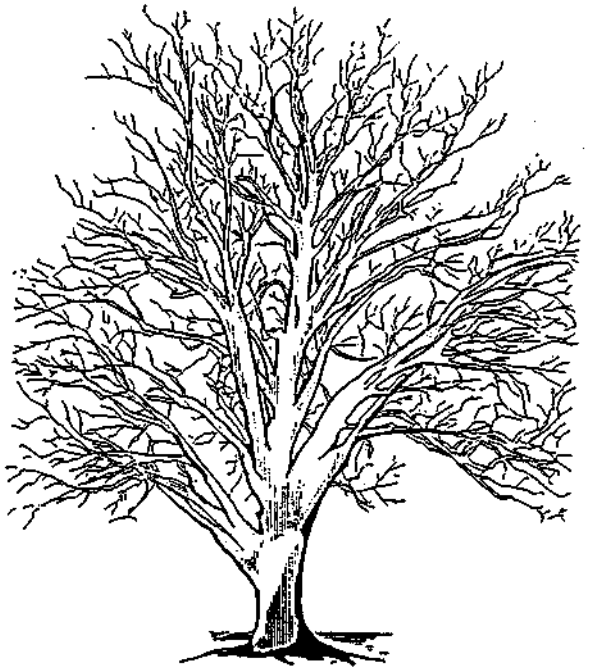
Monroe Township Schools



Curriculum Management System

AP Physics B

Grade 12

July 2008

*** For adoption by all regular education programs as specified and for adoption or adaptation by all Special Education Programs in accordance with Board of Education Policy # 2220.**

Board Approved: August 2008

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Acknowledgments

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Monroe Township Schools

Mission and Goals

Mission

The mission of the Monroe Township School District, a unique multi-generational community, is to collaboratively develop and facilitate programs that pursue educational excellence and foster character, responsibility, and life-long learning in a safe, stimulating, and challenging environment to empower all individuals to become productive citizens of a dynamic, global society.

Goals

To have an environment that is conducive to learning for all individuals.

To have learning opportunities that are challenging and comprehensive in order to stimulate the intellectual, physical, social and emotional development of the learner.

To procure and manage a variety of resources to meet the needs of all learners.

To have inviting up-to-date, multifunctional facilities that both accommodate the community and are utilized to maximum potential.

To have a system of communication that will effectively connect all facets of the community with the Monroe Township School District.

To have a staff that is highly qualified, motivated, and stable and that is held accountable to deliver a safe, outstanding, and superior education to all individuals.

INTRODUCTION, PHILOSOPHY OF EDUCATION, AND EDUCATIONAL GOALS

Philosophy

The AP Physics course will provide students with inquiry- based skills and an understanding of the scientific process, which will enable them to be successful in their exploration and investigation of our ever-changing technological world. Students will develop higher - level critical thinking and problem - solving skills that will allow them to explore their scientific environment in a multi-sensory "hands-on" and "minds-on" manner. Students' inquiry-oriented experiences will allow them to construct their own understanding of science and technology and provide opportunities for modeling true scientific practices. Students will use the Scientific Method as an approach to inquiry-based investigations. Other approaches, such as "ACACC" (developed at Monroe), the "5 E's" used by McGraw Hill or the Frisch model, may be used. Students will be able to recognize the contributions, as well as, the diverse, cultural, and social backgrounds of scientists. Students will be exposed to and use scientific tools and apparatus, scientific nomenclature and SI (metric) measurement. Students will learn and understand the underlying safety principles during their practice of Science. Workplace Readiness and Process skills will be embedded in the Program. The use of technology is infused throughout the curriculum. Students will be exposed to opportunities to develop their skills and knowledge in Mathematics and Language Arts as they practice Science.

Educational Goals

Through the primary goals of AP Physics students will:

- engage in experiences that will foster and develop scientific inquiry,
- develop and construct their own understanding of science,
- understand and utilize the scientific process,
- promote an awareness of the availability and diversity of the scientific profession,
- apply safety practices in scientific exploration,
- integrate technology and other tools throughout the scientific process.

New Jersey State Department of Education
Core Curriculum Content Standards

The New Jersey Core Curriculum Content Standards for Science were revised in 2002. The Cumulative Progress Indicators (CPI's) referenced in this curriculum guide refer to these new standards and may be found in the Curriculum folder on the district servers. A complete copy of the new Core Curriculum Content Standards for Science may also be found at: http://www.nj.gov/njded/cccs.htm.

AP Physics B

Scope and Sequence

<table>
<tr><th colspan="2">Quarter I</th></tr>
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Big Idea: The Influence of Forces on motion and interaction in our world and the Universe.

Sub-Topics

I. Motion in one and two dimensions (Uniform and accelerated motion, Projectiles and circular motion)
II. Forces and Newton's Laws of Motion, applied to single particles and systems of connected objects.
III. Circular motion
IV. Newton's law of Universal Gravitation and Kepler's Laws of Planetary Motion.
V. Torque, Rotational Statics and Dynamics

a. Characteristics and Attributes: Distinguish between speed and velocity; Compare characteristics of uniform and accelerated motion; Identify different types of forces and their origin; Define torque.
b. Models: Construct graphical and analytical models to describe motion; Analyze graphs of kinematic variables versus time; Examine forces using Free-body diagrams; Utilize free-body diagrams to determine net force in the radial direction to describe circular motion; Construct and interpret Free-body diagrams to calculate torque and rotational acceleration.
c. Changes: Transform graphs of position, velocity or acceleration versus time into graphs of an alternative kinematic variable as a function of time; Analyze how the application of forces changes the motion of objects; Survey the factors that affect torque and evaluate the changes in torque when these factors are changed.
d. Systems: Analyze the motion of systems of connected objects, moving under the influence of multiple forces.

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Big Idea: Energy as the source of Motion in the Universe.

Sub-Topics

I. Work
II. Kinetic and Potential Energy.
III. The Work-Energy Theorem
IV. The Law of conservation of Energy and Energy transformations
V. Linear momentum, Impulse, Conservation of Momentum
VI. Application of momentum conservation to collisions
VII. Simple harmonic motion

a. Characteristics and Attributes: Define work and the conditions under which work is performed; Understand the circumstances under which objects have kinetic energy and when they have potential energy; describe the characteristics of simple harmonic motion.
b. Classification: Classify different forms of energy; Distinguish between the two forms of mechanical energy, i.e. Kinetic and potential energy; Differentiate between types of collisions.
c. Models: Utilize pictorial and mathematical models to analyze energy transformations and particle interactions like collisions and explosions; Apply free-body diagrams to determine the restoring forces acting on objects undergoing simple harmonic motion.
d. Changes: Investigate the transformation of energy from one form to another; analyze the mechanism for the conversion of work to energy using the Work-Energy theorem; Understand the factors affecting the period of oscillation of objects executing simple harmonic motion.
e. Systems: Investigate the mutual interactions of systems of colliding objects and the consequent effects on the motion of the objects in the system.

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Quarter II

Big Idea: **The Motion of fluids and its applications in weather phenomena and transportation.**

Subtopics:

I. Fluid Mechanics

a. Characteristics and Attributes: Recognize that fluids exert forces in all directions; Define pressure as force per unit area; Realize that objects immersed in fluids experience buoyant forces; distinguish between laminar and turbulent flow.
b. Models: Determine forces acting on objects placed in a fluid using free-body diagrams
c. Changes: Analyze variation in pressure of a fluid with depth; Relate fluid speed differences to pressure differences.
d. Function: Utilize Archimedes principle, Pascal's principle and Bernoulli's equation to solve problems related to everyday applications of fluid mechanics.
e. Systems: Assess the performance of mechanical systems such as hydraulic presses and hydraulic brakes by applying the principles of fluid mechanics.

Big Idea: **Heat as a form of energy and the laws of thermodynamics as the principle underlying modern household appliances.**

Subtopics:

I. Heat energy, calorimetry and heat transfer processes
II. Kinetic theory of gases and the ideal gas laws.
III. The laws of thermodynamics and their applications.

a. Characteristics and Attributes: Define specific heat capacities; Define the Absolute zero of the Kelvin scale; Define the mechanical equivalent of heat; State the ideal gas laws; Define work, internal energy, entropy; Compare the characteristics of various thermodynamic processes; define the coefficient of expansion of materials when heated or cooled;
b. Classification: Categorize thermodynamic processes as isothermal, adiabatic, isochoric and isobaric processes.
c. Models: Construct pressure-volume graphs to analyze thermodynamic processes.
d. Function: Analyze and apply the ideal gas laws and kinetic theory of gases to evaluate changes in internal energy, heat transferred and work done during a thermodynamic process.
e. Changes: Predict the changes in pressure, temperature and volume caused by a change in any of these state variables; Explain the changes of phase produced by heating or cooling of a substance; Determine the changes in the sizes of objects when subjected to changes in temperature, and the practical applications of the same.

Big Idea: **The transfer of energy through Waves and vibrations and their applications to communication and optics. Sub-topics:**

I. Traveling Waves and Wave Properties (Transverse and Longitudinal waves)
II. Wave Interference and Diffraction (Double slit, Single slit Diffraction, Thin films and diffraction gratings)
III. Stationary waves (Strings and pipes, musical instruments)
IV. Sound waves and the Doppler Effect (Changes in pitch and color)
V. Light waves, Physical and Geometric Optics (Thin Films, Lenses and Mirrors)

a. Function : Analyze Simple harmonic motion produced by pendulums and springs in various configurations;
b. Change: Evaluate the factors that affect the characteristics of simple harmonic vibrations and changes produced by variations of these factors.
c. Systems: Discover the mechanism of transfer of energy by vibrating systems of oscillators to generate traveling waves; Examine the

interactions of waves to generate stationary wave patterns, interference and diffraction patterns. d. Classifications and Attributes: Distinguish between longitudinal and transverse waves and compare their properties; Analyze the properties of sound waves as an example of longitudinal waves and light waves as an example of transverse waves. e. Models: Analyze the perception of pitch and color changes associated with the relative motion of source and observer (Doppler Effect) for both sound and light; Construct ray diagrams for lenses and mirrors to determine the properties of images formed.	

Quarter III

Big Idea: The interplay of electrical and magnetic effects and their impact on daily living.

Subtopics

I. Electrostatics, Electric fields and forces
II. Electrical Energy, Potential and capacitance
III. Current, Resistance, Power and Circuit Analysis

a. Characteristics and Attributes: Analyze "action at a distance" or "field" forces, in particular electrical forces; Discover the behavior of charged particles; Compare the properties of conductors, insulators and superconductors; Discuss the behavior of capacitors; define electrical potential; Define resistivity and conductivity; Define electrical potential and potential difference.
b. Classification: Classify the methods of charging objects, i.e. conduction, induction, polarization; Distinguish between parallel, series and complex circuits.
c. Change: Analyze the transformation of electrical potential energy to kinetic energy and vice versa for charges in motion; Determine the factors affecting resistance and capacitance and the changes produced by variations in these factors; Discover the conversion of energy stored in a capacitor to other forms of energy.
d. Models: Simplify complex circuits, draw schematic circuit diagrams and analyze the currents and potential drops in these circuits; Construct electron charge transfer diagrams to analyze the charging and discharging of various objects; Construct and interpret electric field diagrams for various charge configurations and analyze the properties of the electrical field at any location.
e. Systems: Analyze circuits consisting of systems of resistors, capacitors and electrical devices.

