

# AP Physics B

## Course Overview

This second-year Physics course allows students to pursue more advanced topics in physics and increase their conceptual understanding and problem-solving skills. The course will follow the Advanced Placement Physics B Curriculum published by the College Board. Classes are approximately 55 minutes long. Students will be assigned weekly homework assignments and assessed at the end of each unit as well as at the end of each six-weeks grading period.

## Textbooks and Resource Materials

Each student will use the following resources in this course:

1. *Physics*, 5<sup>th</sup> Revised Edition, by Douglas Giancoli (ISBN 0-13-061143-3), 2002, Prentice Hall, Inc.
2. *Physics: Algebra/Trig*, 2<sup>nd</sup> Edition, by Eugene Hecht (ISBN 0-534-26100-0), 1998, Brooks/Cole Publishing Company
3. *Study Guide for Giancoli Physics*, by Joseph Boyle, (ISBN 0-13-627944-9), 1998, Prentice Hall, Inc.
4. *Physics: A Laboratory Manual*, by Om Puri, Patricia J. Zober, and G. Patrick Zober (ISBN 0-13-061146-8), 2001, Pearson Custom Publishing
5. "The Mechanical Universe" Video Series (ISBN 0-89776-819-3), 1985, California Institute of Technology and Intelcom

## Evaluation

Grades will consist of the following items:

1. Formal Lab Reports – 30%
2. Homework Sets – 20%
3. Tests and Quizzes – 50%

## Homework

Homework will be assigned weekly so that students will become familiar with the content and develop better problem-solving skills. Homework questions will be taken from AP Physics B released tests in addition to questions from textbooks. Many problems will have several different ways they can be solved. Students should look for novel solutions to share with the class when homework is reviewed. Emphasis will be placed on problem-solving skills and approach rather than just simply arriving at the correct answers. Students will be expected to show all work and justify answers using mathematics, graphs, motion maps, free-body diagrams, schematics, and other representational tools.

## Test Review

Students will review for the AP Physics B Exam all year. Test and homework questions will be taken from released AP Physics B Exams. Formal review for the exam will take place after school during the month of April.

## Course Outline

The course outline below is the curriculum provided by the College Board. The percentages show the approximate coverage of that topic on the AP Physics B Exam. Corresponding chapters in the textbook have also been listed.

### FIRST SEMESTER

- I. Mechanics (Giancoli Chs 2-8)
  - A. Kinematics ~ 11%
    1. Motion in one dimension
    2. Motion in two dimensions
      - a. Projectile motion
      - b. Uniform circular motion
  - B. Newton's Laws of Motion ~ 9%
    1. Static equilibrium — 1st law
    2. Dynamics of a single particle — 2nd law
    3. Systems of two or more bodies — 3rd law
  - C. Work, energy and power ~ 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 ~ 4%
    1. Impulse and momentum
    2. Conservation of linear momentum, collisions
  - E. Circular Motion and Rotation ~ 4%
    1. Uniform Circular Motion
    2. Angular Momentum and its Conservation
    3. Torque and Rotational Statics
  - F. Oscillations and Gravitation ~ 6%
    1. Simple harmonic motion
    2. Mass on a Spring
    3. Pendulum
    4. Law of Universal Gravitation
    5. Satellite Motion
- II. Heat, Kinetic Theory, and Thermodynamics (Giancoli Chs 10, 13-15)
  - A. Fluid Mechanics ~ 5%
    1. Hydrostatic Pressure
    2. Buoyancy
    3. Fluid Flow Continuity
    4. Bernoulli's Equation
  - B. Temperature and Heat ~ 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
  - 2. Kinetic model
  - 3. Ideal gas law
  - 4. Laws of thermodynamics
    - a. First law (PV diagrams)
    - b. Second Law (heat engines)

## **SECOND SEMESTER**

### III. Electricity and Magnetism (Giancoli Chs 16-20)

- A. Electrostatics ~ 5%
  - 1. Charge, field, and potential
  - 2. Coulomb's law and point charge field and potential
- B. Conductors and capacitors ~ 4%
  - 1. Electrostatics with conductors
  - 2. Capacitors — Parallel plates
- C. Electric circuits ~ 7%
  - 1. Current, resistance, power
  - 2. Direct current circuits
- D. Magnetostatics ~ 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
  - 4. Electromagnetic induction and waves ~ 5%

### IV. Waves and Optics (Giancoli Chs 11-12, 22-25)

- A. Wave motion (sound and physical optics) ~ 10%
  - 1. Properties of traveling and standing waves
  - 2. Doppler effect
  - 3. Superposition
  - 4. Interference and diffraction
  - 5. Dispersion of light and the electromagnetic spectrum
- B. Geometric optics ~ 5%
  - 1. Reflection and refraction
  - 2. Mirrors
  - 3. Lenses

