Strength as Derivative of Potential
5. Capacitor Fields

II. <u>Magnetic Physics</u>

a. **Magnetic Matter (1 week)**
   i. Magneto-static Phenomena
      1. Magnetic Poles: Gilbert's Analysis
      2. Ferromagnetism

b. **Magnetic Fields (4 weeks)**
   i. Particles in Fields: Circular Motion
   ii. Particles in Fields: Lorentz Force
   iii. Motors
   iv. Calculus Analysis of Current Distributions: Biot-Savart Law
   v. Ampere's Law

c. **Electro-magnetic Induction (4 weeks)**
   i. Generators
   ii. Lenz's Law
   iii. Faraday's Law
   iv. Transformers
   v. Induction Circuits
   vi. Maxwell's Equations

III. **<u>21st Century Physics</u> (3 weeks)**

a. General Relativity

b. Cosmology

c. Particle Physics