Big Idea: The interplay of electrical and magnetic effects and their impact on daily living.

Sub-topics

I. Magnetostatics, magnetic fields and forces
II. Electrodynamics, electromagnetic induction and power generation

a. Characteristics and Attributes: Discuss the properties of Earth's magnetic field; Define magnetic flux; Describe the paths of charged particles in magnetic and electrical fields; State and analyze Ampere's law, Faraday's law and Lenz's law.
b. Change: Examine the factors affecting the magnetic field produced by a current carrying solenoid; Analyze the factors affecting the magnetic flux through a conducting loop and the changes produced in flux by variation of these factors; Determine the electromotive force generated in current carrying loops and conductors by changing magnetic flux.
c. Models: Analyze electro-magnetic forces using free-body diagrams; Determine the directions of forces and fields using hand rules; Visualize magnetic fields and forces by constructing magnetic field line diagrams.
d. Function: Calculate Lorentz forces on charged particles; Determine the force on a current carrying conductor in a magnetic field and the force between two current carrying conductors; calculate the torque on a current carrying loop in a magnetic field; Calculate the magnetic field produced by current carrying straight conductors, loops and solenoids; Determine the emf generated in a conductor using Faraday's and Lenz's laws.

Big Idea: The Fundamental Nature of Energy and Matter in the Universe

Sub-topics

I. The dual nature of the Photon (Photo-electric effect)
II. Wave particle duality and the DeBroglie wavelength of particles
III. The structure of atoms.(Rutherford and Bohr models of the atom)
IV. Atomic energy levels and emission and absorption spectra of atoms.
V. Ground breaking experiments in Quantum Physics
VI. The structure of the Nucleus
VII. Nuclear decay and radioactivity
VIII. Nuclear reactions
IX. Mass-energy equivalence.

a. Characteristics and Attributes: Relate energy of a photon in electron volts or joules to its wavelength and frequency; Define Threshold frequency and work function for target materials; Define mass number and atomic number of nuclei and interpret symbols for nuclei; Link the momentum of an object to its DeBroglie wavelength; State and use $\Delta E=\Delta mc^2$, i.e. mass-energy equivalence; Describe the properties of the three types of radiation, Alpha, Beta and Gamma; Define half-life of radioactive materials; Analyze the nature and production of X-rays; Compare the nature and origins of nuclear forces to other fundamental forces. b. Change: Describe the Compton scattering experiment and account for the increase in photon wavelength; Analyze the variation of the maximum kinetic energy of photo electrons with intensity and frequency of the incident light; Prove that the change in mass that is observed during a nuclear reaction results in energy release. c. Models: Graph stopping potential vs. frequency, and deduce the threshold frequency and work function from the same; Analyze the Bohr and Rutherford models of the atom; Construct energy level diagrams for atoms and utilize these to determine the wavelength of radiation emitted and absorbed during transitions between energy levels.	
Quarter IV	
Big Idea: Synthesis of skills acquired during the year-long learning process **I. Preparation for the AP Physics Examination.** a. Function: Reflection on and synthesis of essential concepts and skills learned during the academic year.	**Big Idea: Synthesis of skills acquired during the year-long learning process** **I. Independent Research project** **II. Independent research and development of a fully operational device** a. Adaptation: Compile existing knowledge and provide in-depth insight, using available resources, into a topic in Modern Physics, not covered previously; Design and build a device to preset specifications.

Suggested blocks of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The Influence of Forces on motion and interaction in our world and the Universe. Topic: 1-D and 2-D Kinematics Goal 1: The student will be able to analyze and perform calculations for motion in one and two-dimensions	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
5	1.1. Analyze position, velocity, and acceleration versus time graphs for an object moving along a straight line to determine if these variables are constant, positive, negative or zero and sketch a graph of each as a function of time. (5.7.12.A, 5.3.12.D.1) 1.2. Discover information about the other two kinematic varables when presented with a graph of a single kinematic variable as a function of time 1.3. Formulate expressions for velocity and position as functions of time, and identify and sketch graphs of these quantities for an object moving with a constant acceleration (5.7.12.A, 5.3.12.D.1) 1.4. Determine the mathematical relationship between velocity, displacement and time for motion with constant velocity (5.7.12.A) 1.5. Solve problems involving one-dimensional motion with constant acceleration, by applying kinematic equations (5.7.12.A) 1.6. Categorize physical quantities into vectors, quantities that have both a magnitude and direction and scalars, quantities that have only magnitude(5.3.12.B.1). 1.7. Determine the component of a vector along a specified axis, or resolve a vector into components along two specified mutually perpendicular axes (5.7.12.A, 5.3.12.B.1) 1.8. Construct a vector diagram and add vectors to determine the net displacement of a	• Why is it important for track athletes to know the maximum bursts of speed that they are capable of? • How would you analyze skid marks to determine whether a vehicle was speeding before an accident? • At what location should a US Air Force plane flying over a disaster area release a relief package, so that it reaches the inhabitants of an isolated village? • Describe the speed and direction in which a javelin thrower at the Olympics should launch his javelin to attain the maximum range for his throw? • What factors should the quarterback consider when he passes the football to a receiver?	**NOTE: The assessment models provided in this document are suggestions for the teacher. If the teacher chooses to develop his/her own model, *it must be of equal or better quality and at the same or higher cognitive levels (as noted in parentheses*).** **Depending upon the needs of the class, the assessment questions may be answered in the form of essays, quizzes, mobiles, PowerPoint, oral reports, booklets, or other formats of measurement used by the teacher.** **Completed student work will be assessed using a variety of evaluative criteria, including but not limited to rubrics.** **Assessment Model #1:** Ask students to imagine that they are TV game show designers and one of the events they design has two motion sequences represented by a position-time and velocity-time graph respectively. The winner is the contestant who is able to interpret the graphs and move so as to most accurately trace the two motion graphs. Each group should construct two motion graphs. Group members move to retrace the graphs. Materials provided include masking tape, motion detectors, timers, and measuring tape. Students should analyze their experiment and present their results and conclusions -Graphically

Suggested blocks of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics B**	**Big Idea: The Influence of Forces on motion and interaction in our world and the Universe.** **Topic: 1-D and 2-D Kinematics** **Goal 1: The student will be able to analyze and perform calculations for motion in one and two-dimensions**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	particle that undergoes successive straight-line displacements (5.7.12.A, 5.3.12.B.1) 1.9. Determine the location of one particle relative to another, by subtracting displacement vectors or calculate average velocity of a particle (5.7.12.A, 5.3.12.B.1) 1.10. Calculate the velocity change, average acceleration of a particle, or the velocity of one particle relative to another by adding or subtracting velocity vectors. (5.7.12.A, 5.3.12.B.1) 1.11. Discover the properties of projectile motion, write expressions for the horizontal and vertical components of velocity and position as functions of time, and sketch and analyze graphs of these components (5.7.12.A, 5.3.12.D.1) 1.12. Analyze the motion of a projectile that is projected above the level ground with a specified initial velocity, and lands at, above, or below the level from which it was projected, using kinematic equations. (5.7.12.A)		-Analytically and mathematically -in a written report **(***Analysis, Synthesis***)** **Assessment Model #2:** An amateur archer is trying to perfect his aim before a competition. Students should develop an experiment to assist the archer by varying the trajectory of a projectile so that it hits the target. Materials provided will include a movable target, a projectile launcher, various projectiles and carbon paper to mark the landing positions of the projectiles. Students will provide analysis of their experiment -Graphically - Mathematically -in a written report **(***Analysis, Synthesis, Evaluation)* **Assessment Model #3:** Reaction time is very important in sports and even while driving a car. The only material needed to measure reaction time is a ruler. Have students work in small group configurations with one partner dropping the ruler and the other trying to catch it as quickly as possible. Students should perform 5 trials and take the average value. They will calculate their own reaction time and then compare it to that of their peers. Analysis of various factors that might affect reaction time is required. Is it safe to drive while drowsy? Students will discuss their conclusions in an oral presentation and by posting results on a whiteboard. **(***Analysis, Synthesis)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The influence of forces on motion and interaction in our world and the larger Universe Topic: Newton's Laws of Motion and Forces Goal 2: The student will be able to demonstrate an understanding of the forces of nature and describe how one or more forces affect the motion of objects.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
10	2.1. Analyze situations in which a particle remains at rest, or moves with constant velocity, under the influence of several forces (5.7.12.A.1) 2.2. Discover the relationship between the force that acts on a body and the resulting change in the body's velocity (5.7.12.A.1) 2.3. Determine, for a body moving in one direction, the velocity change that results when a constant force acts over a specified time interval (5.7.12.A.1) 2.4. Determine, for a body moving in a plane whose velocity vector undergoes a specified change over a specified time interval, the average force that acted on the body (5.7.12.A.1) 2.5. Examine how Newton's Second Law of motion applies to a body subject to forces such as gravity, the pull of strings, or contact forces (5.7.12.A.1) 2.6. Construct a well-labeled free-body diagram showing all real forces that act on the body (5.7.12.A) 2.7. Formulate the vector equation that results from applying Newton's Second Law to the body, and choose appropriate axes to resolve this equation into components (5.7.12.A.1) 2.8. Analyze situations in which a body moves with specified acceleration under the influence of one or more forces and determine the magnitude and direction of the net force, or of the force that makes up the net force for the following situations: vertical motion with constant	• Friction appears to impede motion. Is friction neccessary at all for everyday life? What would happen if friction disappeared? • Why do you lunge forward when your car suddenly comes to a stop? • Would you feel lighter or heavier in an elevator accelerating upward? Why? • Is air resistance always undesirable? What are some applications of air resistance? • If gold were sold by weight, would you rather buy it at Death Valley or in Denver? Where would you rather sell it? Defend your response. • A circus performer hangs from a rope. She then begins to climb upwards. As she begins to climb, is the tension in the rope greater than, equal to or less than when she was stationary? • Your little brother and you stand facing each other on the skating	**Assessment Model #1:** The class will play a quiz game that assesses the students' essential conceptual understanding of the material presented including Newton's Laws of motion and forces. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, iat the end of which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. (**(***Analysis, Synthesis)* **Assessment Model #2:** Knowing the coefficient of friction between two surfaces is valuable information, with applications in highway construction. It is one of the factors considered when highway speed limits are determined. Students will imagine that they are highway engineers and develop an experiment to calculate the coefficients of static and kinetic friction between felt and wood. Any mathematical expressions used must be derived. Students must conduct at least five trials to ensure statistical accuracy. Materials provided will include Felt bottom carts, Wood ramps, spark timers, pulleys, strings, hanging masses, and other materials as

