AP Physics B Course Syllabus

COURSE DESCRIPTION: AP Physics is a yearlong introduction to the algebra-based major areas of physics – mechanics, fluids, waves, optics, electricity, magnetism and modern physics (atomic and nuclear). Students learn to think like scientists: making predictions based on observations, writing hypothesis, designing and completing experiments, and reaching conclusions based on the analysis of data derived from these experiments. Students apply the concepts of physics to their everyday experiences and current events and issues in science and engineering. The course provides opportunities for guided inquiry and student-centered learning to foster critical thinking skills. The course makes extensive use of Physlets® to provide both illustrations and explorations of physics concepts.

COURSE OBJECTIVES:

- Read, understand, and interpret physical information
- Demonstrate proficiency in explaining and solving algebra-based problems in the major areas of physics
- Apply the concepts and procedures of scientific reasoning to understanding physics phenomenon
- Perform experiments, interpret the results of observations and communicate results

PREREQUISITES: Successful completion of Algebra II and Trigonometry with one year of physics highly recommended

COURSE LENGTH: Two Semesters

REQUIRED TEXTS: *Physics: Principles with Applications*, 7/E Giancoli | ©2009 | Pearson 0131370936

Physlet® Physics: Interactive Illustrations, Explorations and Problems for Introductory Physics, 1/E Christian & Belloni | ©2004 | Pearson

LABS: The lab program requires students to solve problems cooperatively and develop hypothesis and share results via class discussions using a student-centered model. To facilitate team work, students examine and discuss case studies in teamwork to identify collaborative skills as part of their pre-lab instruction. Students are required to produce lab reports that include an explanation of the problem, their hypothesis, the procedure, their data and observations, calculations, and analysis and conclusions including possible errors or limitations. Students are required to keep a lab notebook of all lab reports completed in the course.

Reaction Time-- hands on; 1 hour; students calculate their reaction time by using distance of fall (open-ended)
Projectile Motion-- virtual; 1-2 hour; students calculate the initial velocity of a flying ball
Exploring Friction-- hands-on; 1-2 hour; students use friction board and spring scale to calculate the force of friction and the constants of static/kinetic friction of different surfaces
Conservation of Momentum-- hands-on; half-hour; students use marbles to observe the concepts of conservation of momentum
Egg Drop-- hands-on; 2 hours; students build a contraption using paper and tape to save an egg from different heights (open-ended)

Centripetal Force-- hands-on; one hour; students use centripetal force kit to establish quantitatively the variables that affect the centripetal motion/forces of a mass

Torque-- hands-on; 1 hour; students set up different "lever-type" situations to study the concept of balancing torque

Archimedes' Principle-- hands-on; one hour; students devise a way to calculate their weight using water displacement (open-ended)

Ideal Gas Laws-- virtual; 1-2 hours; students devise a method for determining the relationship between pressure and volume, pressure and temperature, and temperature and volume (open-ended)

Entropy Simulation-- hands-on; 1/2 hour; students use hands-on materials to explore the "disorder" of the energy in a system

Mass Spectrometer—virtual; 1 hour; students explore the concepts and complete a qualitative and quantitative analysis of mass spectrometry.

Electric Current—hands-on; 1-2 hours; students use snap circuits to explore the relationship between current and resistance.

Series and Parallel Circuits—hands-on; 1-2 hours; students use snap circuits to explore the difference between series and parallel circuits

Electromagnetism—virtual; 1 hour; students explore qualitatively the affect of a magnetic field on an electric field and vice versa

Simple Pendulum—hands-on; 1 hour; students devise a method to establish the relationship between mass, length, and gravity for a simple pendulum (open-ended)

Spring with Mass—hands-on; 1 hour; students devise a method to establish the relationship between mass, spring constant, and gravity for a spring with mass (open-ended)

Spherical Mirrors—hands-on; 1 hour; students explore the relationship between distance, mirror type, and image.

Snell's Law—hands-on; 1 hour; students establish Snell's law with ray tracing techniques through a refractive substance.

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Theme/Unit	Section Name	Objectives	Assessments	Content Plan
Getting Started: Introduction (Prerequisites)	Reviewing Numbers	Students will be able to: ✓ Express very large and very small numbers using scientific notation	Pre Quiz Post Quiz	Direct Instruction Self-checks Practice Activities Tutorials
	Reviewing Measurement	Students will be able to: ✓ Perform basic measurements ✓ Differentiate between accuracy and precision of measurements and apply these qualities to experimental data. ✓ Estimate solutions to problems using orders of magnitude ✓ Convert between values with different units using the process of dimensional analysis. ✓ Determine the number of significant figures in a value and use the rules regarding significant figures in calculations. ✓ Describe the SI units for different quantities including length, mass, time, electric current, etc. and express numbers using metric multipliers(prefixes)	Pre Quiz Post Quiz	Direct Instruction Self-checks Practice Activities Tutorials
	Reviewing Algebra	Students will be able to: ✓ Apply basic algebra to set up and solve equations algebraically using metric units, including simultaneous equations and use of the quadratic formula	Pre Quiz Post Quiz	Direct Instruction Self-checks Practice Activities Tutorials
	Reviewing Geometry	Students will be able to: ✓ Apply basic geometry such as the meanings of parallel and perpendicular and use angles to define a direction with respect to a reference	Pre Quiz Post Quiz	Direct Instruction Self-checks Practice Activities Tutorials

