AP® Physics B

Syllabus 2

Course Overview

Class meets every day 90 min/day for 180 days. The school year starts at the beginning of August and ends in mid-May, so there is little time left after the AP exam. Whatever time remains is spent covering topics of the students' choosing, but it usually ends up being Special Relativity.
Ninety minutes a day for a full year allows students not only extended opportunities for lab work and cooperative learning groups, but enough time to get into the entire B curriculum and review for the AP exam.

Peer-coaching, peer-teaching and peer-review are an essential part of our course. Students are encouraged from the first day to create or join a study group to work with in and out of class – nobody works in a vacuum.

Course goals include developing each student's intuition, creativity and investigative skills to do the following: (abbreviated from the 2006-07 College Board AP Physics Course Description)

- Read, understand, and interpret physical information.
- Use the scientific method to analyze a particular physical phenomenon or problem.
- Use basic mathematical reasoning in a physical situation or problem.
- Perform experiments, interpret the results of observations and communicate results, including uncertainty assessment. **[C6]**

C6 - Evidence of Curricular Requirement: The course utilizes guided inquiry and student-centered learning to foster the development of critical thinking skills.

The course consists of 12 units (italicized in the Course Outline that follows), with a test at the completion of each unit. Units generally begin with an essential question and a demonstration or two to allow the students to hypothesize and discover the physical relationships. Homework is assigned every night (mostly from the primary textbook) and peer-reviewed the next day. Labs are done at a time to best reinforce the relationships and concepts currently being studied. Informal assessment is done on a daily basis with neighbor-mini-conferences and on-the-fly questions using the Personal Response System (PRS), an interactive assessment system which gives immediate feedback, allowing restructuring the day's activities to suit the class's progress. Throughout the course, emphasis is placed more on the concepts and method of solution or analysis, and less on the actual final product or answer.

As we get closer to May, the emphasis shifts towards preparing for the AP Physics exam by reviewing released exams, past free-response questions and test-taking skills.

Textbooks

Primary textbook:

Giancoli, D. (2002). *Physics: Principles with Applications,* 5th rev. ed. Upper Saddle River, NJ: Prentice-Hall. ISBN 0-13-061143-3

Secondary textbook (used to be primary textbook):

Sears, F., Zemansky, M., & Young, H. (1991). *College Physics*, 7th ed. Boston, MA: Addison-Wesley. ISBN 0-201-17285-2

Course Outline

INTRODUCTION

Unit 1: Math and Data Review (2 weeks)

A. Algebra review
B. Data collection and analysis
C. Vector addition
  1. Graphical methods
  2. Algebraic methods

I. NEWTONIAN MECHANICS **[C1]**

C1 - Evidence of Curricular Requirement: Newtonian mechanics

Unit 2: Kinematics (2.5 weeks)

A. Motion in One Dimension
  1. Position-time and velocity-time graphs
  2. Equations of motion under constant acceleration
B. Motion in Two Dimensions
  1. Projectiles
  2. Circular motion

Unit 3: Newton's Laws (2.5 weeks)

A. Static Equilibrium (First Law)
  1. First Condition – translational equilibrium
  2. Second Condition – rotational equilibrium (torque)
B. Dynamics of a Single Body (Second Law)
C. Systems of Two or More Bodies (Third Law)
D. Gravitation
E. Applications
  1. Inclined planes
  2. Atwood's machines and their modifications

3. Static and kinetic friction
4. Horizontal and vertical circles
5. Planetary motion

Unit 4: Work, Energy, Power & Momentum (2.5 weeks)

A. Work and Work-Kinetic Energy Theorem
B. Conservative Forces and Potential Energy
  1. Gravity
  2. Springs
C. Conservation of Mechanical Energy
D. Power
E. Simple Harmonic Motion
  1. Springs and Pendulums
  2. Energies of SHM
F. Momentum
  1. Impulse-Momentum Theorem
  2. Conservation of Linear Momentum and Collisions
    a. Inelastic, completely inelastic and perfectly elastic collisions
    b. Two-dimensional collisions
  3. Conservation of Angular Momentum (for a point mass)