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics B**	**Big Idea: The influence of forces on motion and interaction in our world and the larger Universe** **Topic: Newton's Laws of Motion and Forces** **Goal 2: The student will be able to demonstrate an understanding of the forces of nature and describe how one or more forces affect the motion of objects.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	acceleration (as in an elevator), motion in a horizontal circle (merry-go-round, banked curve), motion on a horizontal circle (curved track, Ferris wheel) (5.7.12.A.1) 2.9. Discover the significance of the coefficient of friction (5.7.12.B.1) 2.10. Formulate the relationship between the normal force and the frictional forces on a surface (5.7.12.B.1) 2.11. Analyze situations in which a body slides down a rough inclined plane or is pulled or pushed across a rough surface (5.7.12.A.1, 5.7.12.B.1) 2.12. Analyze static situations involving friction to determine under what circumstances a body will start to slip, or to calculate the magnitude of the force of static friction (5.7.12.A.1, 5.7.12.B.1) 2.13. Utilize Newton's Third Law to identify action-reaction force pairs(5.7.12.A.2) 2.14. Analyze the contact forces between two bodies that accelerate together along a horizontal or vertical line, or between two surfaces that slide across one another (5.7.12.A.2) 2.15. Conclude that tension is constant in a light string that passes over a mass-less pulley and utilize this property to analyze the motion of a system of bodies connected by strings (5.7.12.A.1, 5.7.12.A.2)	rink. You push off each other. Who experiences the greater force? Who accelerates more? • You have a choice of *pushing* or *pulling* a sled at an angle to move it at a constant velocity. Friction is present. Should you push or pull the sled? Justify your answer.	necessary. Students will present their results graphically as part of a written lab report. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #3:** Have students predict what would happen to the scale reading on a bath scale if they stood on it while riding on an elevator. Students must justify their predictions with an exposition of the underlying theory. Provide students with bathroom scales to stand on while riding on the school elevator. Students record what happens to the scale reading as the elevator moves upward and downward. Students graph the scale reading as a function of time and analyze what the readings on the scale demonstrate about the acceleration of the elevator. Did your results match your predictions? Present your analysis and conclusions in a written report. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/ AP Physics B	Big Idea: the Influence of forces on the motion in our world and the larger Universe Topic: Rotational Statics, Dynamics and Newton's law of Universal Gravitation Goal 3: The student will be able to exhibit an understanding of rotational motion, rotational equilibrium and rotational dynamics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
10	3.1. Formulate the equation connecting the radius of the circle, the speed or rate of revolution of the particle undergoing uniform circular motion, and the magnitude of the centripetal acceleration (5.7.12.A) 3.2. Identify the direction of the particle's velocity and acceleration at any instant during uniform circular motion (5.7.12.A) 3.3. Determine the components of the velocity and acceleration vectors at any instant of uniform circular motion, and construct and analyze graphs of these quantities (5.7.12.A) 3.4. Discuss the conditions under which the law of conservation of angular momentum is applicable and apply this law to one- and two-particle systems such as satellite orbits (5.7.12.A) 3.5. Determine the force that one spherically symmetrical mass exerts on another, using Newton's Law of Gravitation. (5.7.12.A.3) 3.6. Evaluate the strength of the gravitational field at a specified point outside a spherically symmetrical mass, using Newton's Law of Gravitation. (5.7.12.A.3) 3.7. Estimate the escape velocity of a satellite launched from earth. (5.7.12.A.3) 3.8. Conclude that the motion of a body in circular orbit under the influence of gravitational forces does not depend on the body's mass. (5.7.12.A.3) 3.9. Examine how the velocity, period of revolution, and centripetal acceleration	• You place a penny on a turntable. You start rotating the turntable faster and faster, and the penny flies off at some point. Explain. How would this scenario change if you placed a paperweight at the same location on the turntable? • You like excitement and love to go fast, but your friend is not quite so adventurous. Both of you ride a carousel at Six Flags. Who should sit on the outside of the carousel? • If gravitational attraction were to suddenly disappear, what would happen to our earth and the solar system? Describe the motion of earth if such a circumstance were to occur • Why are sharp turns on a highway heavily banked? • Why is it especially important to stay under the speed limit on curves when the road conditions are icy? • You will notice that the speed limit is often lower in sections where the road curves sharply. How is this speed limit calculated by road architects?	**Assessment Model #** 1: The teacher will present the following scenario to the class. Tarzan sees Jane on the opposite bank of a stream, running from an irate tiger. Tarzan swings across on a vine to rescue Jane. When Tarzan and Jane swing back, what must the tensile strength of the vine be, so that the vine does not break, depositing them safely on the opposite bank, as opposed to the piranha-infested stream? Students will be asked to develop an experiment to measure the tension of a swinging string with a suspended mass, at the bottom of its swing. Students should predict whether changing the mass would affect the tension. Materials provided will include computers, force meters, string and various masses. Students should analyze results and present their observations graphically and write a detailed report listing their predictions with scientific justification, and their conclusions. There could be a classroom discussion of errors and modifications to optimize the experiment. **(***Analysis, Synthesis, Evaluation)* **Assessment Model # 2:** The class will play a quiz game that tests the students' essential conceptual understanding of the circular motion and Universal Gravitation. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/ AP Physics B**	**Big Idea: the Influence of forces on the motion in our world and the larger Universe** **Topic: Rotational Statics, Dynamics and Newton's law of Universal Gravitation** **Goal 3: The student will be able to exhibit an understanding of rotational motion, rotational equilibrium and rotational dynamics.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	depend upon the radius of the circular orbit (5.7.12.A.3) 3.10. Derive expressions for the velocity and period of revolution of a body in circular orbit (5.7.12.A.3) 3.11. Analyze and apply Kepler's laws of planetary motion 3.12. Determine the velocity and radial distance of an object in a general orbit at any point, by applying conservation of angular momentum (5.7.12.A.3) 3.13. Analyze and apply angular momentum conservation and energy conservation to relate the speeds of a body at the two extremes of an elliptic orbit (5.7.12.B.2) calculate the magnitude and sense of the torque associated with a given force (5.7.12.A) 3.14. Determine the torque on a rigid body due to gravity (5.7.12.A) 3.15. Analyze problems in statics and state the conditions for translational and rotational equilibrium of a rigid body (5.7.12.A) 3.16. Analyze the translational and rotational equilibrium of a rigid body under the combined influence of a number of coplanar forces applied a different locations (5.7.12.A)	• Does the earth orbit the sun at a constant speed? Justify your answer. • You try to balance a baton by placing and your fingertip under its center, but you find that it spins and falls. Why? • Why are door knobs placed at the edge farthest away from the hinges? • How would you balance a seesaw with several children of different weights sitting on it?	other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model # 3:** Students will be asked to design and construct a complex mobile with hanging components of varying masses. Students will draw a schematic of their mobile with a free-body diagram superimposed on it. Each group will calculate the torques acting on each of the arms of the mobile and demonstrate that the mobile satisfies the conditions for static equilibrium. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #4**: A seesaw in the toddler playground is not pivoted at the center. Students will develop an experiment in the lab to calculate the mass of the seesaw. Materials available are meter-sticks, pivot, various hanging masses and mass hangers. Students will present results and conclusions in a written report. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System **Grade Level/Subject: 12/ AP Physics**	**Big Idea: Energy as the source of motion in the Universe** **Topic: Work, Power and Energy** **Goal 4: The student will be able to define, explain and calculate work, different forms of energy and energy transformations**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
8	4.1. Define work (5.7.12.A) 4.2. Determine the work done by a specified constant force on a body that undergoes a specified displacement (5.7.12.A) 4.3. Perceive that the work done by a force is the area under a graph of force as a function of position, and calculate the work in the case where the force is a linear function of position(5.3.12.D.1, 5.7.12.A) 4.4. Evaluate the work performed by a specified constant force on a body that undergoes a displacement in a plane (5.7.12.A) 4.5. Infer the relationship between potential energy and work done by a conservative force. 4.6. Utilize the expression for the restoring force exerted by an ideal spring to calculate the potential energy stored in a stretched or compressed spring (5.7.12.B.2) 4.7. Determine the potential energy of a single body in a uniform gravitational field (5.7.12.B.2) 4.8. Define kinetic energy 4.9. Define mechanical energy as the sum of Kinetic energy, elastic potential energy and gravitational potential energy. 4.10. Determine the work performed by the net force, or by each of the forces that constitute the net force, on a body that undergoes a specified chasnge in speed and kinetic energy (5.7.12.B) 4.11. Explain the work-energy theorem and calculate the change in total energy that results from the performance of a specified	• According to legend, Atlas carries the earth on his shoulders. Presumably Atlas is very, very, tired. Has Atlas been doing any work? Explain. • A satellite orbits the earth in a circular orbit of 500 km. Does Earth's gravitational force do work? Explain. • A waiter carries a heavy tray of food across the restaurant to a table in the corner. Does the waiter do any work on the tray? • Two playground slides are of the same height. One is long and spirals down, while the other is a "wave" slide. At the bottom of which slide are children going faster? • On "El Toro" at Six Flags Great Adventure, is any hill higher than the first hill? Why? • A bowling ball is suspended from the ceiling of the Physics lab by a strong cord. The ball is now released from rest at the tip of the demonstrator's nose. Is the demonstrator safe as the ball swings back towards her nose? Does anything change if the ball is given a push at release? • Your Grandmother's old jalopy accelerates from 0-60 mph in 20 seconds, while your dad's Porsche does the same in 2 seconds. Whose	**Assessment Model #1:** Ask each student to imagine that they are a daredevil motorcyclist trying to leap across a canyon by driving horizontally off a cliff. The other side is lower than their side. They need to calculate the speed at which they must take off in order to land safely on the other side of the canyon. Using the materials provided i.e. a ramp, a small projectile and carbon paper, students should design an experiment to simulate their jump across the canyon. Students should derive any equations they use, and explain clearly the principles underlying their experimental design. Students will present results and conclusions in a detailed written report containing graphical and mathematical analysis. Student reports must include error analysis as well as a discussion of modifications to improve their experiment. **(***Analysis, Synthesis, Evaluation)* **Assessment Model # 2:** The class will play a quiz game that tests the students' essential conceptual understanding of the concepts of energy conservation and transformations. We will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/ AP Physics**	**Big Idea: Energy as the source of motion in the Universe** **Topic: Work, Power and Energy** **Goal 4: The student will be able to define, explain and calculate work, different forms of energy and energy transformations**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	amount of work by a non-conservative force acting on an object (5.7.12.B) 4.12. Employ the work-energy theorem to determine the change in an object's mechanical energy that results from the application of specified forces, or to determine the force that is required in order to bring a body to rest in a specified distance (5.7.12.B) 4.13. Discuss the law of conservation of energy as a special case of the work energy theorem, when no dissipative forces act on an object, and identify situations in which mechanical energy is conserved (5.7.12.B.2) 4.14. Analyze the motion of objects that are moving in a gravitational field and are subjected to constraints imposed by strings or surfaces (5.7.12.B.2, 5.7.12.B.3) 4.15. Utilize conservation of energy to analyze the motion of objects that move under the influence of springs (5.7.12.B.2, 5.7.12.B.3) 4.16. Define power and calculate the power required to maintain the motion of an object moving with constant acceleration (5.7.12.B) 4.17. Determine 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 (5.7.12.B)	car engine has greater power output?	participation. **(***Analysis, Synthesis)*