	Reviewing Data Collection and Analysis	Students will be able to: ✓ Construct and interpret graphs, draw to scale, and identify and extract an object from its surroundings in a drawing ✓ Represent the size of an abstract quality by the length of a line ✓ Calculate and apply simple statistics including mean, median, mode, range, and standard deviation	Pre Quiz Post Quiz	Direct Instruction Self-checks Practice Activities Tutorials

Theme/Unit	Section Name	Objectives	Assessments	Content Plan
	Motion in One Dimension	Students will be able to: ✓ Analyze a graph of one of the kinematic quantities, position, velocity, or acceleration, as a function of time to determine in what time intervals the other two are positive, negative or zero ✓ Identify and sketch a graph of position, velocity, and acceleration as a function of time ✓ Write expressions for velocity and position as functions of time and identify and sketch graphs of these quantities ✓ Use equations to solve problems involving one-dimensional motion with constant acceleration	Discussion: Teamwork Skills Lab: Reaction Time Section Quiz Portion of Unit Exam	Battery-operated Car Mini-lab Distance, Position, and Displacement Speed vs. Velocity Constant Velocity Average vs. Instantaneous Velocity Constant Acceleration Motion on an Incline Free Fall Graphical Analysis Physlets Self-Checks **Lab: Reaction Time**

	Motion in Two Dimensions	Students will be able to:
		
		✓ Add, subtract, and resolve displacement and velocity vectors
		  o to determine the components of a vector along two specified, mutually perpendicular axes
		  o to determine the net displacement of a particle or the location of a particle relative to another
		  o to determine the change in velocity of a particle or the velocity of one particle relative to another
		✓ Write expressions, sketch and identify graphs for the horizontal and vertical components of velocity and position as functions of time
		✓ Apply these expressions in analyzing the motion of a projectile that is projected with arbitrary initial velocity
			Lab: Projectile Motion
			
			Section Quiz
			
			Portion of Unit Exam
				Vector Decomposition
				
				Projectile Motion
				
				Two-Dimensional Motion Problem Solving
				
				Relative Velocity Example
				
				Physlets
				
				Lab: Projectile Motion

Theme/ Unit	Section Name	Objectives	Assessments	Content Plan
Unit 2: Newton's Laws of Motion	Concepts of Newton's Laws	Students will be able to: ✓ Analyze situations in which a particle remains at rest, or moves with constant velocity, under the influence of several forces ✓ Identify the force pairs and the objects on which they act, and state the magnitude and direction of each force ✓ Calculate, for an object moving in one dimension, the velocity change that results when a constant force F acts over a specified time interval ✓ Determine, for an object moving in a plane whose velocity vector undergoes a specified change over a specified time interval, the average force that acted on the object ✓ Identify the force pairs and the objects on which they act, and state the magnitude and direction of each force	Section Quiz Unit Exam	What is Force? Newton's First Law and Reference Frames Newton's Second Law and Force Example: Kinematics and Newton's Second Law Newton's Third Law: Action-Reaction Pairs Newton's Third Law, Contact Forces Mass vs. Weight Your Weight on Different Planets Physlets Practice Problems

	Newton's Laws Problem Solving	Students will be able to: ✓ Draw a well-labeled, free-body diagram showing all real forces that act on the object. ✓ Write the vector equation that results from applying Newton's Second Law to the object, and take components of this equation along appropriate axes ✓ Analyze situations in which an object moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that makes up the net force, such as motion up or down with constant acceleration ✓ Write the relationship between normal and frictional forces on a surface utilizing the coefficient of friction. ✓ Analyze situations in which an object moves along a rough inclined plane or horizontal surface ✓ Analyze under what circumstances an object will start to slip, or to calculate the magnitude of the force of static friction ✓ Calculate the terminal velocity of an object moving vertically under the influence of a retarding force dependent on the velocity	Section Quiz Unit Exam	Using Free-Body Diagrams for Problem Solving Mass on an Incline Static and Kinetic Friction Physlets Practice Problems **Lab: Exploring Friction** Tutorial: Friction Data Analysis Terminal Velocity
	Systems of Two or More Objects	Students will be able to: ✓ Apply Newton's third law to analyze the force of contact between two objects that accelerate together along a horizontal or vertical line, or between two surfaces that slide across one another ✓ Analyze the motion of a system of two objects joined by a string, in which the tension is constant, including systems in which the string passes over a massless pulley. ✓ Solve problems in which application of Newton's laws leads to two or three simultaneous linear equations involving unknown forces or accelerations	Section Quiz Unit Exam	Tutorial: Problem Solving w/Two-Body Systems Atwood's Machine What About More Than Two Bodies? Practice Problems