II. FLUIDS MECHANICS & THERMAL PHYSICS [C2]

C2 - Evidence of Curricular Requirement: Fluid mechanics and thermal physics

Unit 5: Fluid Mechanics (2 weeks)

A. Density and pressure
  1. Density and specific gravity
  2. Pressure as a function of depth
  3. Pascal's Law
B. Buoyancy – Archimedes' Principle
C. Fluid flow continuity
D. Bernoulli's equation
E. Applications
  1. Hydraulics
  2. Effects of atmosphere on weather, baseballs, etc.
  3. Flotation and SCUBA
  4. Flight
  5. Plumbing

Unit 6: Thermal Physics (2.5 weeks)

A. Temperature and Thermal Effects
  1. Mechanical equivalent of heat
  2. Heat transfer and thermal expansion
    a. linear expansion of solids
    b. volume expansion of solids and liquids
  3. Calorimetry
B. Kinetic Theory, Ideal Gases & Gas Laws
C. Thermodynamics
  1. Processes and PV diagrams

a. isothermal
b. isobaric
c. isometric
d. adiabatic
e. cyclic
2. First Law of Thermodynamics
a. Internal energy
b. Energy conservation
c. Molar heat capacity of a gas
3. Second Law of Thermodynamics
a. Directions of processes
b. Entropy
4. Heat Engines and Refrigerators

III. ELECTRICITY & MAGNETISM [C3]

C3 - Evidence of Curricular Requirement: Electricity and magnetism

Unit 7: Electrostatics (2.5 weeks)

A. Coulomb's Law
B. Electric Fields and Gauss' Law
C. Electric Potential Energy and Electric Potential
E. Capacitance
1. Graphical description of capacitance (charge vs. voltage)
a. slope – capacitance
b. area – energy stored
2. Capacitors in series and parallel
D. Applications
1. Point charge distributions
2. Parallel plates
3. Cathode ray tubes
4. Millikan Oil Drop Experiment
5. Condensers, uninterruptible power supplies, tone controls

Unit 8: Current Electricity (2 weeks)

C. Electric Circuits
1. Emf, Current, Resistance and Power
2. DC circuits
a. Series and parallel circuits
b. Batteries and internal resistance
c. Ohm's Law and Kirchhoff's rules
d. Voltmeters and ammeters
e. Capacitors in circuits (RC circuits)
3. Applications

Unit 9: Electromagnetism (2 weeks)

D. Magnetostatics
1. Force of a magnetic field on a moving charge
2. Force of a magnetic field on a current carrying wire
3. Torque on a current carrying loop

4. Magnetic fields due to straight and coiled wires

E. Electromagnetic Induction

1. Magnetic flux
2. Faraday's Law and Lenz's Law

F. Applications

1. Mass spectrometers
2. Motors
3. Generators
4. Particle colliders

IV. Waves & Optics [C4]

C4 - Evidence of Curricular Requirement: Waves and optics

Unit 10: Wave motion and Sound (1.5 weeks)

A. Description and characteristics of waves

B. Standing waves and harmonics

a. Waves on a string
b. Waves in a tube (open and closed)

C. The Doppler Effect (in one dimension)

D. Sound intensity, power and relative sound intensity

E. Musical applications

Unit 11: Optics (2.5 weeks)

A. Geometric Optics

1. Reflection, Refraction and Snell's Law
   a. Reflection and refraction at a plane surface
   b. Total internal reflection
2. Images formed by mirrors
3. Images formed by lenses
4. Ray Diagrams and the thin lens/mirror equation

B. Physical Optics

1. The electromagnetic spectrum
2. Interference and path difference
3. Interference effects
   a. Single slit
   b. Double slit
   c. Diffraction grating
   d. Thin film

V. Atomic & Nuclear Physics [C5]

C5 - Evidence of Curricular Requirement: Atomic and nuclear physics

Unit 12: Modern Physics (2.5 weeks)