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics**	**Big Idea: Energy as the source of motion in the Universe** **Topic: Impulse and Momentum** **Goal 5: The student will be able to calculate linear momentum based on the definition and the law of conservation of momentum for different types of collisions**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
5	5.1. Relate mass, velocity, and linear momentum for a moving body, and calculate the total linear momentum of a system of bodies (5.7.12.A) 5.2. Relate impulse to the change in linear momentum and the average force acting on a body (5.7.12.A) 5.3. Identify situations in which linear momentum, or a component of the linear momentum vector, is conserved (5.7.12.A) 5.4. Determine the final velocities when two bodies that are moving along the same line, or at right angles, collide and stick together, (perfectly inelastic collision) and calculate how much kinetic energy is lost in such a collision (5.7.12.A, 5.7.12.B) 5.5. Analyze collisions of particles in one or two dimensions (head on and glancing collisions) to determine unknown masses or velocities, and calculate how much kinetic energy is lost in such a collision (5.7.12.A, 5.7.12.B)	• Cars manufactured since the nineties have the added safety features of airbags in addition to crumple zones. Explain how and why these have improved safety on the road. • How does NASA utilize the principles of momentum to launch their rockets? • Can a single object have kinetic energy but no momentum? Can a collection of two or more objects have KE but no momentum? • When an outfielder catches a fly-ball, he lets his glove move backward in the direction of motion of the ball. Explain. • When you are driving a golf ball a good follow-through helps to increase the distance of the drive. Explain. • An astronaut out on a spacewalk is alarmed to find that his tether is broken. All he has with him is his oxygen tank and his repair toolbox. How can the astronaut get back to the space station?	**Assessment Model # 1:** Ask students to imagine that they are playing pool. Students will design and implement an experiment using collisions that could assist them to score more points. Materials provided will include computers, photo-gates, and dynamic carts. Students will present their results and conclusions in a written report. **(***Analysis, Synthesis, Evaluation)* **Assessment Model # 2:** The class will play a quiz game that tests the students' essential conceptual understanding of momentum, impulse and collisions. We will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)*

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics B**	**Big Idea: Energy is the source of Motion In the Universe** **Topic: Simple harmonic Motion** **Goal 6: The student will be able to demonstrate an understanding of simple harmonic motion.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
7	6.1. Examine the kinematics of simple harmonic motion, create and identify a graph of displacement as a function of time, and determine from such a graph the amplitude, period, and frequency of the motion (5.7.12.A) 6.2. Formulate an appropriate expression for displacement of the form $A\sin\omega t$ or $A\cos\omega t$ to describe the motion (5.7.12.A) 6.3. Identify the points in the motion where the velocity is zero, at a positive or negative maximum (5.7.12.A) 6.4. Analyze and quantify the relationship between acceleration and displacement for an object executing simple harmonic motion.(5.7.12.A) 6.5. Identify points in the motion where the acceleration is zero and achieves its greatest positive or negative value (5.7.12.A) 6.6. Derive and apply the relationship between frequency and period (5.7.12.A) 6.7. Analyze how the total energy of an oscillating system depends on the amplitude of the motion, sketch or identify a graph of kinematic or potential energy as a function of time, and identify points in the motion where this energy is all potential or all kinetic (5.7.12.A, 5.7.12.B.2) 6.8. Determine the kinetic and potential energies of an oscillating system as functions of time, sketch and identify graphs of these functions, and prove that the sum of kinetic and	• Two people are sitting on identical playground swings. One person is pulled back one foot and released, while the other is pulled back 2 feet and released at exactly the same time. Will they both come back to the starting point at the same time? Justify. • The motion of pendulum and the oscillation of a spring can both be used to keep time in the mechanism of a clock. If taken to the top of a mountain which of these clocks keeps more accurate time? • Suppose a grandfather clock is running slowly. Should one shorten or lengthen the pendulum to make the clock keep correct time?	**Assessment Model # 1**: The teacher will ask students to imagine that they have been kidnapped by space aliens and held prisoner. All they have is a watch and their shoes with shoelaces of a known length. Students will develop an experiment to determine whether they are still on earth. Materials provided are string, pendulum bobs, and timers. Require the students to analyze their results and present them in analytical and graphical form as part of a written lab report. **(***Analysis, Synthesis, Evaluation)* **Assessment Model # 2:** The class will play a quiz game that tests the students' essential conceptual understanding of the principles underlying periodic motion. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Energy is the source of Motion In the Universe Topic: Simple harmonic Motion Goal 6: The student will be able to demonstrate an understanding of simple harmonic motion.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	potential energies is constant (5.7.12.A, 5.7.12.B.2, 5.7.12.D.1) 6.9. Analyze and apply knowledge of simple harmonic motion and the expression for the period of oscillation of a mass on a spring (5.7.12.A) 6.10. Analyze and apply knowledge of simple harmonic motion and the expression for the period of a simple pendulum (5.7.12.A) 6.11. Explain what approximation must be made in deriving the period of a simple pendulum (5.7.12.A)		

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The Motion of fluids and its applications in weather phenomena and transportation. Topic: Fluid Mechanics Goal 7: The student will be able to demonstrate an understanding of fluid mechanics, with applications to lift experienced by airplanes enabling flight.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
8	7.1. Realize that a fluid exerts pressure in all directions (5.7.12.A) 7.2. Conclude that a fluid at rest exerts pressure perpendicular to any surface that it contacts (5.7.12.A) 7.3. Analyze and apply Pascal's principle(5.7.12.A). 7.4. Reason that pressure increases with depth in fluids; derive and use the relationship between pressure and depth in a fluid (5.7.12.A) 7.5. Deduce that the difference in the pressure between the upper and lower surfaces of an object immersed in liquid results in an upward force on the object (5.7.12.A) 7.6. Analyze and apply Archimedes' principle: the buoyant force on a submerged object is equal to the weight of the fluid it displaces (5.7.12.A) 7.7. Construct and interpret a free-body diagram of forces affecting an object immersed in a fluid and deduce whether the object will sink or float (5.7.12.A). 7.8. Verify that, for laminar flow, the volume flow rate of a liquid through any cross section is the same at any point along its path of the fluid and apply the equation of continuity (5.7.12.A). 7.9. Observe that the pressure of a flowing liquid is low where the velocity is high, and vice versa (5.7.12.A). 7.10. Analyze and apply Bernoulli's equation (5.7.12.A)	• A woman wearing stiletto heeled shoes is invited into a kitchen with hardwood floors. Why should the homeowner be concerned? • A pound of lead and a pound of Styrofoam have the same weight. If they are placed on a sensitive equal arm balance , will the scales balance? • Use Pascal's principle to explain how hydraulic brakes work. • When you are driving a small car on a highway and a truck passes you at high speed, why do you feel pulled towards the truck? • Tornados and hurricanes often lift the roofs off houses. Use the Bernoulli Effect to explain why. Why should you keep your windows open under these circumstances? • A barge carries a load of gravel along a river. It approaches a low bridge and the captain realizes that the top of the pile of gravel will not make it under the bridge. The captain orders his crew to shovel gravel from the top of the pile into the water. Is this a good decision?	**Assessment Model #1:** The teacher should present the following scenario to the class. A woman purchases a gold bracelet at a flea market. She comes home and wonders whether the bracelet is really made of gold. The students will develop an experiment to help this woman determine whether the bracelet is gold or otherwise. Materials provided will include irregularly shaped objects, spring scales, beakers, scales etc. Students will present results in a written report detailing the theory behind their experimental design, data, and error analysis. Each group will summarize their results on whiteboards and make an oral presentation to the class. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students' essential conceptual understanding of fluid mechanics. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation.