Theme/ Unit	Section	Objectives	Assessments	Content Plan
Unit 3: Work, Energy, and Momentum	Work and Energy	Students will be able to: ✓ Identify situations where work is positive, negative or zero. ✓ Calculate the work done by a specified constant force on an object that undergoes a specified displacement ✓ Relate the work done by a force to the area under a graph of force as a function of position, and calculate this work in the case where the force is a linear function of position ✓ Use the scalar product operation to calculate the work performed by a specified constant force F on an object that undergoes a displacement in a plane ✓ Calculate the change in kinetic energy or speed that results from performing a specified amount of work on an object ✓ Calculate the work performed by the net force, or by each of the forces that make up the net force, or an object that undergoes a specified change in speed or kinetic energy ✓ Apply the work-energy theorem to determine the change in an object's kinetic energy and speed that results from the application of specified forces, or to determine the force that is required in order to bring an object to rest in a specified distance ✓ Calculate the potential energy of one or more objects in a uniform gravitational field	Section Quiz Unit Exam	Calculating Work Multiple Forces Doing Work Energy and the Work-Energy Theorem Potential Energy Relationship Between Potential Energy and Kinetic Energy Elastic Potential Energy Physlets Practice Problems
	Conservation of Energy	Students will be able to: ✓ Describe and identify situations in which mechanical energy is converted to other forms of energy ✓ Analyze situations in which an object's mechanical energy is changed by friction or by a specified externally applied force ✓ Identify situations in which mechanical energy is or is not conserved ✓ Apply conservation of energy to analyzing the motion of systems of connected objects such as an Atwood's machine ✓ Apply conservation of energy in analyzing the motion of objects that move under the influence of springs	Section Quiz Unit Exam	Choice of System External Forces and Energy Conservative Forces Example: Roller-Coaster Speed Non-Conservative Forces A Collision Between a Ball and a Spring Physlets Practice Problems

	Power	Students will be able to ✓ Calculate the power required to maintain the motion of an object with constant acceleration (e.g., to move an object along a level surface, to raise an object to a constant rate, or to overcome friction for an object that is moving at a constant speed) ✓ Calculate the work performed by a force that supplies constant power, or the average power supplied by a force that performs a specified amount of work	Section Quiz Unit Exam	Physlets Practice Problems Tutorial: What is Power?
	Momentum & Impulse	Student will be able to: ✓ Relate mass, velocity, and linear momentum for a moving object, and calculate the total linear momentum of a system of objects ✓ Relate impulse to the change in linear momentum and the average force acting on an object ✓ Calculate the area under a force versus time graph and relate it to the change in momentum of an object ✓ Identify situations in which linear momentum, or a component of the linear momentum vector, is conserved ✓ Apply linear momentum conservation to one-dimensional elastic and inelastic collisions and two-dimensional completely inelastic collisions ✓ Analyze situations in which two or more objects are pushed apart by a spring or other agency, and calculate how much energy is released in such a process	Conservation of Momentum Lab Quiz Section Quiz Unit Exam	Linear Momentum Newton's Second Law Redefined Impulse The Difference Between Impulse and Work Change in Momentum Collisions Elastic and Inelastic Collisions Tutorial: Collision Problems Physlets Practice Problems **Lab: Conservation of Momentum** **Lab: Egg Drop** Students must design a "contraption" to protect a raw egg from breaking during a 2 meter fall onto a hard surface. The contraption must be made from 5 sheets of notebook paper and 1 meter of masking tape.

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	Circular and Rotational Kinematics	Student will be able to: ✓ Relate the radius of the circle and the speed or rate of revolution of the particle to the magnitude of the centripetal acceleration ✓ Describe the direction of the particle's velocity and acceleration at any instant during motion ✓ Determine the components of the velocity and acceleration vectors at any instant, and sketch and identify graphs of these quantities	Section Quiz Unit Exam	Acceleration of a Golf Ball That Rims the Hole Uniform Circular Motion Radius of the Circle Physlets Practice Problems Tutorial: Centripetal Acceleration Frequency and Period Angular Coordinates Non-Uniform Circular Motion Constant Angular Acceleration
	Circular and Rotational Dynamics	Student will be able to: ✓ Analyze situations in which an object moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that makes up the net force, in the following situations ○ motion in a horizontal circle (e.g., mass on a rotating merry-go-round, or car rounding a banked curve ○ Motion in a vertical circle (e.g., mass swinging on the end of a string, cart rolling down a curved track, rider on a Ferris wheel) ✓ Calculate the magnitude and direction of torque associated with a given force ✓ Calculate the torque on a rigid object due to gravity ✓ State the conditions for translational and rotational equilibrium of a rigid object ✓ Apply these conditions in analyzing the equilibrium of a rigid object under the combined influence of a number of coplanar forces applied at different locations	Section Quiz Unit Exam	Physlets Practice Problems Tutorial: Friction and Banking **Lab: Centripetal Force** Revolving in Horizontal and Vertical Circles Torque: The Cause of Rotational Motion **Lab: Torque** Conservation Laws and Angular Quantities The Force and Torque for Equilibrium

