

AP PHYSICS B SYLLABUS

Textbook: *Physics: Principles with Applications* Sixth Edition by Douglas C. Giancoli
ISBN 0-13-184661-2 Prentice Hall, 2005

Supplemental Resources: Mario Belloni and Wolfgang Christian: *Physlet*[®]
Physics CD: Interactive Illustrations, Explorations, and Problems for Introductory Physics
0-13-140334-6 Prentice Hall, 2004

Grading Policy:

- **Tests—40 percent**

Tests are administered after each unit of material. Each test consists of three sections:

1. Multiple-choice questions
2. Free-response problems
3. Lab-based question: may include questions on labs done in class or questions on a lab that was not performed in class.

- **Labs and Quizzes—30 percent**

Labs: Most of the lab experiments are open-ended: The students are given an objective and a list of equipment. Students design their own procedure, data gathering, and data analysis.

The allotted time is for conducting the experiment and recording the pertinent data. The students perform the data analysis and complete the lab report at home. Reports are collected in a lab notebook.

Quizzes: Quizzes may contain questions and/or problems from the homework, the reading assignments, and/or recently covered or previously learned material.

- **Class Work—15 percent**

This grade reflects in-class problem-solving exercises, AP Released Exams, and Physlet[®] problems.

- **Homework—15 percent**

Homework assignments consist of 30 questions each and are given from the online version of the textbook available at www.webassign.net and from AP Released Exams.

The AP Physics B course starts the first week of September. The material is covered in 28 weeks leaving two full weeks to conduct a review prior to the AP Exam.

COURSE SYLLABUS

I. Newtonian Mechanics

Instructional Time: 10 weeks

A. Kinematics

Reading/Homework Assignments:

Selected items from Chapters 2 and 3

Homework #1 at www.webassign.net

Physlet problems: 2.1, 2.3, and 3.8

Learning Objectives:

At the end of this unit the student should be able to:

- Describe a frame of reference
- Compare and contrast Aristotle and Galileo's views of motion
- Define and apply definitions of displacement, average velocity, instantaneous velocity, and average acceleration
- Demonstrate proficiency in solving problems using kinematics equations, including problems involving free fall by using the value of the acceleration due to gravity
- Analyze motion graphs qualitatively and quantitatively, including calculations of the slope of the tangent of an x -versus- t graph, the slope of the v -versus- t graph, the area under the v -versus- t graph and the area under the a -versus- t graph
- Distinguish between vectors and scalars
- Add vectors using graphical methods: parallelogram and polygon methods
- Add vectors using the component method of vector addition

- Describe the horizontal and vertical motion of a projectile
- Demonstrate proficiency in solving problems of situations involving projectiles fired horizontally and at an angle
- Apply the concepts of vectors to solve problems involving relative velocity.

Laboratory Experiments:

1. Motion in One Dimension

Objective: To analyze the motion of objects moving at constant speed and at uniform accelerated motion. Data should be collected to produce a graph of x versus t and use the graph to plot a v - versus t -graph for each object.

Equipment: A recording timer to record the motion of various objects: a bowling ball rolling on a carpet and a dynamics car on a track

Type of Lab: Open-ended

Allotted Time: 90 minutes

2. Vector Addition

Objective: To compare the experimental value of a resultant of several vectors to the values obtained through graphical and analytical methods.

Equipment: A force table set

Type of Lab: Open-ended

Allotted Time: 30 minutes

3. Projectile Motion

Objective: To determine the initial velocity of a projectile and the angle at which the maximum range can be attained.

Equipment: A projectile launcher and a meter stick

Type of Lab: Open-ended

Allotted time: 50 minutes

B. Newton's Laws Of Motion

Reading/Homework Assignments:

Selected items from Chapters 4 and 9

Homework #2 at www.webassign.net

Physlet problems: 4.11, 5.5 and 5.7

Learning Objectives:

At the end of this unit the student should be able to:

- Distinguish between contact forces and field forces by identifying the agent that causes the force
- Distinguish between mass and weight, and calculate weight using the acceleration due to gravity

- Differentiate between static and kinetic friction
- State and apply Newton's first law of motion for objects in static equilibrium
- Demonstrate proficiency in accurately drawing and labeling free-body diagrams
- State and apply Newton's second law of motion
- Demonstrate proficiency in solving problems that involve objects in motion with constant acceleration by analyzing the resultant force(s) in horizontal surfaces, inclined planes, and pulley systems (Atwood's machines)
- State and apply Newton's third law of motion

Laboratory Experiments:

4. Atwood's Machine: Newton's Second Law

Objective: To determine the acceleration of a system and the tension in the string.

