AP® Physics B
Syllabus 4

Course Overview

The school day consists primarily of eight 43-minute periods. Science classes meet six periods a week. One of these periods backs up to the regular class time, allowing time for a two-period lab. [C7]

C7—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 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.

Texts

Physics by Giancoli, 3rd edition; UPCO's *Review of Physics* (United Publishing Company Inc., Albany, N.Y.)

The review book is often changed among different publishers' versions between one year and the next. It provides a review of New York State Regents–level material that follows the basic AP® Physics B content. I use it during the year as simple base-level material that is enhanced to the AP level by the textbook.

Course Outline

The following is a course content outline with a suggested timeline. The percentages are those listed in the AP Physics Course Description for coverage on the AP Exam. Chapters relate to our textbook. Any review for the AP Exam takes place in the ninth period (after school). Review generally consists of AP Released Exams. Review problems are assigned over February and April breaks and review classes start in March.

I. Mechanics (1/2 year) [C1]

C1—Newtonian mechanics

A. Kinematics.....11%
1. Motion in one dimension—Chapter 2
2. Motion in two dimensions
    a) Projectile motion—Chapter 3
    b) Uniform circular motion—Chapter 5
    c) Torque and Rotational statics—Chapter 8
    d) Angular momentum and its conservation—Chapter 9

B. Newton's Laws of Motion—Chapters 4 and 9 .....9%
1. Static equilibrium—First law
2. Dynamics of a single particle—Second law
3. Systems of two or more bodies—Third law

C. Work, energy, and power—Chapter 6..... 5%
1. Work and the work–energy theorem
2. Conservative forces and potential energy
3. Conservation of energy
4. Power

D. Systems of particles, linear momentum—Chapter 7 ..... 4%

1. Impulse and momentum
2. Conservation of linear momentum, collisions

E. Oscillations and gravitation—Chapter 11 ..... 6%

1. Simple harmonic motion
2. Mass on a spring
3. Pendulum and other oscillations
4. Newton's law of gravity
5. Kepler's laws

II. Fluid Mechanics, Heat, Kinetic Theory, and Thermodynamics (1 ½ weeks) **[C2]**

C2—Fluid mechanics and thermal physics

A. Fluid mechanics—Chapter 10

1. Fluid statics
    a) Pressure and density
    b) Variation of pressure with depth
    c) Pascal's principle
    d) Archimedes' principle (buoyancy)
2. Fluid dynamics
    a) Continuity equation
    b) Bernoulli's equation
    c) Applications

B. Temperature and heat—Chapter 14..... 3%

1. Mechanical equivalent of heat
2. Specific and latent heat
3. Heat transfer and thermal expansion

C. Kinetic theory and thermodynamics..... 7%

1. Ideal gases—Chapter 13
    a) Kinetic model
    b) Ideal gas law
2. Laws of thermodynamics—Chapter 15
    a) First law (pV diagrams)
    b) Second law (heat engines)

III. Electricity and Magnetism (4 ½ weeks) [C3]

C3—Electricity and magnetism

A. Electrostatics—Chapter 16 ..... 5%
   1. Charge, field, and potential
   2. Coulomb's law and point charge field and potential

B. Conductors and capacitors—Chapter 17 ..... 4%
   1. Electrostatics with conductors
   2. Capacitors—parallel plates

C. Electric circuits 7%
   1. Current, resistance, power—Chapter 18
   2. Direct current circuits—Chapter 19

D. Magnetostatics—Chapter 20 ..... 4%
   1. Forces on moving charges in magnetic fields
   2. Forces on current-carrying wires in magnetic fields
   3. Fields of long current-carrying wires

E. Electromagnetic induction and waves—Chapters 21 and 22 ..... 5%

IV. Waves and Optics (3 ½ weeks) [C4]

C4—Waves and optics

A. Wave motion (sound and physical optics) 10%
   1. Properties of traveling and standing waves—Chapter 11
   2. Doppler effect—Chapter 12
   3. Superposition
   4. Interference and diffraction—Chapter 24
   5. Dispersion of light and the electromagnetic spectrum—Chapters 22 and 24

B. Geometric optics—Chapter 23 ..... 5%
   1. Reflection and refraction
   2. Mirrors
   3. Lenses

V. Modern Physics (2 ½ weeks)

C5—Atomic and nuclear physics

A. **Atomic physics and quantum effects [C5]**—Chapter 27 ..... 10%
   1. Alpha particle scattering and Rutherford model
   2. Photons and the photoelectric effect
   3. Bohr model
   4. Wave particle duality

B. **Nuclear physics [C5]**—Chapter 30 ..... 5%
   1. Radioactivity and half-life
   2. Nuclear reactions
   3. Mass and energy effects

Laboratory

Our labs are placed throughout the instructional year. An attempt is made to do them when they fit best in the curriculum. We do use TI 83s and CBL (Calculator-Based Laboratory) materials in the lab program, but most of the labs are still done without computers or TI 83s. Labs begin with the presentation of a question or problem. For example, "Given some lenses, a diffraction grating, and meter sticks, how can one determine the wavelength of a laser pointer?" Students are led in a guided discussion to formulate a hypothesis to answer the question or solve the problem. They are then presented with an assortment of equipment and supplies and asked to design and carry out an experiment to test their hypothesis. They make observations, collect data, manipulate the data (if necessary) and then form conclusions. **[C6]** Each experiment requires a written report, kept in an organized lab notebook.