	Gravitational Motion	Students will be able to: ✓ Determine the gravitational force that one spherically symmetrical mass exerts on another ✓ Determine the strength of the gravitational field at a specified point outside a spherically symmetrical mass ✓ For a circular orbit: o describe qualitatively how the velocity, period of revolution, and centripetal acceleration depend upon the radius of the orbit o derive expressions for the velocity and period of revolution in such an orbit o derive Kepler's Third Law for the case of circular orbits	Section Quiz Unit Exam	Projectiles Becoming Satellites Newton's Law of Universal Gravitation Acceleration of Gravity and the Universal Law of Gravitation Kepler's Laws Properties of Elliptical Orbits Conservation of Momentum Orbital Speed Physlets Practice Problems

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Unit 5: Fluid Mechanics	Density and Pressure	Students will be able to: ✓ Apply the relationship between pressure, force, and area in a fluid. ✓ Apply the principle that a fluid exerts pressure in all directions ✓ Apply the principle that a fluid at rest exerts pressure perpendicular to any surface that it contacts ✓ Determine the locations of equal pressure in a fluid ✓ Determine the values of absolute and gauge pressure for a particular situation ✓ Apply the relationship between pressure and depth in a liquid	Section Quiz Unit Exam	What is Density? Pressure in a Liquid Illustration Pascal's Principle Physlets Practice Problems
	Buoyancy	Students will be able to: ✓ Determine the forces on an object immersed partly or completely in a liquid ✓ Apply Archimedes' principle to determine buoyant forces and densities of solids and liquids	Section Quiz Lab Report: Archimedes' Principle Discussion: Archimedes' Principle Unit Exam	Density and Buoyant Force Buoyancy and Fluid Layers Exploration Physlets Practice Problems **Lab: Archimedes' Principle**
	Fluids in Motion	Students will be able to: ✓ Apply the equation of continuity to fluids in motion ✓ Apply Bernoulli's equation to fluids in motion	Section Quiz Unit Exam	Flow Rate The Continuity Equation Bernoulli's Principle Viscous Flow Bernoulli's Principle Application Physlets Practice Problems Tutorial: Example Problem

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Unit 6: Thermal Physics	Heat and Temperature	Students will be able to: ✓ Determine how much heat can be produced by the performance of a specified quantity of mechanical work ✓ Calculate how the flow of heat through a slab of material is affected by changes in the thickness or area of the slab, or the temperature difference between the two faces of the slab ✓ Analyze what happens to the size and shape of an object when it is heated ✓ Analyze qualitatively the effects of conduction, radiation, and convection in thermal processes	Section Quiz Unit Exam	Specific Heat and Calorimetry Mechanical Equivalent of Heat Heat Sample Problem Latent Heat Latent Heat Sample Problem Conduction, Convection, and Radiation Thermal Conductivity Thermal Expansion Sample Problem Physlets Practice Problems
	Ideal Gases	Students will be able to: ✓ State the assumptions of the kinetic theory model of an ideal gas ✓ State the connection between temperature and mean translational kinetic energy, and apply it to determine the mean speed of gas molecules as a function of their mass and the temperature of the gas ✓ State the relationship among Avogadro's number, Boltzmann's constant, and the gas constant R, and express the energy of a mole of a monatomic ideal gas as a function of its temperature ✓ Explain qualitatively how the model explains the pressure of a gas in terms of collisions with the container walls, and explain how the model predicts that, for fixed volume, pressure must be proportional to temperature	Lab Report: Ideal Gas Laws Section Quiz Unit Exam	Physlets Practice Problems **Lab: Ideal Gas Laws** Ideal Gas Law: Moles v. Molecules A Look at Graphs—PV Diagrams Thermodynamic Processes Kinetic Theory and Temperature Speed of the Molecules Kinetic Theory