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Heat as a form of energy and the laws of thermodynamics as the principle underlying modern household appliances Topic: Heat and the Transfer of heat energy Goal 8: The student will be able to define, explain and perform various temperature and heat calculations.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
6	8.1. Define the 'mechanical equivalent of heat' and calculate how much a substance will be heated by the performance of a specified quantity of mechanical work (5.7.12.B) 8.2. Explore the concepts of specific heat, heat of fusion, and heat of vaporization 8.3. Identify, given a graph relating the quantity of heat added to a substance and its temperature, the melting point, and boiling point and determine the latent heats of fusion and vaporization and the specific heat of each phase (5.7.12.B) 8.4. Determine how much heat must be added to a sample to raise its temperature from one specified value to another, or to cause it to melt or vaporize (5.7.12.B) 8.5. Compare the mechanisms of heat transfer and thermal expansion and determine the final temperature achieved when substances, all at different temperatures, are mixed and allowed to come to thermal equilibrium (5.7.12.B) 8.6. Determine 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 (5.7.12.B) 8.7. Analyze qualitatively what happens to the size and shape of a body when it is heated (5.7.12.B)	• Why do glass containers sometimes crack when hot liquids are poured into them? What characteristic of Pyrex prevents such breakage? • A steel wheel bearing is 1mm smaller in diameter than an axle. How can the bearing be fit onto the axle without removing any material from the axle? • When a car engine overheats, you are warned not to remove the radiator cap to add cold water until the engine cools down. Is this good advice? Why or why not? • Why do small planets tend to have little or no atmosphere? • Thermostats often use bimetallic strips to regulate temperature. Describe how a bimetallic strip might work. • A warning sign often seen on highways just before a bridge is "Caution – Bridge freezes before road". Explain why this happens. • To help lower the temperature of a patient with a fever, an alcohol rub is sometimes used. Why does the procedure work?	**Assessment Model #1:** The class will play a quiz game that tests the students' essential conceptual understanding of heat transfer, thermal expansion. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #2:** Students will be provided with everyday materials to explore the effects of heat expansion and heat transfer. Students will work in groups and make an oral presentation on an exploratory activity of the teacher's choice. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/ AP Physics B	Big Idea: Heat as a form of energy and the laws of thermodynamics as the principle underlying modern household appliances Topic: Kinetic theory of gases and the Ideal gas laws Goal 9: The student will be able to exhibit as understanding of kinetic theory, ideal gas laws and thermodynamics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
6	9.1. Elaborate on the assumptions of the kinetic theory model of an ideal gas (5.7.12.B) 9.2. Derive 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 (kinetic theory model of an ideal gas) (5.7.12.B) 9.3. Define the relationship between Avogadro's number, Boltzmann's constant, and the gas constant *R*. 9.4. Express the energy of a mole of monatomic ideal gas as a function of its temperature (5.7.12.B) 9.5. Explain qualitatively how the kinetic theory model of an ideal gas demonstrates the origins of the pressure of a gas in terms of collisions with the container walls, and explain how the model predicts that pressure must be proportional to temperature for a fixed volume (5.7.12.B) 9.6. Deduce the relationship between the pressure and volume of a gas during an isothermal expansion or compression by applying the ideal gas law (5.7.12.B) 9.7. Derive the relationships between the pressure and temperature of a gas during constant-volume heating or cooling, or the volume and temperature during constant-pressure heating or cooling by applying the ideal gas law.(5.7.12.B)	• A tightly sealed house has a large ceiling fan that blows air out of the house and into the attic. If the owners forget to open the windows while the fan is on, what happens to the pressure in the house after the fan has been on for a while? Does it become easier or harder for the fan to do its job? Explain. • Above the liquid in a can of hair spray, there is a gas at a relatively high pressure. The label on the can includes the warning "Do not store at high temperatures". Explain why the warning is given. • Atmospheric pressure decrease with increasing altitude. Explain why helium filled weather balloons are under-inflated when launched from the earth. • A commonly used packing material consists of bubbles of air trapped between bonded layers of plastic. Explain why this packing material offers less protection on cold days than on warm days. • When a plane takes off your eardrums pop outward as the air pressure decreases, and vice versa as the plane come in for landing. At the sea coast there is a cave that can only be entered by swimming through a	**Assessment Model #1:** The class will play a quiz game that tests the students' essential conceptual understanding of the kinetic theory of gases and the ideal gas laws. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #2:** Ask students to imagine being part of a pioneering group of scientists (Dalton, Boyle et. Al.) studying the effects of variation in pressure, temperature and volume of an ideal gas. Students will utilize lab equipment provided to gather empirical data and confirm graphically that the value of the absolute zero is indeed -273^0C. Students will present their experimental results in a scientific report, with graphical and mathematical analysis to the scientific community. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/ AP Physics B	Big Idea: Heat as a form of energy and the laws of thermodynamics as the principle underlying modern household appliances Topic: Kinetic theory of gases and the Ideal gas laws Goal 9: The student will be able to exhibit as understanding of kinetic theory, ideal gas laws and thermodynamics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	9.8. Determine the work performed on or by a gas during an expansion or compression at constant pressure by applying the ideal gas law and thermodynamics principles (5.7.12.B) 9.9. Explore the processes of adiabatic expansion or compression of a gas by applying the ideal gas law and thermodynamics principles (5.7.12.B) 9.10. Construct or identify on a *pV* diagram the curves that represent each of the above processes (5.7.12.B, 5.3.12.D.1)	completely submerged passage and entering an air pocket within the cave. This air pocket is not vented to the atmosphere. As the tide comes into the cave and the water level rises, your eardrums pop. Do they pop outward or inward? Explain.	

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics B**	**Big Idea: Heat as a form of energy and the laws of thermodynamics as the principle underlying modern household appliances** **Topic: The Laws of thermodynamics** **Goal 10: The student will be able to define, explain, and demonstrate an understanding of the Laws of Thermodynamics.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
8	10.1. Analyze the first law of thermodynamics to deduce the relationship between the heat absorbed by a gas, the work performed by the gas, and the internal energy change of the gas for various thermodynamic processes(5.7.12.B) 10.2. Utilize the first law of thermodynamics to relate the work performed by a gas in a cyclic process to the area enclosed by a curve on a *pV* diagram (5.7.12.B, 5.3.12.D.1) 10.3. Analyze the second law of thermodynamics, the concept of entropy, and heat engines and the Carnot cycle (5.7.12.B) 10.4. Determine whether entropy will increase, decrease, or remain the same during a particular process(5.7.12.B) 10.5. Evaluate the maximum possible efficiency of heat engine operating between two given temperatures (5.7.12.B) 10.6. Determine the actual efficiency of a heat engine (5.7.12.B) 10.7. Relate the heats exchanged at each thermal reservoir in a Carnot cycle to the temperature of the reservoirs (5.7.12.B)	• The plunger of a bicycle pump is rapidly pushed down with the end of the pump sealed so no air escapes and there is little time for heat to flow through the cylinder wall. Explain why the cylinder of the pump becomes warm to the touch. • If you saw an advertisement for a car that claimed the same gas mileage with and without the air-conditioning operating, would you be suspicious? Explain, using the principles of thermodynamics. • On a summer day, a window air-conditioner cycles on and off. Are you more likely to be able to fry an egg on the outside of the unit when it is on or off? • In solar ponds constructed in Israel, the Sun's energy is concentrated near the bottom of a salty pond. With proper layering temperatures as high as 100^0C can be reached. What is the maximum efficiency with which mechanical work can be extracted from the pond?	**Assessment Model #1:** The class will play a quiz game that tests the students' essential conceptual understanding of heat engines, refrigerators, heat pumps and entropy. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #2:** Students will study entropy by tossing coins and determine that the ordered result has much lower probability of occurrence, indicating that processes in nature tend to occur in such a way as to maximize entropy or disorder. Students will present their observations orally. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics B**	**Big Idea: Waves and vibrations and their applications to communication and optics.** **Topic: Waves, Vibrations and Sound** **Goal 11: The student will be able to explain and calculate the properties and effects of basic wave motion and sound waves.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
6	11.1. Construct and interpret graphs that represent traveling waves and determine the amplitude, wavelength and frequency of a wave from such a graph (5.7.12.B.1) 11.2. Relate wavelength, frequency, and velocity of a traveling wave (5.7.12.B.1) 11.3. Explain the principle of superposition and apply it to traveling waves moving in opposite directions, and describe how standing waves may be formed by superposition (5.7.12.B.1) 11.4. Sketch and identify graphs that describe reflection of a wave from the fixed or free end of a string (5.7.12.B.1) 11.5. Analyze the factors which determine the speed of waves on a string and the speed of sound (5.7.12.B.1) 11.6. Predict 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 (5.7.12.B.1) 11.7. 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 (5.7.12.B.1) 11.8. Explain the mechanism that gives rise to a frequency shift in both the moving-source and moving-observer case, and derive an expression for the frequency heard by the observer (5.7.12.B.1)	• JELLO starts out as a liquid and then solidifies. Predict what happens to the speed of sound as the JELLO sets. • A wire is strung tightly between two fixed posts. Discuss how an increase in temperature affects the speed of a transverse wave on this string. • A loudspeaker is emitting sound uniformly in all directions. There are no reflections anywhere. Will the sound intensity be the same at all points of a flat surface facing the source? Explain. • When a car is at rest its horn emits a frequency of 600Hz. A jaywalker hears the horn with a frequency of 580 Hz. Should the jaywalker jump out of the way? Justify your answer.	**Assessment Model #1:** Students will be provided with long "Slinkies" and will experiment to determine i. The speed of propagation of a wave pulse. ii. Observe the effect of two overlapping waves. iii. Observe what happens when the pulse is reflected from a fixed barrier. iv. Present the results of their experiment using a whiteboard **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students' essential conceptual understanding of waves, sound and the Doppler Effect. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #3:** Ask students to imagine that they are apprentices at a workshop where musical instruments are built. Students will utilize everyday materials such as straw and Soft drink containers to generate vibrating columns and study

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	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	11.9. Derive and apply the equations that describe the moving-source and moving-observer Doppler effect, and sketch or identify graphs that describe the effect (5.7.12.B.1)		the characteristics of the sound produced. Students will present their experimental observations in a written, well illustrated report containing the underlying theory behind the production of sound by air columns. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Waves and vibrations and their applications to communication and optics. Topic: Wave Phenomena in Optics Goal 12: The student will be able to demonstrate an understanding of physical optics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
8	12.1. Analyze the principles underlying interference and diffraction of waves (5.7.12.B.4) 12.2. Explain the conditions under which the waves reaching an observation point from two or more coherent sources will interfere constructively, or under which the waves from two sources will interfere destructively (5.7.12.B.4) 12.3. Determine location 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 (5.7.12.B.4) 12.4. Relate the amplitude and intensity produced by two or more sources that interfere constructively to the amplitude and intensity produced by a single source (5.7.12.B.4) 12.5. Construct or 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 (5.7.12.B.4) 12.6. Determine, for a single-slit pattern, the angles or the positions on a distant screen where the intensity is zero (5.7.12.B.4) 12.7. Sketch or 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 (5.7.12.B.4)	• In a laboratory accident you spill two liquids onto water. As the liquids spread and form thin films, one film reflects light while the other appears black. Why might this occur? • If young's double slit experiment were performed under water, how would the observed interference pattern be affected? • Often fingerprints left on glass show colored spectra as in a diffraction grating. Explain why this might occur? • Would it be possible to place a non-reflective coating on a fighter jet to cancel radar waves of wavelength 3 cm?	**Assessment Model #1:** Students, working in groups of 3-4, will utilize pen lasers and single slits of known width to observe the single slit diffraction pattern on a screen, and calculate the wavelength of the pen laser. With the calculated wavelength, students will then utilize another single slit of unknown width and calculate the slit width. Students will present their results in a formal written report, with error analysis and the theory behind the formation of the pattern. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students' essential conceptual understanding of light waves, interference and diffraction effects. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Waves and vibrations and their applications to communication and optics. Topic: Wave Phenomena in Optics Goal 12: The student will be able to demonstrate an understanding of physical optics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	12.8. Calculate for two-slit interference pattern, the angles or the positions on a distant screen at which intensity maxima or minima occur (5.7.12.B.4) 12.9. Describe or identify the interference pattern formed by a grating of many equally spaced narrow slits, calculate the location of intensity maxima, and explain qualitatively why a multiple-slit grating is better than a two-slit grating for making accurate determination of wavelength (5.7.12.B.4) 12.10. Analyze the conditions under which a phase reversal occurs when light is reflected from the interface between two media of different indices of refraction (5.7.12.B.4) 12.11. Deduce whether rays of monochromatic light reflected from two such interfaces interfere constructively or destructively, and thereby account for Newton's rings and similar phenomena, and explain how glass my be coated to minimize reflection of visible light (5.7.12.B.4) 12.12. Analyze the causes of dispersion and the properties of the electromagnetic spectrum (5.7.12.B.4) 12.13. Relate a variation of the index of refraction with frequency to a variation in refraction of electromagnetic radiation of different frequencies (5.7.12.B.4) 12.14. Compile a list of different types of electromagnetic radiation and arrange in order of increasing wavelength, and decreasing penetration the following: visible		**Assessment Model #3:** Students will utilize transmission gratings of known spacing to observe the diffraction pattern on a screen and calculate the wavelength of the incident light beam. Students will further use the previously obtained experimental results to experimentally determine the spacing of an unknown grating. Students will present their experimental results in a formal written lab report, with error analysis. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Waves and vibrations and their applications to communication and optics. Topic: Wave Phenomena in Optics Goal 12: The student will be able to demonstrate an understanding of physical optics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	light of various colors, ultraviolet light, radio waves, x-rays, and gamma rays. (5.7.12.B.4) 12.15. explain qualitatively how the transverse nature of light causes polarization phenomena(5.7.12.B.4) 12.16. Utilize the inverse-law to calculate the intensity of light at a given distance from a source of specified power and compare the intensities of light at different distances from the source (5.7.12.B.4)		