Equipment: Modified Atwood's machine: dynamics cart and track, meter stick, stopwatch, and a set of masses

Type of Lab: Open-ended

Allotted Time: 50 minutes

5. Frictional Forces

Objective: Determination of static and kinetic coefficients of friction using two different methods.

Equipment: Rectangular blocks of different materials (felt and wood), spring scale, wooden board that can be used as an inclined plane, protractor

Type of Lab: Open-ended

Allotted Time: 50 minutes

C. Work, Energy, Power

Reading/Homework Assignments:

Selected items from Chapter 6

Homework #3 at www.webassign.net

Physlet problems: 6.9, 6.11, 7.4, and 7.6

Learning Objectives:

At the end of this unit the student should be able to:

- Define and apply the concepts of work done by a constant force, potential energy, kinetic energy, and power
- Calculate the work from the area under the curve of a force-versus-displacement graph
- Distinguish between conservative and non-conservative forces

- State and apply the principle of conservation of mechanical energy
- Demonstrate proficiency in solving problems by applying the work–energy theorem to situations that involve conservative and non-conservative forces

Laboratory Experiments:

6. Conservation of Mechanical Energy

Objective: To determine the velocity of a system in order to verify the conservation of mechanical energy.

Equipment: Modified Atwood's machine: dynamics cart and track, a set of masses, meter stick and stopwatch.

Type of Lab: Open-ended

Allotted Time: 50 minutes

D. Systems Of Particles, Linear Momentum

Reading/Homework Assignments:

Selected items from Chapter 7

Homework #4 at www.webassign.net

Physlet problems: 8.6 and 8.9

Learning Objectives:

At the end of this unit the student should be able to:

- Define and give examples of impulse and momentum
- Restate Newton's second law of motion in terms of momentum
- Calculate the change in momentum from the area under the curve of a force versus time graph
- Derive a statement of the conservation of momentum between two objects by applying Newton's third law
- Define and recognize examples of elastic and inelastic collisions
- Explain which conservation laws apply to each type of collisions
- Demonstrate proficiency in solving problems involving conservation of momentum in collisions in one and two dimensions

Laboratory Experiments:

7. Conservation of Linear Momentum

Objective: To determine the velocity of each cart in a spring-loaded set before and after a collision.

Equipment: spring-loaded cart set, a set of masses, meter stick and recording timer.

Type of Lab: Open-ended

Allotted Time: 50 minutes

E. Circular Motion And Rotation

Reading/Homework Assignments:

Selected items from Chapters 5 and 8

Homework #5 at www.webassign.net

Physlet problem: 3.15

Learning Objectives:

At the end of this unit the student should be able to:

- Explain the characteristics of uniform circular motion
- Derive the equation for centripetal acceleration of an object moving in a circle at constant speed
- Understand that centripetal force is not a new type of force
- Understand that centrifugal force does not exist
- Demonstrate proficiency in solving problems involving banking angles, the conical pendulum and motion in a vertical circle
- Define and calculate the torque of a given force about an axis of rotation
- State the two conditions of equilibrium (translational and rotational) and apply them to solve for unknown forces and/or distances in a variety of situations

Laboratory Experiments:

8. Centripetal Force

Objective: To determine the velocity of a flying toy and the tension in the string.