	Law of Thermodynamics	Students will be able to: ✓ Relate the pressure and volume of a gas during an isothermal expansion or compression ✓ Relate the pressure and temperature of a gas during constant-volume heating or cooling, or the volume and temperature during constant-pressure heating or cooling ✓ Calculate the work performed on or by a gas during an expansion or compression at constant pressure ✓ Explain the process of adiabatic expansion or compression of a gas ✓ Identify and sketch on a PV diagram the curves that represent each of the above processes ✓ Apply the first law of thermodynamics to ✓ relate the heat absorbed by a gas, the work performed by the gas, and the internal energy change of the gas for any of the processes in prior section ✓ Relate the work performed by a gas in a cyclic process to the area enclosed by a curve on a PV diagram ✓ Determine whether entropy will increase, decrease, or remain the same during a particular situation ✓ Compute the maximum possible efficiency of a heat engine operating between two given temperatures ✓ Compute the actual efficiency of a heat engine ✓ Relate the heats exchanged at each thermal reservoir in a Carnot cycle to the temperatures of the reservoirs	Section Quiz Lab Report: Entropy Simulation Unit Exam	Physlets Practice Problems Tutorial: First Law of Thermodynamics Second Law of Thermodynamics Entropy and Heat Exchange **Lab: Entropy Simulation** Carnot Engine Engines and Entropy Engine Efficiency

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Theme/Unit	Section	Objectives	Assessments	Content Plan
Semester Exam	Preparing for the Exam	Students will be able to: Demonstrate proficiency in AP Physics B		Review for Semester Exam
	Taking the Exam	Students will be able to: Demonstrate proficiency in AP Physics B	Semester Exam (Model AP Exam)	

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Unit 7: Electrostatics	Electric Charge and Fields	Students will be able to: ✓ Describe the types of charge and the attraction and repulsion of charges. ✓ Describe polarization and induced charges. ✓ Calculate the magnitude and direction of the force on a positive or negative charge due to other specified point charges ✓ Analyze the motion of a particle of specified charge and mass under the influence of an electrostatic force ✓ Define electric field in terms of the force on a test charge ✓ Describe and calculate the electric field of a single point charge ✓ Calculate the magnitude and direction of the electric field produced by two or more point charges ✓ Calculate the magnitude and direction of the force on a positive or negative charged placed in a specified field ✓ Interpret an electric field diagram	Discussion—Effective Habits Section Quiz Unit Exam	The Tape: A Demonstration of a Fundamental Concept Electric Charge of an Atom and Polarity Charge and Coulomb's Law Monopoles, Dipoles, and Quadruples Quantitative Analysis: Multiple Charges Electric Fields Physlets Practice Problems
	Electric Field and Electric Potential	Students will be able to: ✓ Analyze the motion of a particle of specified charge and mass in a uniform electric field ✓ Determine the electric potential in the vicinity of one or more point charges ✓ Calculate the electrical work done on a charge or use conservation of energy to determine the speed of a charge that moves through a specified potential difference ✓ Determine the direction and approximate magnitude of the electric field at various positions given a sketch of equipotentials ✓ Calculate the potential difference between two points in a uniform electric field, and state which point is at the higher potential ✓ Calculate how much work is required to move a test charge from one location to another in the field of fixed point charges ✓ Calculate the electrostatic potential energy of a system of two or more point charges, and calculate how much work is required to establish the charge system	Section Quiz Unit Exam	Electric Potential Energy Potential Difference Energy, Voltage, and Equipotentials Electron Volt Tutorial: Electric Potential Physlets Practice Problems **Lab: Mass Spectrometer**

	Conductors	Students will be able to: ✓ Explain the mechanics responsible for the absence of electric field inside a conductor and that all excess charge must reside on the surface of the conductor ✓ Explain why a conductor must be an equipotential and apply this principle in analyzing what happens when conductors are connected by wires ✓ Describe and sketch a graph of the electric field and potential inside and outside a charged conducting sphere ✓ Describe the process of charging by induction ✓ Explain why a neutral conductor is attracted to a charged object	Section Quiz (C&D combined) Unit Exam	Tutorial: Charging By Induction Conductors Physlets Practice Problems
	Capacitors	Students will be able to: ✓ Relate stored charge and voltage for a capacitor ✓ Relate voltage, charge, and stored energy for a capacitor ✓ Recognize situations in which energy stored in a capacitor is converted to other forms ✓ Describe the electric field inside the capacitor, and relate the strength of this field to the potential difference between the plates and the plate separation ✓ Determine how changes in dimension will affect the value of the capacitance	Section Quiz (C&D combined) Unit Exam	Capacitor Connected to a Battery Capacitor with a Dielectric Capacitors, Charge, and Electric Potential Conductors and Dielectrics Tutorial: Capacitance Physlets Practice Problems