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

The following is a list of our labs, most of which we will do during the school year before the AP Exam. **[C7]**

C7—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 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.

General Labs

1. Measurement of Length

   Objectives:

   —To use the Vernier and the micrometer calipers and read their scales.

   —Explain how the number of significant figures in a measured value depends on the least count of the measured instrument.

Velocity and Acceleration

2. Bulldozer

   Objective:

   —Analysis of the measurements of position and time of a toy car to calculate its velocity.

3. Graphing Your Motion

   Objective:

   —To use a motion detector to replicate the motion given in a teacher-generated worksheet.

4. What Goes Up Must Come Down

   Objective:

   —Determination of the acceleration due to gravity.

Projectile Motion

5. Shoot for Your Grade

   Objective:

   —Determination of muzzle velocity of a dart gun and calculation of the range.

Newton's Laws and Vectors

6. Newton's Second Law

Objective:

—Graphical analysis of the variation of acceleration and force for different masses.

7. Addition of Force Vectors

Objective:

—Experimental, graphical, and analytical addition of force vectors.

8. Coefficient of Friction

Objective:

—Determination of static and kinetic coefficients of friction for various materials.

Work, Momentum, and Energy, Circular Motion

9. Conservation of Momentum in Explosions

Objective:

—Analysis of the "explosion" of a dynamics cart system to determine if momentum is conserved.

10. Work and the Inclined Plane

Objective:

—Design two methods to determine the work due to nonconservative forces using an inclined plane.

11. Conservation of PE and KE

Objective:

—Verify the conservation of mechanical energy using a modified Atwood's machine.

12. Conservation of Momentum and Energy—Collision in 2D

Objective:

—Vector conservation of momentum in two-dimensional collisions on the air table.

13. Centripetal Force

Objective:

—Relationship between the period, mass, speed, and radius of an object in uniform circular motion.

Forces, Simple Harmonic Motion

14. Torque

Objective:

—Determination of an unknown mass using translational and rotational equilibrium.

15. Hooke's Law

Objective:

—Analysis of the spring constants of several springs.

16. Simple Pendulum

Objective:

—Investigation of the dependence of the period on the mass, length, angle, and determination of the acceleration due to gravity.

17. Kepler's Laws

Virtual Lab (http://www.astro.utoronto.ca/~zhu/ast210/kepler.html)

Objective:

—Use of a simulation to analyze Kepler's laws of planetary motion.

Electricity and Magnetism

18. Static Electricity

Objective:

—Discovery activity to understand how attraction and repulsion between charged objects occurs.

19. Part I. Ohm's Law
Part II. Series and Parallel Circuits

Objectives:

—Measurement of the relationship between voltage, current and resistance, dependence of resistance on length and cross-sectional area, series and parallel combinations of resistances.

20. Magnetic Fields Around Magnets

Objectives:

—Tracing of magnetic fields produced by various magnets.

21. Electromagnetic Induction

Objectives:

—Determination of the induced emf in a coil as a measure of the magnetic field from an alternating current in a long straight wire.

Waves and Optics

22. Wave Properties

Objectives:

—Relationship among wave variables using a ripple tank.

23. The Speed of Sound

Objectives:

—Determination of the speed of sound using a tuning fork and a column of water.

24. Part I. Law of Reflection
    Part II. Snell's Law

    Objectives:

    —Analysis of reflection and determination of the index of refraction of a material.

25. Part I. Images formed by Curved Mirrors
    Part II. Convex and Concave Lenses

    Objectives:

    —Experimental, geometrical, and analytical determination of the formation of images.

26. Wavelength of Light

    Objectives:

    —Measurement of the wavelength of a laser beam using a diffraction grating.

Classes

Classes that do not involve labs generally consist of problem review, a 20-minute lecture (often with demonstrations), and real-life applications. The remaining time is used by students to start their new assignment, which usually involves the application of critical thinking skills in order to solve problems associated with the lecture/demonstration. Students are allowed to pair up and help each other. **[C6]** This gives the instructor time to help students individually.

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

Problem Assignments

Problems given to students come from the textbook, review book, AP Released Exams, and worksheets designed by the instructor. An orderly problem-solving process is stressed to enable students to find solutions to all problems they may encounter. This process is covered every time the instructor reviews a problem. Real-life, problem-based learning assignments are also given.

Evaluation

Students are tested at the end of every unit with some quizzes given in between. Tests consist of Regents exam multiple-choice questions for part one and AP free-response questions for part two. Students are allowed to use AP reference tables and calculators. The only cumulative exams given are the AP Physics B Exam and the Regents exam. Laboratory and homework scores are combined with the test/quiz grades to give an overall grade for the course.