### V. Modern Physics (Giancoli Chs 27, 30, 31)

- A. Atomic physics and quantum effects ~ 10%
  - 1. Alpha particle scattering and Rutherford model
  - 2. Photons and the photoelectric effect
  - 3. Bohr model
  - 4. Wave particle duality
- B. Nuclear physics ~ 5%
  - 1. Radioactivity and half-life

2. Nuclear reactions
3. Mass and energy effects

### ***Learning Physics and Pedagogy***

Research has shown that physics is best learned using experimentation and inquiry methods. Students need to construct their own understanding with help from the teacher. In this course, students will interact daily with each other and the instructor using inquiry and Socratic discourse.

Each new topic will be introduced with a question about or observation of an event. Students will decide, with the teacher's guidance, what variables could affect one particular aspect of the event. After discussing the possible effects, students will design an experiment to test two or more variables related to the event. Data will be graphed, manipulated (if needed), and then analyzed by the students. Students will present their conclusions to the class. Discussion (including slope, y-intercept, and integral of graphs; experimental procedure and error) will assist students in understanding the new-found relationships, determining any limiting factors, and writing equations. The Socratic-style discussion following the lab allows students to draw conclusions, ask questions, and refine what they understand from the lab. Formal lab reports will be written and turned in following each lab.

The application of newly-learned concepts to new situations will occur during problem-solving sessions. During these sessions, students will solve multiple-step problems and discuss their solutions with the class. Additional depth or clarification of topics will be provided by the teacher during these sessions.

Process skills are emphasized during labs and will utilize approximately 40% of instructional time. These skills include:

- planning experiments
- collecting data
- graphing techniques
- analysis of data
- drawing conclusions
- communicating results
- determining sources of error and reducing errors
- problem solving

### ***Laboratory Experiments***

**Below is a listing of the experiments conducted in this course (not necessarily in the order in which they are conducted):**

1. **Orders of Magnitude**—estimate (no calculators!) the mass of air in the class room and the thickness of tire tread worn off of a tire during one rotation
2. **Vector Racetrack**—use calculated vectors (velocity and acceleration) to move racecars around a track (the student with the fewest moves wins).
3. **Normal Force and Friction**—investigate the normal force and the force due to friction acting on a block sliding down a ramp.

4. **The Flying Pig**—students determine the relationship between velocity and mass, velocity and force, and velocity and radius of an object moving in uniform circular motion.’
5. **The Record Player**—determine the relationship between tangential velocity and angular velocity; find the relationship between radius and arc length
6. **Balancing Meter sticks**—determine the mass of an unknown object by balancing a meter stick with given masses and lever arms.
7. **Mass on a Spring**—determine the relationship between the period of oscillation and the mass hanging on the spring, amplitude of the oscillation, and spring constant of the spring.
8. **The Orbit of Mars**—plot the orbit of Mars and compare areas swept out over equal time intervals; calculate the speed of Mars at different locations
9. **The Heat is On**—determine the relationship between temperature and length using metal bars of differing lengths.
10. **Characteristics of Waves**—observations and measurements of water waves in a ripple tank.
11. **Standing Waves on a String**—determine the relationship between frequency and wavelength on a string; determine the relationship between the number of antinodes and the frequency of the wave.
12. **Wave Velocity on a String**—determine the relationship between wave velocity and the tension in the string; determine the relationship between the wave velocity and the linear density of the string.
13. **Speed of Sound**—determine the speed of sound using a column of water
14. **Unknown Frequency**—determine the frequency of an unknown tuning fork using open-ended pipes
15. **Double-Slit Interference**—determine the wavelength of light from an unknown light source; determine the slit width on an unknown diffraction grating.
16. **Electric Field Mapping**—collect approximately 300 readings of potential from different configurations and create and analyze a 3-D electric field map.
17. **Static Balloons**—verify Coulomb’s Law using a balloon and a pith ball.
18. **Ohm’s Law**—determine the relationship between voltage and current in a simple circuit.
19. **Series Circuits**—investigate voltage, current, and resistance in a multiple-resistor series circuit.
20. **Parallel Circuits**—investigate voltage, current, and resistance in a multiple-resistor parallel circuit.
21. **Magnetic Field Investigation**—investigate the magnetic field around a current-carrying wire.
22. **Magnetic Force**—determine the relationship between force and current, force and length of wire, and force and magnetic field strength.