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Unit 8: Electric Circuits	Currents, Resistance, & Power	Students will be able to: ✓ Relate the magnitude and direction of the current to the rate of flow of positive and negative charge ✓ Relate current and voltage for a resistor ✓ Describe how the resistance of a resistor depends upon its length and cross-sectional area, and apply this result in comparing current flow in resistors of different material or different geometry ✓ Apply the relationships for the rate of heat production in a resistor	Section Quiz Unit Exam	Batteries, Circuits, and Current Open/Closed/Complete Circuits Ohm's Law Physlets Practice Problems **Lab: Electric Current** Resistivity Electric Power Alternating Current
	Direct Currents	Students will be able to: ✓ Identify on a circuit diagram whether resistors are in series or parallel ✓ Determine the ratio of the voltages across resistors connected in series or the ratio of the currents through resistors connected in parallel ✓ Calculate the equivalent resistance of a network of resistors that can be broken down into series and parallel combinations ✓ Calculate the voltage, current, and power dissipation for any resistor in such a network of resistors connected to a single power supply ✓ Design a simple series-parallel circuit that produces a given current through and potential difference across one specified component, and draw a diagram for the circuit using conventional symbols ✓ Calculate the terminal voltage of a battery of specified emf and internal resistance from which a know current is flowing ✓ Determine a single unknown current, voltage, or resistance in a DC circuit using Ohm's law and Kirchhoff's rules. ✓ State whether the resistance in a voltmeter or ammeter is high or low ✓ Identify or show correct methods of connecting meters into circuits in order to measure voltage or current	Section Quiz Unit Exam	Electromotive Force (EMF) Physlets Practice Problems **Lab: Series and Parallel Circuits** Kirchhoff's Rules Tutorial: Complex Circuit

	Capacitors in Circuits	Students will be able to: ✓ Calculate the equivalent capacitance of a series or parallel combination of capacitors ✓ Describe how stored charge is divided between capacitors connected in parallel ✓ Determine the ratio of voltages for capacitors connected in a series ✓ Calculate the voltage or stored charge, under steady-state conditions, for a capacitor connected to a circuit consisting of a battery and resistors	Section Quiz Unit Exam	Circuits Containing Capacitors Tutorial: Equivalent Capacitance RC Circuits Physlets Practice Problems

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Theme/ Unit	Section	Objectives	Assessments	Content Plan
Unit 9: Magnetic Fields and Electromagnetism	Magnetic Fields	Students will be able to: ✓ Calculate the magnitude and direction of the forces in terms of q, v, and B, and explain why the magnetic force can perform no work ✓ Deduce the direction of a magnetic field from information about the forces experienced by charged particles moving through that field ✓ Describe the paths of charged particles moving in uniform magnetic fields ✓ Derive and apply the formula for the radius of the circular path of a charge that moves perpendicular to a uniform magnetic field ✓ Describe under what conditions particles will move with constant velocity through crossed electric and magnetic fields ✓ Calculate the magnitude and direction of the force on a straight segment of current-carrying wire in a uniform magnetic field. ✓ Indicate the direction of magnetic forces on a current-carrying loop of wire in a magnetic field, and determine how the loop will tend to rotate as a consequence of these forces ✓ Calculate the magnitude and direction of the field at a point in the vicinity of a long, straight current-carrying wire ✓ Use superposition to determine the magnetic field produced by two long wires ✓ Calculate the force of attraction or repulsion between two long current-carrying wires	Section Quiz Unit Exam Lab: Electromagnetism Quiz	Electric Currents Produce Magnetic Fields Force on a Current in a Magnetic Field Force on a Charge in a Magnetic Field Using the Right-Hand Rules Tutorial: Magnetic Forces and Fields Mass Spectrometer and Velocity Selector Tutorial: Multiple Current-Carrying Wires Fields from Wires and Loops Physlets Practice Problems
	Electromagnetic Induction	Students will be able to ✓ Calculate the flux of a uniform magnetic field through a loop of arbitrary orientation ✓ Recognize situations in which changing flux through a loop will cause an induced emf or current in the loop ✓ Calculate the magnitude and direction of the induced emf and current in a loop of wire or a conducting bar when the magnitude of a related quantity such as magnetic field or area of the loop is changing at a constant rate	Section Quiz Unit Exam	**Lab: Electromagnetism (Faraday's Law)** Induced EMF Lenz's Law Emf Induced in a Moving Conductor Electric Generator Physlets Practice Problems

Theme/ Unit	Section	Objectives	Assessments	Content Plan
Unit 10: Vibrations and Waves	Simple Harmonic Motion	Students will be able to: ✓ Sketch and identify a graph of displacement as a function of time, and determine from such a graph the amplitude, period, and frequency of the simple harmonic motion. ✓ Write down an appropriate expression for displacement of the form A sin ωt or A cos ωt to describe the motion. ✓ State the relations between acceleration, velocity, and displacement, and identify points in the motion where these quantities are zero or achieve their greatest positive and negative values. ✓ State and apply the relation between frequency and period. ✓ State how the total energy of an oscillating system depends on the amplitude of the motion, sketch and identify a graph of kinetic or potential energy as a function of time, and identify points in the motion where this energy is all potential or all kinetic. ✓ Calculate the kinetic and potential energies of an oscillating system as functions of time, sketch or identify graphs of these functions, and prove that the sum of kinetic and potential energy is constant ✓ Apply the expression for the period of oscillation of a mass on a spring ✓ Analyze problems in which a mass hangs from a spring and oscillates vertically ✓ Analyze problems in which a mass attached to a spring oscillates horizontally ✓ Apply the expression for the period of a simple pendulum ✓ State what approximation must be made in deriving the period	Section Quiz Unit Exam	**Lab: Simple Pendulum** **Lab: Spring w/ Mass** Simple Harmonic Motion Energy and SHM Physlets Practice Problems