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Waves and vibrations and their applications to communication and optics. Topic: Reflection, Refraction, Lenses and Mirrors Goal 13: The student will be able to demonstrate an understanding of the principles of geometric optics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
8	13.1. Analyze the principles of reflection and refraction (5.7.12.B.4) 13.2. Determine how the speed and wavelength of light changes when light passes from one medium into another (5.7.12.B.4) 13.3. Construct a ray diagram to indicate the directions of reflected and refracted rays (5.7.12.B.4) 13.4. Analyze and apply Snell's Law to relate the direction of the incident ray and the refracted ray, and the indices of refraction of the media (5.7.12.B.4) 13.5. Identify the conditions under which total internal reflection will occur (5.7.12.B.4) 13.6. Analyze image formation by plane or spherical mirrors (5.7.12.B.4) 13.7. Relate the focal point of a spherical mirror to its center of curvature (5.7.12.B.4) 13.8. Locate by ray tracing, given a diagram of a mirror with the focal point shown, the image of a real object and determine whether the image is real or virtual, upright or inverted, enlarged or reduced in size (5.7.12.B.4) 13.9. Analyze image formation by converging or diverging lenses (5.7.12.B.4) 13.10. 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 (5.7.12.B.4) 13.11. Determine, using ray tracing, the location of	• Why does the arc of a rainbow appear with red on top and violet on the bottom? • Under what conditions is a mirage formed? On a hot day, what are we seeing when we observe a mirage of a water puddle on the road? • Why does a diamond show flashes of color under white light? • Why do astronomers looking at distant galaxies talk about looking backward in time? • A scientific supply catalog advertises a material having a refractive index of 0.85. Is this a good material to buy? • Why does a clear stream always appear shallower than it really is? • In a Jules Verne novel, a piece of ice is shaped into a magnifying lens to focus sunlight to start a fire. Is this possible? Explain. • Your car's side view mirrors carry the warning "Objects are closer than they appear". Explain.	**Assessment Model #1:** Students will develop an experiment to verify the laws of reflection utilizing plane mirrors, pins and paper. Students will submit a short written report, including the ray diagram constructed with the pins. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** Students will explore the nature of light rays and various properties by performing optical experiments at various stations. Students will present their explanations of the optical phenomena utilizing ray diagrams on a whiteboard. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #3:** Students will determine the refractive index of water using two different methodologies. i. Students will vary the angle of incidence and locate the corresponding angle of refraction, and graphically determine the index of refraction. ii. Determine the critical angle for total internal reflection and calculate the index of refraction from the critical angle. iii. Students will present their results in a formal written lab report with error analysis. Materials provided will include semi-circular water container and light ray box. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #4:** Students will determine the

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Waves and vibrations and their applications to communication and optics. Topic: Reflection, Refraction, Lenses and Mirrors Goal 13: The student will be able to demonstrate an understanding of the principles of geometric optics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	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 (5.7.12.B.4) 13.12. Utilize 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 (5.7.12.B.4) 13.13. Analyze simple situations in which the image formed by one lens serves as the object for another lens (5.7.12.B.4)		focal length of a converging lens using an optical bench, by varying the object distance and locating the corresponding image. Students will submit a written lab report detailing the theory underlying the experiment, calculations and error analysis. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/ AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Electric Fields, Forces and Potentials Goal 14: The student will be able to exhibit an understanding of electrostatics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
7	14.1. Define electric field in terms of the force on a test charge (5.7.12.A) 14.2. Determine the magnitude and direction of the electric force on a positive or negative charge placed in a specific field (5.7.12.A.4) 14.3. Given a diagram on which an electric field is represented by flux lines, determine the direction of the field at a given point, identify locations where the field is strong and where it is weak, and identify where positive or negative charges must be present (5.7.12.A) 14.4. Analyze the motion of a particle of specified charge and mass in a uniform electric field (5.7.12.A.4) 14.5. Analyze and apply the concept of electric potential to calculate the electrical work done on a positive or negative charge that moves through a specified potential difference (5.7.12.B) 14.6. Determine the direction and approximate magnitude of the electric field at various positions, given a sketch of equipotentials for a charge configuration (5.7.12.A) 14.7. Utilize conservation of energy to determine the speed of a charged particle that has been accelerated though a specified potential difference (5.7.12.B) 14.8. Determine the potential difference between two points in a uniform electric field, and state which is at the higher potential (5.7.12.B) 14.9. Analyze and apply Coulomb's law and the	• Why must hospital personnel wear special conducting shoes while working around oxygen in an operating theatre? What might happen if the personnel wore shoes with rubber soles? • A balloon that has been negatively charged by rubbing clings to a wall. What can you conclude about the charge on the wall? Why does the balloon eventually fall? • In the event of a thunderstorm, you are safe if you are in your car. Explain. • An uncharged metallic coated Styrofoam ball is suspended between two oppositely charged vertical metallic plates. Describe the motion of the ball after it is brought into contact with one of the plates. Explain the motion. • A charged comb often attracts small bits of dry paper that then fly away when they touch the comb. Explain. • There are strong similarities between electric and gravitational fields. A room can be electrically shielded so that there are no electric fields inside the room. Can a room be gravitationally shielded?	**Assessment Model #1:** The class will play a quiz game that tests the students' essential conceptual understanding of electrostatics. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #1:** Students will investigate static electricity by performing experiments at various stations utilizing common household materials. For example, i. Students will suspend two inflated balloons by strings from a door and observe what happens when the balloons are charged by rubbing each balloon with wool cloth. ii. Students will rub an inflated balloon with a piece of wool and press it against a wall, then observe what happens. iii. Students will tear some paper into very small bits and observe what happens when a charged comb is brought near them. Students will present their observations and explanations in a white-board presentation. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/ AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Electric Fields, Forces and Potentials Goal 14: The student will be able to exhibit an understanding of electrostatics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	principle of superposition to determine the force that acts between specified point charges, and describe the electric field of a single point charge (5.7.12.A.4) 14.10. Utilize Coulomb's law and the principle of superposition for vectors to determine the electric field of a single point charge (5.7.12.A.4) 14.11. Determine the electric potential in the vicinity of one or more point charges by applying the potential function for that point charge (5.7.12.B) 14.12. Describe the electric field between parallel charged plates (5.7.12.A)		**Assessment Model # 3:** Using two charged pieces of tape, students will verify Coulomb's law. Students will present their results in a written report. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #4:** Students will perform various experiments with a Van-de-Graff generator. Each group of students will make an oral presentation of their experimental observations and explanations. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Electrical energy, Potential, and Capacitance Goal 15: The student will be able to explain the properties of conductors, capacitors, and dielectrics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
7	15.1. Explain the absence of electric field inside a conductor, and why all excess charge must reside on the surface of the conductor due to the nature of the electric fields in and around conductors (5.7.12.A.4) 15.2. Explain why a conductor must be an equipotential, and apply this principle in analyzing what happens when conductors are connected by wires (5.7.12.A) 15.3. Determine the direction of the force on a charged particle brought near an uncharged or grounded conductor due to the nature of the electric fields in and around conductors (5.7.12.A) 15.4. Describe and sketch a graph of the electric field and potential inside and outside a charged conducting sphere (5.7.12.A) 15.5. Describe qualitatively the process of charging by induction (5.7.12.A) 15.6. Determine the direction of the force on a charged particle brought near an uncharged or grounded conductor due to electrostatic shielding (5.7.12.A) 15.7. Define capacitance and relate stored charge and voltage for a capacitor (5.7.12.A) 15.8. Relate voltage, charge, and stored energy for a capacitor (5.7.12.B) 15.9. Recognize situations in which energy stored in a capacitor is converted to other forms (5.7.12.B) 15.10. Describe the electric field inside a parallel-plate capacitor, and relate the strength of this	• A proton and electron are simultaneously released between the plates of a parallel plate capacitor. Ignoring their mutual interaction, which particle will reach one of the plates first? • The electric field at a certain location is zero. Does that necessarily indicate that the potential is zero at this location? Give an example to justify your answer. • Suppose you are sitting in a car and a 20 kV power line drops across the car. Should you stay in the car or climb out? Justify your answer. • If you were asked to design a capacitor for which small size and large capacitance were required, what factors would be important in your design?	**Assessment Model #1:** The class will play a quiz game that tests the students' essential conceptual understanding of electrical energy, potential and capacitance. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #2:** Students will develop an experiment to observe the charging and discharging of a capacitor with a resistor in series. Students will present their results graphically as part of a written formal lab report. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #3:** Tell students to design a circuit for a camera flash. Provide students with a battery, capacitor, two switches and a light bulb. The circuit must perform the following functions: The closing of one switch results in the charging of the capacitor, but does not light the light bulb. The closing of the second switch causes the light bulb to flash momentarily. Students will present their circuit diagram and the underlying theory in a written report, which will

