This course prepares students for the AP® Exams, Physics C: Mechanics and Physics C: Electricity & Magnetism.

The Mechanics portion will provide instruction in each of the following six content areas assessed on the AP® Exam: Kinematics; Newton's laws of motion; work, energy, and power; systems of particles and linear momentum; circular motion and rotation; and oscillations and gravitation.

The Electricity & Magnetism portion will provide instruction in each of the following five content areas assessed on the AP® Exam: Electrostatics; conductors, capacitors, and dielectrics; electric circuits; magnetic fields; and electromagnetism.

Additional topics of modern physics are also included in the course curriculum.

The course will utilize guided inquiry and student-centered learning to foster the development of critical-thinking skills. It will use introductory differential and integral calculus throughout the course. This course meets for three 44-minute periods per week, plus two 90-minute lab periods.

Prerequisites: Students who have successfully completed Honors Physics with a "B" minimum and have already completed or are taking concurrently AP® Calculus or Calculus.

Text: *Fundamentals of Physics, Extended*, 9th ed., by Halliday, Resnick, and Walker, 2010, John Wiley & Sons. This is a standard text for calculus-based physics teaching at both the AP® and university levels. The text will be supplemented by additional material when appropriate.

Teaching Strategies: Students will be assigned all of the end-of-chapter conceptual questions for the chapters covered. These will be followed by student-centered roundtable discussions to assure understanding by all. Students will also proceed, in groups and individually, to work through an intense selection of the end-of-chapter problems. Although all students will be expected to solve the same problems, each will have his or her own set of randomized numbers through use of an online assignment service. The problem assignments also include a writing component.

Laboratory Work

The laboratory component of this course constitutes at least 20% of the class time. Lab assignments are generally set up in the form of guided inquiry – using data to answer a research question. Differential and integral calculus will be a part of the laboratory analysis.

Students will frequently have the laboratory goal of developing a mathematical model – i.e. a physics formula – based on their experimental data. Alternatively, they may be seeking to apply formulas learned in the course to their data to make a testable prediction. The prediction is then tested in a second hands-on activity set up as a contest, for example, to strike a target with a projectile or forecast the time for an object to traverse a course. Finally, some of the labs culminate in a design problem, such as a launching mechanism for a roller coaster.

From the laboratory work, students will develop a portfolio of written lab reports. These reports will usually be completed as a collaborative learning activity, including both individual and group accountability.

Curriculum

I. Newtonian Mechanics

Unit A. Kinematics (including vectors, vector algebra, components of vectors, coordinate systems, displacement, velocity, and acceleration)
Time Frame: 2 weeks

1. Motion in one dimension
2. Motion in two dimensions, including projectile motion

Textbook Chapters: 2, 3, 4
Labs: Mathematical modeling from data – circumference of a circle; Kinematics of sliding blocks; Projectile motion with video; Projectile motion with target; Record-player kinematics.

Unit B. Newton's laws of motion
Time Frame: 3 weeks

1. Static equilibrium (first law)
2. Dynamics of a single particle (second law)
3. Systems of two or more objects (third law)

Textbook Chapters: 5, 6, 12
Labs: Equilibrium balance; Three-dimensional dangling equilibrium; Coffee filter drop and terminal velocity; Measurement and modeling of friction; Inclined plane with soft landing.

Unit C. Work, energy, power
Time Frame: 2 weeks

1. Work and work–energy theorem
2. Forces and potential energy
3. Conservation of energy
4. Power

Textbook Chapters: 7, 8
Labs: Bungee-jump conservation of energy; Modeling elastic force and work; Flaming razor blade (pendulum-launched projectile).

Unit D. Systems of particles, linear momentum
Time Frame: 2 weeks
1. Center of mass
2. Impulse and momentum
3. Conservation of linear momentum, collisions

Textbook Chapters: 9
Labs: Ballistic pendulum and conservation of momentum.

Unit E. Circular motion and rotation
Time Frame: 3 weeks
1. Uniform circular motion
2. Torque and rotational statics
3. Rotational kinematics and dynamics
4. Angular momentum and its conservation

Textbook Chapters: 10, 11
Labs: Rolling downhill; Numerical integration and rotational inertia.

Unit F. Oscillations and gravitation
Time Frame: 2 weeks
1. Simple harmonic motion (dynamics and energy relationships)
2. Mass on a spring
3. Pendulum and other oscillations
4. Newton's law of gravity
5. Orbits of planets and satellites
    a. Circular
    b. General

Textbook Chapters: 13, 15
Labs: Spring-oscillator clock; Orbital-period modeling; Gravitational simulator.

II. Electricity & Magnetism

Unit G. Electrostatics
Time Frame: 5 weeks
1. Charge and Coulomb's law
2. Electric field and electric potential (including point charges)
3. Gauss's law
4. Fields and potentials of other charge distributions

Textbook Chapters: 21, 22, 23, 24
Labs: Electric charges & force; Electric field lines from distributed charges; Two-dimensional potential mapping.

Unit H. Conductors, capacitors, dielectrics
Time Frame: 1 week
1. Electrostatics with conductors
2. Capacitors

a. Capacitance
b. Parallel plate
c. Spherical and cylindrical

3. Dielectrics

Textbook Chapter: 25
Labs: Capacitors.

Unit I. Electric Circuits
Time Frame: 2 weeks

1. Current, resistance, power
2. Steady-state direct current circuits with batteries and resistors only
3. Capacitors in circuits
    a. Steady state
    b. Transients in RC circuits

Textbook Chapters: 26, 27
Labs: Developing Ohm's law; Series and parallel resistors; Electric power and batteries; Internal resistances; RC circuits.

Unit J. Magnetic Fields
Time Frame: 2 weeks

1. Forces on moving charges in magnetic fields
2. Forces on current-carrying wires in magnetic fields
3. Fields of long current-carrying wires
4. Biot-Savart law and Ampere's law

Textbook Chapters: 28, 29
Labs: Electromagnetic-force simulator; Magnetic field of Earth.

Unit K. Electromagnetism
Time Frame: 2 weeks

1. Electromagnetic induction (including Faraday's law and Lenz's law)
2. Inductance (including LR and LC circuits)
3. Maxwell's equations

Textbook Chapters: 30, 32
Labs: LR circuits.

III. AP Exam Preparation
Time Frame: 5 weeks

IV. Other Topics

Unit L. Modern Physics
Time Frame: 4 weeks

1. Relativity
2. Nuclear physics
3. Energy from the nucleus

Textbook Chapters: 37, 42, 43

Labs: Minkowski relativity plots; Radioactive decay simulator; Radiation inverse-square relationship.