	Wave s	Students will be able to: ✓ Sketch and identify graphs that represent traveling waves and determine the amplitude, wavelength, and frequency of a wave from such a graph ✓ Apply the relation among wavelength, frequency, and velocity for a wave ✓ Describe reflection of a wave from the fixed or free end of a string ✓ Describe qualitatively what factors determine the speed of waves on a string and the speed of sound ✓ Differentiate between transverse and longitudinal waves and explain qualitatively why transverse waves can exhibit polarization ✓ Use the inverse-square law to calculate the intensity of waves at a given distance from a source of specified power and compare the intensities at different distances from the source ✓ Sketch possible standing wave modes for a stretched string that is fixed at both ends and determine the amplitude, wavelength, and frequency of such standing waves ✓ Apply the principle of superposition to traveling waves moving in opposite directions and describe how a standing wave may be formed by superposition	Section Quiz Unit Exam	Wave Energy and Intensity Reflection and Transmission Superposition Standing Waves Physlets Practice Problems
	Sound	Students will be able to: ✓ Describe possible standing sound waves in a pipe that has either open or closed ends and determine the wavelength and frequency of such standing waves ✓ Explain qualitatively using the Doppler effect for sound why there is a frequency shift in both the moving-source and moving-observer case	Section Quiz Unit Exam	Sound Waves Tutorial: Characteristics of Sound Sound Interference The Doppler Effect Physlets Practice Problems

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Theme/ Unit	Section	Objectives	Assessments	Content Plan
Unit 11: Optics	Electromagnetic Spectrum	Students will be able to: ✓ Identify the names associated with electromagnetic radiation and arrange them in order of increasing wavelength the following: visible light of various colors, ultraviolet light, infrared light, Radio waves, x-rays, and gamma rays.	Section Quiz Unit Exam	Maxwell's Equations Electromagnetic Waves The Existence of EM Waves The Electromagnetic Spectrum Measuring the Speed of Light Physlets Practice Problems
	Reflection and Mirrors	Students will be able to: ✓ Locate by ray tracing the image of an object formed by a plane mirror and determine whether the image is real or virtual, upright or inverted, enlarged or reduced in size ✓ Relate the focal point of a spherical mirror to its center of curvature ✓ Locate by ray tracing the image of a real object, given a diagram of a mirror with the focal point shown, and determine whether the image is real or virtual, upright or inverted, enlarged or reduced in size ✓ Use the mirror equation to relate the object distance, image distance, and focal length for a lens, and determine the image size in terms of the object size	Section Quiz Unit Exam	Ray Model of Light Describing Images Flat Mirrors Curved Mirrors Lab: Spherical Mirrors Mirror Equations Physlets Practice Problems

	Refraction and Lenses	Students will be able to: ✓ Determine how the speed and wavelength of light change when light passes from one medium to another ✓ Show on a diagram the directions of reflected and refracted rays ✓ Use Snell's Law to relate the directions of the incident ray and the refracted ray, and the indices of refraction of the media ✓ Identify conditions under which total internal reflection will occur ✓ Determine whether the focal length of a lens is increased or decreased as a result of a change in the curvature of its surfaces or in the index of refraction of the material of which the lens is made, or the medium in which it is immersed ✓ Determine by ray tracing the location of the image of a real object located inside or outside the focal point of the lens, and state whether the resulting image is upright or inverted, real or virtual ✓ Use the thin lens equation to relate the object distance, image distance, and focal length for a lens, and determine the image size in terms of the object size ✓ Analyze simple situations in which the image formed by one lens serves as the object for another lens	Section Quiz Unit Exam	Index of Refraction and Snell's Law **Lab: Snell's Law** Total Internal Reflection Lenses Thin Lenses and Ray Tracing Magnification Lens Combinations Physlets Practice Problems