Equipment: Holy Cow or Flying Pig, a meter stick, and a triple-beam balance

Type of Lab: Open-ended

Allotted Time: 30 minutes

F. Oscillations And Gravitation

Reading/Homework Assignments:

Selected items from Chapters 5, 6, and 11

Homework #6 at www.webassign.net

Physlet problems: 4.11, 5.5, 5.7, 16.5, and 16.7

Learning Objectives:

At the end of this unit the student should be able to:

- Define and identify the following terms on a displacement-versus-time graph: equilibrium position, amplitude, period, and frequency
- Define simple harmonic motion
- Use the reference circle to describe the displacement, velocity and acceleration
- Describe and apply Hooke's law and Newton's second law to determine the acceleration as a function of displacement
- Apply the principles of conservation of mechanical energy for an object moving with simple harmonic motion
- Derive and apply the equation to obtain the period of a mass-spring system
- Derive and apply the equation to obtain the period of a simple pendulum
- Demonstrate proficiency in solving problems involving horizontal and vertical mass-spring systems
- Define resonant frequency and give examples of resonance
- State and apply Newton's law of universal gravitation
- Describe Cavendish's experiment to determine the value of the universal gravitation constant
- Derive the acceleration due to gravity at the surface of the earth or other planets
- Explain and apply the relationship between the speed and the orbital radius of a satellite
- Demonstrate proficiency in solving problems involving apparent weightlessness in a satellite and in an elevator
- State Kepler's three laws of planetary motion
- Derive and apply Kepler's third law of planetary motion

Laboratory Experiments:

9. Potential Energy Investigation: Spring and Gravitational.

Objective: To determine the spring constant of the spring, the evaluation of the extent to which the change in gravitational potential energy of the mass is equal to the change in the spring potential energy.

Equipment: Hooke's law apparatus, a set of masses, and a meter stick.

Type of Lab: Open-ended

Allotted Time: 50 minutes

10. Kepler's Laws

Objective: To plot a planetary orbit and apply Kepler's Laws

Equipment: Worksheet with planetary data and polar graph paper

Type of Lab: Teacher directed

Allotted Time: None in class; this lab exercise is given as a homework assignment.

II. Fluid Mechanics and Thermal Physics

Instructional Time: 4 weeks

A. Fluid Mechanics

Reading/Homework Assignments:

Selected items from Chapter 10

Homework #7 at www.webassign.net

Physlet problems: 14.1, 14.3, and 15.7

Learning Objectives:

At the end of this unit the student should be able to:

- Define atmospheric pressure, gauge pressure, and absolute pressure, and the relationship among these terms
- Define and apply the concept of fluid pressure
- State and apply Pascal's principle in practical situations such as hydraulic lifts
- State and apply Archimedes' principle to calculate the buoyant force
- Demonstrate proficiency in accurately drawing and labeling free-body diagrams involving buoyant force and other forces
- State the characteristics of an ideal fluid
- Apply the equation of continuity in solving problems
- Understand that Bernoulli's equation is a statement of conservation of energy
- Demonstrate proficiency in solving problems involving changes in depth and/or changes in pressure and/or changes in velocity

Laboratory Experiments:

11. Archimedes' Principle

Objective: To determine the density of two unknown materials.

Equipment: Triple-beam balance, overflow can, beaker, various metal objects and string

Type of Lab: Open-ended

Allotted Time: 30 minutes

12. Torricelli's Theorem

Objective: To determine the exit velocity of a liquid and to investigate the range attained with holes at varying heights.

Equipment: Clear plastic bottle with three holes at various heights, plastic container, water, and meter stick.

Type of Lab: Open-ended

Allotted Time: 50 minutes

B. Temperature and Heat

Reading/Homework Assignments:

Selected items from Chapters 13 and 14

Homework #8 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Understand and apply the mechanical equivalent of heat
- Describe the condition for thermal equilibrium and define temperature
- Define the coefficient of linear expansion and apply the equation to calculate linear thermal expansion
- Explain the mechanisms of heat transfer: conduction, radiation, and convection
- Demonstrate proficiency in solving problems involving thermal conductivity

C. Kinetic Theory and Thermodynamics

Reading/Homework Assignments:

Selected items from Chapters 13 and 15

Homework #9 at www.webassign.net

Physlet problems: 21.11 and 21.5

Learning Objectives:

At the end of this unit the student should be able to:

- State and apply the gas laws: Boyle's, Charles's and Gay Lussac's
- Apply the Ideal Gas law and the General Gas law to the solution of problems involving changes in volume, pressure, and temperature
- State the postulates of the kinetic theory
- Understand that the average translational energy of molecules in a gas is directly proportional to the absolute temperature
- State and apply the first law of thermodynamics
- Define and illustrate the four thermodynamic processes: isothermal, adiabatic, isovolumetric, isobaric process
- Calculate of the work done by graphical methods
- State and understand the implications of the second law of thermodynamics

- Describe a typical heat engine and define the efficiency of a heat engine
- Understand a Carnot engine and how its efficiency is expressed in terms of the Kelvin temperatures between which it operates
- Demonstrate proficiency in solving problems related to thermodynamic processes

III. Electricity and Magnetism

Instructional Time: 8 weeks

A. Electrostatics

Reading/Homework Assignments:

Selected items from Chapters 16 and 17

Homework #10 at www.webassign.net

Physlet problems: 23.8

Learning Objectives:

At the end of this unit the student should be able to:

- Define electrostatics and the nature of an electric charge
- State the law of electrostatics and the law of conservation of charge
- State Coulomb's law and its equation to calculate the electrostatic force between two charges
- Define the permittivity of free space
- Define the electric field and derive for a single point charge
- Describe electric field lines as means to depict the electric field
- Demonstrate proficiency in solving problems involving electric charges by applying appropriate vector addition methods
- Define and apply the concepts of electric potential energy, electric potential, and electric potential difference
- Describe and apply the relationship of the potential difference between two points to the uniform electric field existing between the points
- Understand that equipotential lines are perpendicular to electric field lines
- Demonstrate proficiency in solving problems involving the calculation of the total potential at any point in the vicinity of a number of known charges

- Demonstrate proficiency in solving problems involving the calculation of the work required to move a known charge from one point to another
- Apply a relationship between the electric field and the potential difference in a parallel plate configuration

B. Conductors and Capacitors

Reading/Homework Assignments:

Selected items from Chapters 16, 17, and 19

Homework #11 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Explain the charging of an object by contact and by induction
- Distinguish between conductors and insulators
- Understand the distribution of charge in a conductor
- Define capacitance and apply the equation to calculate the total charge
- Understand and apply the fact that the capacitance depends on the geometry of the capacitor: area and separation between the plates
- Calculate the equivalent capacitance of capacitors connected in series and in parallel
- Determine the energy stored in a parallel plate capacitor

Laboratory Experiments:

13. Static Electricity Investigation

Objective: To make qualitative observations of the behavior of an electroscope when it is charged by conduction and by induction.

Equipment: Electroscope and electrostatic materials set

Type of Lab: Open-ended

Allotted Time: 30 minutes

C. Electric Circuits

Reading/Homework Assignments:

Selected items from Chapters 18 and 19

Physlet problems: 30.1 a–e and 30.3

Homework #12 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Define electric current as the rate of flow of charge
- Understand some reasons for the conventional direction of electric current
- Explain the term *emf* (electromotive force) and what is a source of *emf*
- Define resistance and the factors affecting the resistance of a conductor
- State and apply Ohm's law
- Understand and apply the equation of electric power as the rate of energy transferred in the form of heat
- Draw schematic diagrams of circuits, including measuring devices such as ammeters and voltmeters
- Analyze series and parallel circuits and demonstrate proficiency in calculations of equivalent resistance, current, and voltage drop
- Calculate the terminal voltage, taking into account the internal resistance of a battery
- State and apply Kirchhoff's laws to solve complex networks
- Analyze circuits with resistors and capacitors (steady state) and demonstrate proficiency in calculations of equivalent resistance, current, and voltage drop

Laboratory Experiments:

14. Series and parallel circuits

Objective: To investigate the behavior of resistors in series, parallel, and series-parallel circuits. The lab should include measurements of voltage and current.