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Electrical energy, Potential, and Capacitance Goal 15: The student will be able to explain the properties of conductors, capacitors, and dielectrics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	field to the potential difference between the plates and the plate separation (5.7.12.A) 15.11. Determine how changes in dimension of a parallel-plate capacitor, or the introduction of a dielectric material between the plates will affect the value of the capacitance (5.7.12.A)		include data, observations and suggestions for improvement of the experimental design. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/ AP Physics B**	**Big Idea: The interplay of electrical and magnetic effects and their impact on daily living.** **Topic: Current, Resistance, Power and Circuit Analysis** **Goal 16: The student will be able to illustrate an understanding of electric current, resistance, electric circuits and be able to analyze electric circuits.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
8	16.1. Define electric current so and relate the magnitude and direction of the current in a wire or ionized medium to the rate of flow of positive and negative charge (5.7.12.A) 16.2. Define conductivity, resistivity, and resistance (5.7.12.A) 16.3. Relate current and voltage for a resistor (5.7.12.A) 16.4. Explain how the resistance of a resistor depends upon its length and cross-sectional area (5.7.12.A) 16.5. Analyze and apply the relationships for the rate of heat production in a resistor (5.7.12.B) 16.6. Interpret a circuit diagram to determine whether resistors are in series or in parallel (5.7.12.A) 16.7. Determine the ratio of the voltages across resistors connected in series or the ratio of the currents through resistors connected in parallel (5.7.12.A) 16.8. Determine the equivalent resistance of two or more resistors connected in series or in parallel, or of a network of resistors that can be broken down into series and parallel combinations (5.7.12.A) 16.9. Determine the voltage, current, and power dissipation for any resistor in such a network of resistors connected to a single battery (5.7.12.B) 16.10. Design a simple series-parallel circuit that produces a given current and terminal voltage for one specified component, and	• Newspapers often have statements such as “10,000 volts of electricity surged *through* the victim’s body”. What is wrong with this statement? • Some homes have light dimmers that are operated by rotating a knob. What is being changed in the electric circuit when the knob is rotated? • In an analogy between traffic flow and electric current, what would correspond to charge Q and current I? • One of the circuit breakers in your house is frequently tripped. What suggestion could you make to your parents to alleviate this problem? • Why is it possible for a bird to sit on a high-voltage wire without being electrocuted? • Embodied in Kirchhoff’s rues are two conservation laws. What are they? • Would a fuse or circuit breaker work successfully if it were placed in parallel with the device it was supposed to protect?	**Assessment Model #1:** Ask your students to design a string of Christmas lights. As a prototype ask them to construct a circuit with five lights and a power source. Students will present their design in poster form and demonstrate the efficacy of their circuit design by putting their prototype into action. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students’ essential conceptual understanding of circuits and their applications to households. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to ‘steal’ the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/ AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Current, Resistance, Power and Circuit Analysis Goal 16: The student will be able to illustrate an understanding of electric current, resistance, electric circuits and be able to analyze electric circuits.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	draw a diagram for the circuit using conventional symbols (5.7.12.C.1) 16.11. Calculate the terminal voltage of a battery of specified emf and internal resistance from which a known current is flowing (5.7.12.A) 16.12. Analyze direct-current circuits to determine a single unknown current, voltage, or resistance, using Ohm's Law and Kirchhoff's rules.(5.7.12.A) 16.13. Analyze the properties of voltmeters and ammeters (5.7.12.A) 16.14. State whether the resistance of a voltmeter and ammeter is high or low (5.7.12.A) 16.15. Indicate the correct methods of connecting voltmeter and ammeter into circuits in order to measure voltage or current (5.7.12.A) 16.16. Analyze the behavior of capacitors connected in series or in parallel (5.7.12.A) 16.17. Determine the equivalent capacitance of a series or parallel combination of capacitors(5.7.12.A) 16.18. Explain how stored charge is divided between two capacitors connected in parallel (5.7.12.A) 16.19. Determine the ratio of voltages for two capacitors connected in series (5.7.12.A) 16.20. Calculate the voltage or stored charge, under steady-state conditions, for a capacitor connected to a circuit consisting of a battery and resistors (5.7.12.A) 16.21. Analyze the behavior of circuits containing several capacitors and resistors to determine		**Assessment Model #3:** Students will develop an experiment to determine the equivalent resistance of a combination of resistors. Students will predict the resistance of the combination as determined by circuit analysis, and compare it to the experimental observations. Students will present their results in a formal lab report, including a detailed error analysis. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/ AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Current, Resistance, Power and Circuit Analysis Goal 16: The student will be able to illustrate an understanding of electric current, resistance, electric circuits and be able to analyze electric circuits.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	voltages and currents immediately after a switch has been closed and also after stead-state conditions have been established (5.7.12.A)		

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Magnetostatics and the study of Magnetic forces on charges and current carrying conductors. Goal 17: The student will be able to display an understanding of magnetostatics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
10	17.1. Calculate the magnitude and direction of the force in terms of *q, **v**, and **B***, and explain why the magnetic force can perform no work (5.7.12.A) 17.2. Deduce the direction of a magnetic field from information about the forces experienced by charged particles moving through that field (5.7.12.A.7) 17.3. Analyze and apply the formula for the circular path of a charge that moves perpendicular to a uniform magnetic field, and derive this formula from Newton's Second Law and the magnetic force law (5.7.12.A.8) 17.4. Describe the most general path possible for a charged particle moving in a uniform magnetic field, and describe the motion of a particle that enters a uniform magnetic field moving with specified initial velocity (5.7.12.A.7) 17.5. Explain quantitatively the conditions under which particles will move with constant velocity through crossed electric and magnetic fields (5.7.12.A.8) 17.6. Determine the magnitude and direction of the force on a straight segment of current-carrying wire in a uniform magnetic field (5.7.12.A.8) 17.7. 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 (5.7.12.A.8)	• Can a constant magnetic field set a proton at rest into motion? Explain your answer. • How can the motion of a charged particle be used to distinguish between an electric and magnetic field in a certain region? • How can a current loop be used to indicate the presence of a magnetic field in a certain region of space? • Why does the picture on a TV screen become distorted when a magnet is brought near the screen? • The two ends of a hanging Slinky are attached to a powerful battery and a switch. When the switch is closed so that it now carries current, does the Slinky expand or contract? • Explain how the earth's magnetic field causes the Northern lights.	**Assessment Model #1:** Students will circulate among several stations where they will investigate various magneto-static phenomena. For example: i. Students will observe the orientation of a freely suspended magnet to determine the direction of the earth's magnetic field in the lab ii. Construct an electromagnet constructed by wrapping coils around a nail and determine the strength of the generated magnetic field. Investigate how to strengthen or weaken the field. Students will present their observations and explanations verbally and on whiteboards. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students' essential conceptual understanding of the magnetic forces on charges and current loops, and the magnetic fields produced by the same. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The interplay of electrical and magnetic effects and their impact on daily living. Topic: Magnetostatics and the study of Magnetic forces on charges and current carrying conductors. Goal 17: The student will be able to display an understanding of magnetostatics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	17.8. Determine the magnitude and direction of the field at a point in the vicinity of a long straight current-carrying wire (5.7.12.A.7) 17.9. Utilize superposition to determine the magnetic field produced by two long wires (5.7.12.A.7) 17.10. Determine the force of attraction or repulsion between two long current-carrying wires (5.7.12.A.8)		**Assessment Model #3:** Students will construct magnetic field line diagrams utilizing bar magnets, paper and iron filings. Students will present their findings in a short report that includes the field line diagram. **(***Analysis, Synthesis)*

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics B**	**Big Idea: The interplay of electrical and magnetic effects and their impact on daily living.** **Topic: Electrodynamics, Induced EMFs, Power generation.** **Goal 18: The student will be able to exhibit an understanding of electrodynamics.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
8	18.1. Analyze the concept of magnetic flux and calculate the flux of a uniform magnetic field through a loop of arbitrary orientation (5.7.12.A.8) 18.2. Utilize Faraday's Law and Lenz's Law to recognize situations in which changing flux though a loop will cause an induced emf or current in the loop (5.7.12.A.7) 18.3. Determine the magnitude and direction of the induced emf and current in square loop of wire pulled at a constant velocity into or out of a uniform magnetic field (5.7.12.A.7) 18.4. Calculate the magnitude and direction of the induced emf and current in a loop of wire placed in a spatially uniform magnetic field whose magnitude is changing at a changing at constant rate (5.7.12.A.7) 18.5. Determine the magnitude and direction of the induced emf and current in a loop of wire that rotates at a constant rate about an axis perpendicular to a uniform magnetic field (5.7.12.A.7) 18.6. Determine the magnitude and direction of the induced emf and current in a conducting bar moving perpendicular to a uniform magnetic field (5.7.12.A.7)	• A circular loop is located in a uniform and constant magnetic field. Describe how a current can be induced in the loop under these circumstances. • Wearing a metal bracelet in a region of strong magnetic fields can be hazardous. Explain. • A magneto is used to cause the spark in a spark plug in many lawn mowers. A magneto consists of a permanent magnet mounted on a flywheel, so that it spins past a coil. Explain how this arrangement generates enough potential difference to produce a spark. • A bar magnet is dropped toward a conducting ring lying on the floor. As the magnet falls toward the ring, is it in free fall? • Describe how a wind turbine generates electricity for use by consumers.	**Assessment Model #1:** Students will experiment with a current loop of many turns in a changing magnetic field and generate enough electromotive force to light up a small light bulb connected to the circuit. Students will demonstrate their experimental results to the class and explain the underlying principles of magnetism in an oral presentation. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students' essential conceptual understanding of currents produced in conducting loops by changing magnetic flux. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation **(***Analysis, Synthesis)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The Fundamental Nature and Behavior of Energy and Matter in the Universe Topic: Photons, the Photoelectric Effect, Atomic Structure and Atomic Spectra, Matter waves. Goal 19: The student will be able to display an understanding of the concepts of atomic physics and quantum effects.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
6	19.1. Analyze Rutherford's Scattering experiment and explain how it provides evidence for the existence of the atomic nucleus (5.7.12.A.5) 19.2. Analyze the properties of photons and the photoelectric effect (5.7.12.A.5) 19.3. Relate the energy of a photon in joules or electron-volts to its wavelength or frequency (5.7.12.A.5) 19.4. 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 (5.7.12.A.5) 19.5. Determine the number of photons per second emitted by a monochromatic source of specific wavelength and power (5.7.12.A.5) 19.6. Describe a typical photoelectric effect experiment, and explain what experimental observations provide evidence for the photon nature of light (5.7.12.A.5) 19.7. Explain qualitatively how the number of photoelectrons and their maximum kinetic energy depend on the wavelength and intensity if the light striking the surface, and account for this dependence in terms of a photon model of light (5.7.12.A.5) 19.8. Determine the maximum kinetic energy of photoelectrons for a different photon energy or wavelength, when given the maximum kinetic energy of photoelectrons ejected by photons of one energy. (5.7.12.A.5) 19.9. Construct or interpret a graph of stopping	• Does a photon emitted by a higher wattage red light bulb have more energy than a photon emitted by a lower wattage red bulb? • Science fiction novels describe a method for propulsion of interstellar spaceships uses a large sail. Photons striking the sail would propel the spaceship much as wind would propel a sailboat. Should the surface of the sail facing the light source be shiny or black to produce the greatest propulsion? • A stone is dropped from the top of Mt. Everest. Does its de Broglie wavelength change as it falls? • Radiation of a certain wavelength causes electrons to be emitted from one metallic target but not from the surface of another. Explain why this could be. • The Bohr theory of the atom is based upon several assumptions. Discuss these assumptions and their significance. Do any of them contradict classical physics? • If matter has a wave nature, why is it that we do not observe it in our daily experience? • Does the light emitted by a neon sign constitute a continuous spectrum or only a few colors? Defend your answer	**Assessment Model #1:** Have students form groups of two. One partner should use modeling clay to form one or more mounds, and place a piece of cardboard on the mound. The remaining member will now attempt to find the sizes and number of the mounds by rolling marbles at the target mounds. This experiment simulates the Rutherford scattering experiment. The team will make a whiteboard presentation of heir results. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students' essential conceptual understanding of the nature of photons, matter waves and the structure of atoms . Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #3:** Students will observe the spectra of various light sources utilizing a grating spectroscope. Students will measure the characteristic wavelengths emitted by various sources. Students will present their observations in a written report detailing the theory underlying the