	Interference, Diffraction, and Polarization	Students will be able to ✓ Describe the conditions under which the waves reaching an observation point from two or more coherent sources will all interfere constructively or under which the waves from two coherent sources will interfere destructively ✓ Determine locations of interference maxima or minima for two sources or determine the frequencies or wavelengths that can lead to constructive or destructive interference at a certain point ✓ Relate the amplitude produced by two or more sources that interfere constructively to the amplitude and intensity produced by a single source ✓ Sketch and identify the intensity pattern that results when monochromatic waves pass through a single slit and fall on a distant screen, and describe how this pattern will change if the slit width or the wavelength of the waves is changed ✓ Calculate for a single-slit pattern the angles or the positions on a distant screen where the intensity is zero ✓ Sketch and identify the intensity pattern that results when monochromatic waves pass through a double slit, and identify which features of the pattern result from single-slit diffraction and which from two-slit interference ✓ Calculate, for a two-slit, interference pattern, the angles or the positions on a distant screen at which intensity maxima or minima occur ✓ Describe and identify the interference pattern formed by a diffraction grating, calculate the location of intensity maxima and explain qualitatively why a multiple-slit grating is better than a two-slit grating for making accurate determinations of wavelength ✓ State under what conditions a phase reversal occurs when light is reflected from the interface between two media of different indices of refraction (thin films) ✓ Determine whether rays of monochromatic light reflected perpendicularly from two such interfaces will interfere constructively or destructively, and thereby account for Newton's rings and similar phenomena, and explain how glass may be coated to minimize reflection of visible light ✓ Relate a variation of index of refraction with frequency to a variation in refraction	Section Quiz Unit Exam	Huygens' Principle Single-Slit Diffraction Diffraction Maxima and Minima Young's Double-Slit Experiment Double-Slit Interference Maxima and Minima Diffraction Grating Thin Film Interference Polarization Physlets Practice Problems

AP Physics B Course Syllabus

Theme/ Unit	Section	Objectives	Assessments	Content Plan
Unit 12: Modern Physics	Atomic Physics and Quantum Effects	Students will be able to: ✓ Relate the energy of a photon in joules or electron-volts to its wavelength or frequency ✓ Relate the linear momentum of a photon to its energy or wavelength and apply linear momentum conservation to simple processes involving the emission, absorption, or reflection of photons ✓ Calculate the number of photons per second emitted by a monochromatic source of specific wavelength and power ✓ Describe a typical photoelectric-effect experiment and explain what experimental observations provide evidence for the photon nature of light ✓ Describe qualitatively how the number of photoelectrons and their maximum kinetic energy depend on the wavelength and intensity of the light striking the surface and account for this dependence in terms of a photon model of light ✓ Determine the maximum kinetic energy of photoelectrons ejected by photons of one energy or wavelength when given the maximum kinetic energy of photoelectrons for a different photon energy or wavelength ✓ Sketch and identify a graph of stopping potential versus frequency for a photoelectric-effect experiment, determine from such a graph the threshold frequency and work function, and calculate an approximate value of h/e ✓ Describe Compton's experiment and state what results were observed and by what sort of analysis these results may be explained (Compton scattering) ✓ Account quantitatively for the increase of photon wavelength that is observed and explain the significance of the Compton wavelength ✓ Calculate the shortest wavelength of x-rays that may be produced by electrons accelerated through a specified voltage	Section Quiz Unit Exam	Video: Atomic Physics Planck and Blackbody Radiation Photon Theory of Light and the Photoelectric Effect Photon Mass, Momentum, and Energy Lab: The Photoelectric Effect (virtual) Compton Effect and X-Ray Scattering Pair Production Practice Problems

	Atomic Energy Levels and Wave-Particle Duality	Students will be able to: ✓ Calculate the energy or wavelength of the photon emitted or absorbed in a transition between specified energy levels of the atom or the energy or wavelength required to ionize an atom ✓ Explain qualitatively the origin of emission or absorption spectra of gases ✓ Calculate the wavelength or energy for a single-step transition between energy levels, given the wavelengths or energies of photons emitted or absorbed in a two-step transition between the same energy levels ✓ Draw a diagram to depict the energy levels of an atom when given an expression for these levels and explain how this diagram accounts for the various lines in the atomic spectrum ✓ Calculate the wavelength of a particle as a function of its momentum ✓ Describe the Davisson-Germer experiment and explain how it provides evidence for the wave nature of electrons ✓ Explain wave-particle duality of the atom and how it relates to the concept of de Broglie wavelength.	Section Quiz Unit Exam	Wave-Particle Duality Particles as Waves: The de Broglie Wavelength What is an Electron? Atomic Structure Video: Bohring the Atom Atomic Spectra Practice Problems
	Nuclear Physics	Students will be able to: ✓ Interpret symbols for nuclei that indicate mass number and charge of nuclei ✓ Use conservation of mass number and charge to complete nuclear reactions ✓ Determine the mass number and charge of a nucleus after it has undergone specified decay processes ✓ Compare the strength and range of nuclear force with those of electromagnetic force ✓ Describe a typical neuron-induced fission and explain why a chain reaction is possible ✓ Qualitatively relate energy released in nuclear processes to the change in mass ✓ Apply the relationship $\Delta E = (\Delta m)c^2$ in analyzing nuclear processes.	Section Quiz Unit Exam	Video: Structure of the Atom Radioactive Decay Equations Video: Energy From an Atom Fission and Fusion Equations Practice Problems

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Theme/ Unit	Section	Objectives	Assessments	Content Plan
Final Exam	Preparing for the Exam	Demonstrate proficiency in AP Physics B	Practice AP Exam	Review for Final Exam Review for AP Exam
	Taking the Exam	Students will be able to: Demonstrate proficiency in AP Physics	Final Exam (AP Exam)	