Equipment: Circuit board set, voltmeter, ammeter, and batteries

Type of Lab: Open-ended

Allotted Time: 90 minutes

D. Magnetic Fields

Reading/Homework Assignments:

Selected items from Chapter 20

Physlet problems: 27.8

Homework #13 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Describe the magnetic fields created by magnets
- Calculate the magnetic force exerted on a moving charge and determine the direction of the magnetic field, the velocity of the charge, and the magnetic force by using a right-hand-rule
- Calculate the magnetic force on a current carrying wire (or loop of wire) and determine the direction of the magnetic field, the current, and the magnetic force by using a right-hand-rule
- Calculate the magnetic force on a long, straight wire and determine the direction of the magnetic field, the current, and the magnetic force by using a right-hand rule
- Determine the magnitude and direction of the magnetic force between two parallel wires

Laboratory Experiments:

15. Magnetic Field Investigation

Objectives: To map the magnetic field around a bar magnet and to determine the strength of the magnetic field.

Equipment: Bar magnet, compasses, meter stick and protractor

Type of Lab: Open-ended

Allotted Time: 30 minutes

E. Electromagnetism

Reading/Homework Assignments:

Selected items from Chapter 21

Physlet problems: 29.3

Homework #14 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Describe Faraday's experiments that led to the conclusion that a changing magnetic field induces an emf
- State Faraday's law of induction and Lenz's law
- Demonstrate proficiency in solving problems involving an induced *emf* in cases where the magnetic flux density changes and in cases where the area of a loop of wire is changed
- Apply Lenz's law to determine the direction of the induced current in a variety of situations including motional *emf*

Laboratory Experiments:

16. *Electromagnetic Induction*

Objectives: To qualitatively examine the effects of changing magnetic field by observing currents induced in a solenoid and to determine whether your observations agree with the theory of electromagnetic induction and Lenz's law.

Equipment: Power supply, galvanometer, bar magnet, and solenoid

Type of Lab: Open-ended

Allotted Time: 30 minutes

IV. Waves and Optics

Instructional Time: 4 weeks

A. Wave Motion and Sound

Reading/Homework Assignments:

Selected items from Chapters 11 and 12

Physlet problems: 17.4, 18.12, and 18.14

Homework #15 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Define and give characteristics and examples of longitudinal, transverse, and surface waves
- Apply the equation for wave velocity in terms of its frequency and wavelength

- Describe the relationship between energy of a wave and its amplitude
- Describe the behavior of waves at a boundary: fixed-end, free-end, boundary between different media
- Demonstrate proficiency in solving problems involving transverse waves in a string
- Distinguish between constructive and destructive interference
- State and apply the principle of superposition
- Describe the formation and characteristics of standing waves
- Describe the characteristics of sound and distinguish between ultrasonic and infrasonic sound waves
- Calculate the speed of sound in air as a function of temperature
- Describe the origin of sound in musical instruments
- Use boundary behavior characteristics to derive and apply relationships for calculating the characteristic frequencies for an open pipe and for a closed pipe
- Explain the interference of sound waves and the formation of beats
- Apply the Doppler effect to predict the apparent change in sound frequency

Laboratory Experiments:

17. Resonance of Sound Waves

Objective: To measure experimentally the frequency of sound waves produced by tuning forks based on the principle of resonance.

Equipment: Resonance apparatus of a graduated glass tube connected to an aluminum reservoir, tuning forks

Type of Lab: Open-ended

Allotted Time: 90 minutes

B. Physical Optics

Reading/Homework Assignments:

Selected items from Chapters 22 and 24

Homework #16 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Explain how electromagnetic waves are produced
- Describe the electromagnetic spectrum and the relationship between frequency, wavelength, and speed of electromagnetic waves

- Describe Roemer and Michelson's experiment to determine the speed of light
- Explain the dispersion of light and the visible spectrum
- State the conditions for constructive interference and destructive interference
- Describe Young's double-slit experiment and apply the results of the experiment to predict the location of bright and dark fringes
- Describe the pattern observed by the use of a diffraction grating
- Demonstrate proficiency in solving problems involving the use of a single slit, a double slit and a diffraction grating
- Explain and apply the characteristics of thin-film interference using the concepts of boundary behavior
- Calculate the thickness of a film

C. GEOMETRIC OPTICS

Reading/Homework Assignments:

Selected items from Chapter 23

Physlet problems: 33.4, 34.4, and 35.4

Homework #17 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Discuss the evidence supporting the ray model of light
- State and apply the law of reflection
- Define the following terms for spherical mirrors: principal axis, focal point, and focal length
- Demonstrate proficiency in the use of ray diagrams to find the image of an object using a converging and a diverging mirror
- Understand how mirrors form real and virtual images
- Demonstrate proficiency in solving problems that use the mirror equation to calculate the focal length of a mirror, image distance, image height, and the magnification
- Explain what is meant by spherical aberration
- Define the index of refraction and describe the behavior of refracted light

- Apply Snell's law to the solution of problems
- Explain the concepts of critical angle and total internal reflection
- Demonstrate proficiency in the use of ray diagrams to find the image of an object using a converging and a diverging lens and a combination of lenses
- Understand how lenses form real and virtual images
- Demonstrate proficiency in solving problems that use the lens equation to calculate the focal length of a lens, image distance, image height, and the magnification

Laboratory Experiments:

18. Index of Refraction

Objectives: To determine the index of refraction of an acrylic block

Equipment: Optics bench, ray table, light source and acrylic block

Type of Lab: Open-ended

Allotted Time: 30 minutes

19. Mirrors and Lenses

Objectives: This lab is divided into two sections:

1. Using a concave mirror, determine three locations where a real image can be formed and one where a virtual image is formed.
2. Determine the focal length of a converging lens directly and the focal length of a diverging lens by combining it with a converging lens.

Equipment: Optics bench, set of lenses and mirrors, light source

Type of Lab: Open-ended

Allotted Time: 50 minutes

V. Atomic and Nuclear Physics

Instructional Time: 2 weeks

A. Atomic Physics And Quantum Effects

Reading/Homework Assignments:

Selected items from Chapter 27

Homework #18 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Describe Thomson and Millikan's experiments related to the electron
- Discuss the basics of Planck's hypothesis
- Define a photon and relate its energy to its frequency and/or wavelength

- Convert energy units: joules to electronvolts and vice versa
- Demonstrate proficiency in solving problems involving the energy of a photon and the conservation of momentum in photon interactions
- Explain the characteristics of the photoelectric effect and define the terms “work function” and “threshold frequency”
- Given a graph of energy versus frequency, understand the meaning of the slope, the x -intercept, and the y -intercept
- Demonstrate proficiency in solving problems involving the calculation of the maximum kinetic energy of photoelectrons
- Understand the nature and production of X-rays
- Describe the results of the collision of an X-ray photon with an electron (Compton effect) and the results of the scattering of X-rays from a crystal (Davisson–Germer experiment)
- Understand the dual nature of light and matter, and apply de Broglie’s equation to calculate the wavelength of a particle
- Describe how atomic spectra are produced
- Demonstrate proficiency in drawing and interpreting energy-level diagrams
- Calculate the energy absorbed or emitted by an atom when an electron moves to a higher or lower energy level

Laboratory Experiments:

20. Energy Levels

Objectives: To determine the energy levels of hydrogen and mercury

Equipment: Spectrometer, hydrogen and mercury spectrum tubes

Type of Lab: Open-ended

Allotted Time: 30 minutes

B. Nuclear Physics

Reading/Homework Assignments:

Selected items from Chapters 30 and 31

Homework #19 at www.webassign.net

Learning Objectives:

At the end of this unit the student should be able to:

- Describe the structure and properties of the nucleus
- Apply Einstein's equation of mass energy equivalence
- Calculate the mass defect and the total binding energy of the nucleus
- Understand the origin of the strong and weak nuclear forces
- Describe three types of radiation emitted in radioactivity: alpha decay, beta radiation and gamma radiation
- Understand how nuclear reactions are produced
- Define the following terms: threshold energy, chain reaction, and critical mass
- Explain the process of nuclear fission and the basic operation of a nuclear reactor
- Describe a chain reaction
- Explain the process of nuclear fusion and how magnetic and inertial confinements can provide thermonuclear power

Review Homework #20 at www.webassign.net

School: Cathedral High School

Class: AP PHYSICS 2008-2009

Prepared by: B. Fejzo - Physics teacher

Approved by:  CollegeBoard