A. Atomic Physics and Quantum Effects

1. Photons and the Photoelectric effect
2. X-ray production
3. Electron energy levels
4. Compton scattering
5. Wave nature of matter

B. Nuclear Physics
1. Atomic mass, mass number, atomic number
2. Mass defect and nuclear binding energy
3. Nuclear processes
    a. modes of radioactive decay (α, β, γ)
    b. fission
    c. fusion
4. Mass-Energy Equivalence and Conservation of Mass and Energy

Labs

Labs are generally open-ended. Students are given an objective, e.g. "Determine the coefficient of static friction of wood on wood", and standard materials – string, ruler, protractor, mass set, light pulley, etc. Students are allowed to create their own experimental design, but ultimately most of the lab designs must lead to the collection of data which can be analyzed through graphical methods. Students must graph by hand using a ruler and graph paper, but are encouraged to check their work with a spreadsheet or statistical functions on their graphing calculators. Students work in pairs, but each student must submit a lab report which is turned in the day after the conclusion of each activity, then graded and returned. The report design and format is left up to the student, but generally each report should include:

- a statement of the problem,
- an hypothesis,
- a discussion or outline of how the procedure will be carried out,
- the data recorded,
- a discussion or outline of how the data was analyzed, and
- a conclusion including error analysis and topics for further study.

Students are required to keep the reports in their notebooks in case the college of their choice requires evidence, artifacts or documentation prior to awarding college credit for physics. **[C6, C7]**

C6 - Evidence of Curricular Requirement: The course utilizes guided inquiry and student-centered learning to foster the development of critical thinking skills.

C7 - Evidence of Curricular Requirement: The course includes a laboratory component comparable to college-level physics laboratories, with a minimum of 12 student-conducted laboratory investigations representing a variety of topics covered in the course. 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 which 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 Web site.

Lab List

area	General area of study	order	Specific topic	Lab Title	demo or hands on	Time (min)
I	Mechanics	1	gravity	Determining the acceleration due to gravity	student hands on	90
I	Mechanics	2	projectile motion	Determining the initial speed and direction of a projectile	student hands on	90
I	Mechanics	3	Newton's Laws	Determining an unknown mass using a modified Atwood's machine	student hands on	180
I	Mechanics	4	friction	Determining the coefficient of static friction	student hands on	90
I	Mechanics	5	power	Determining your personal power output	student hands on	90
I	Mechanics	6	circular motion	Determining the mass of an object in circular motion	student hands on	90
I	Mechanics	7	Hooke's Law	Determining the force constant of a spring	student hands on	180
I	Mechanics	8	work, energy, motion	Physics Day at Six Flags Over Georgia (a variety of exercises focusing on analyzing the physics and engineering of amusement park rides)	student hands on	240
II	Fluids	1	buoyancy	Determining the density of an unknown material	student hands on	90
II	Thermodynamics	1	specific heat	Determining the specific heat of an unknown material	student hands on	90
III	Electricity & Magnetism	1	electrostatics	Investigation and discovery with the Van de Graaff generator	both	90
III	Electricity & Magnetism	2	electric fields	Mapping electric fields	student hands on	180
III	Electricity & Magnetism	3	circuits	Using electric circuits to verify Ohm's Law	student hands on	180
IV	Waves	1	speed of sound	Determining the speed of sound	student hands on	90
IV	Waves	2	standing waves	Determining the linear mass density of a string	student hands on	90
IV	Optics	1	refraction	Determining the index of refraction	student hands on	90
IV	Optics	2	geometric optics	Determining the focal length of a lens	student hands on	90
IV	Optics	3	two-source interference	Investigating the relationship among screen distance, wavelength and slit separation	student hands on	90
IV	Optics	4	two-source interference	Determining the wavelength of a laser using two-slit interference	student hands on	90
V	Modern	1	photoelectric effect	Determining Planck's constant	student hands on	90
					total number of labs	20