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The Fundamental Nature and Behavior of Energy and Matter in the Universe Topic: Photons, the Photoelectric Effect, Atomic Structure and Atomic Spectra, Matter waves. Goal 19: The student will be able to display an understanding of the concepts of atomic physics and quantum effects.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	potential verses frequency for a photoelectric effect experiment, and determine from such a graph the threshold frequency and work function, and calculate an approximate value of *h/e* (5.7.12.A.5, 5.3.12.D.1) 19.10. Visualize the permitted energy levels within an atom (5.7.12.A.5) 19.11. Determine the energy or wavelength of the photon emitted or absorbed in a transition between specified levels, or the energy or wavelength required to ionize an atom (5.7.12.A.5) 19.12. Explain the origin of emission or absorption spectra of gases (5.7.12.A.5) 19.13. Determine the wavelength or energy for a single-step transition between the same levels, given the wavelengths or frequencies of photons emitted or absorbed in a two-step transition between levels (5.7.12.A.5) 19.14. Express the energy levels of hydrogen in terms of the ground-state energy, construct a diagram to depict these levels, and explain how this diagram accounts for the various 'series' in the hydrogen spectrum (5.7.12.A.5) 19.15. Analyze the assumptions and conclusions for the Bohr Model for the hydrogen atom (5.7.12.A.5) 19.16. Utilize the concept of the DeBroglie wavelength to calculate the wavelength of a particle as a function of its momentum (5.7.12.A.5)		characteristic spectra that they observe. **(***Analysis, Synthesis, Evaluation)*

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	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	19.17. Analyze the Davisson-Germer experiment, and explain how it provides evidence for the wave nature of electrons (5.7.12.A.5) 19.18. Determine the shortest wavelength of x-rays that may be produced by electrons accelerated through a specified voltage (5.7.12.A.5) 19.19. Analyze the methodology and results of Compton's Scattering experiment(5.7.12.A.5) 19.20. Explain the increase of photon wavelength that is observed, and the significance of the Compton wavelength (5.7.12.A.5)		

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The Fundamental Nature and behavior of Energy and Matter in the Universe. Topic: Nuclear Physics and Nuclear Reactions Goal 20: The student will be able to exhibit an understanding of the principles of nuclear physics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
3	20.1. Recognize that half-life in radio-active decay is independent of the number of nuclei present or of external conditions (5.7.12.A.5) 20.2. Create or interpret a graph to indicate what fraction of a radioactive sample remains as a function of time, and indicate the half-life on such a graph (5.3.23.D.1) 20.3. Determine, for an isotope of specified half-life, what fraction of the nuclei have decayed after a given time has elapsed (5.7.12.A.5) 20.4. Interpret symbols for nuclei and identify mass number and charge of nuclei (5.7.12.A.5) 20.5. Employ conservation of mass number and charge to complete nuclear reactions. (5.7.12.A.5) 20.6. Determine the mass number and charge of a nucleus after it has undergone specified decay processes (5.7.12.A.5) 20.7. Compare the processes of α, β, and γ decay and write a reaction to describe each (5.7.12.A.5) 20.8. Explain why the existence of the neutrino had to be postulated in order to reconcile experimental data from β decay with fundamental conservation laws (5.7.12.A.5) 20.9. Compare the strength and range of Nuclear forces with those of electromagnetic forces. (5.7.12.A.5) 20.10. Investigate nuclear fission, describe a typical neutron-induced fission reaction and explain why a chain reaction is possible (5.7.12.A.5) 20.11. Deduce mass-energy equivalence by relating	• Two nuclei have different nucleon numbers. Are they necessarily isotopes of the same element? Defend your answer. • Why do alpha and beta decay produce new elements while gamma decay does not? • To which of the following objects, each about 1000 years old, can the radiocarbon dating technique not be applied: A wooden box, a gold statue and some plant seeds? Explain. • A student claims that a heavy form of hydrogen decays by alpha emission. How would you respond? • Isotopes of a given element have different physical properties but the same chemical properties. Explain.	**Assessment Model #1:** The teacher will ask students to imagine that they are paleontologists trying to determine the antiquity of a dinosaur fossil. Students will perform a simulation of radioactive decay and calculate half life utilizing M&Ms. Students will present their results graphically as part of a written report, and extrapolate their results to radiocarbon dating. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** The class will play a quiz game that tests the students' essential conceptual understanding of nuclear decay and nuclear reactions. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis, Evaluation)*

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: The Fundamental Nature and behavior of Energy and Matter in the Universe. Topic: Nuclear Physics and Nuclear Reactions Goal 20: The student will be able to exhibit an understanding of the principles of nuclear physics.	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
	the energy released in nuclear processes to the change in mass (5.7.12.A.5) 20.12. Analyze nuclear processes by applying the relationship $E = mc^2$ (5.7.12.A.5)		

Suggested days of Instruction	Curriculum Management System Grade Level/Subject: 12/AP Physics B	Big Idea: Synthesis of the knowledge and skills acquired in the year-long learning process Topic: Preparation for the AP Exam Goal 21: Students will reflect on and synthesize their preceding knowledge in preparation for the AP Exam	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) The student will be able to:	**Essential Questions Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
10	21.1. Synthesize the concepts and skills acquired in the preceding quarters in preparation for the AP Physics B examination.	• What is the fundamental cause of any change in motion? • Under what conditions are energy or momentum conserved? • How is fluid mechanics used in the design of ships and submarines? • How does a heat engine work? • How does a camera flash operate? • Describe how a bugle produces musical notes? • Why does the pitch of an approaching locomotive's whistle change? • Why do we see a multicolored spectrum on oil slicks on a road? • How does a magnifying lens work? • Why does a diamond sparkle? • What type of circuit should kitchen appliances be connected in, so that failure of one appliance does not prevent the others from functioning normally? • How are magnetic forces used to separate isotopes of an element in a mass spectrograph? • How is electric power generated by the Hoover dam? • How does a nuclear power plant generate electricity?	**Assessment Model #1:** Students will participate in intensive classroom discussions of preceding material. (Analysis) **Assessment Model #2:** The class will play quiz games that review the students' essential conceptual understanding of the essential concepts of Physics presented during the course. Students will form teams consisting of four members. Each team will be asked questions in turn, given 20 seconds to discuss the concept, in which time every member of the team must be prepared to answer the question. The teacher will ask a randomly selected team member to provide the answer. If the team is unable to provide a satisfactory answer, the other teams are allowed to 'steal' the question for bonus points. Team members will be assessed on mastery of the concepts, cohesiveness of the group, and participation. **(***Analysis, Synthesis)* **Assessment Model #3:** Students will take full length timed practice tests under AP exam conditions to prepare for the upcoming examinations. Students will participate in classroom discussions and analysis of these questions, and make whiteboard presentations of solutions. **(***Synthesis, Evaluation)*

Suggested days of Instruction	**Curriculum Management System** **Grade Level/Subject: 12/AP Physics B**	**Big Idea: Synthesis of the knowledge and skills acquired in the year-long learning process** **Topic: Independent research and construction projects** **Goal 22: Students will complete an independent research and a design and building project.**	
	Objectives / Cluster Concepts / Cumulative Progress Indicators (CPI's) **The student will be able to:**	**Essential Questions** **Sample Conceptual Understandings**	**Instructional Tools / Materials / Technology / Resources / Learning Activities / Interdisciplinary Activities / Assessment Model**
20	22.1. Independenty research on a topic of their choice, that has not been covered in the AP Physics B syllabus. Sample topics might include: Special Relativity, Black Holes, Superconductivity etc. 22.2. Design and build a device that meets teacher specified guidelines. Examples: Gliders. Musical instruments, Trebuchets, electric vehicles, simple robots, etc.	• Conceptual understandings will vary with the research topics chosen by the students and the specific construction project assigned by the instructor	**Assessment Model #1:** Students will work in groups of two on a research topic of their choosing. They will present their research in a 15-20 minute PowerPoint presentation, submit an in-depth written report and include demonstrations and models as appropriate. Students will be assessed according to a rubric created by the Instructor. **(***Analysis, Synthesis, Evaluation)* **Assessment Model #2:** Students will work in groups of four and construct a device which meets specifications provided by the teacher. The device constructed must perform some pre-assigned tasks. Projects will be assessed based on a rubric that takes into consideration the innovativeness of the design, the efficiency with which the assigned tasks are performed, and student participation in the project. **(***Analysis, Synthesis, Evaluation)*

AP Physics B

COURSE BENCHMARKS

1. **The student will be able to analyze and perform calculations for motion in one and two-dimensions.**
2. **The student will be able to demonstrate an understanding of the forces of nature and describe how one or more forces affect the motion of objects.**
3. **The student will be able to exhibit an understanding of rotational motion, rotational equilibrium and rotational dynamics.**
4. **The student will be able to define, explain and calculate work, different forms of energy and energy transformations**
5. **The student will be able to calculate linear momentum based on the definition and the law of conservation of momentum for different types of collisions**
6. **The student will be able to demonstrate an understanding of simple harmonic motion.**
7. **The student will be able to demonstrate an understanding of fluid mechanics, with applications to lift experienced by airplanes enabling flight.**
8. **The student will be able to define, explain and perform various temperature and heat calculations.**
9. **The student will be able to exhibit as understanding of kinetic theory, ideal gas laws and thermodynamics.**
10. **The student will be able to define, explain, and demonstrate an understanding of the Laws of Thermodynamics.**
11. **The student will be able to explain and calculate the properties and effects of basic wave motion and sound waves.**
12. **The student will be able to demonstrate an understanding of physical optics.**
13. **The student will be able to demonstrate an understanding of the principles of geometric optics.**
14. **The student will be able to exhibit an understanding of electrostatics.**
15. **The student will be able to explain the properties of conductors, capacitors, and dielectrics.**
16. **The student will be able to illustrate an understanding of electric current, resistance, electric circuits and be able to analyze electric circuits.**
17. **The student will be able to display an understanding of magnetostatics.**
18. **The student will be able to exhibit an understanding of electrodynamics.**
19. **The student will be able to display an understanding of the concepts of atomic physics and quantum effects.**
20. **The student will be able to exhibit an understanding of the principles of nuclear physics.**
21. **Students will reflect on and synthesize their preceding knowledge in preparation for the AP Exam**
22. **Students will complete an independent research and a design and building project**.

Supplemental Instructional Materials

Internet Resources:

- http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/2262.html, The AP Physics Web Guide includes links and brief descriptions of simulations for every single topic of the AP Physics curriculum.
- http://www3.interscience.wiley.com:8100/legacy/college/halliday/0471320005/simulations6e/index.htm, Simulations from Interscience -Wiley .
- http://phet.colorado.edu/web-pages/simulations-base.html, Project at the University of Colorado includes over 50 excellent simulations on various areas of Mechanics, Waves and Electricity and Magnetism.
- http://wps.aw.com/aw_young_physics_11/0,8076,898587-,00.html, This is a very comprehensive resource to accompany University Physics by Young & Freedman.
- http://www.hazelwood.k12.mo.us/~grichert/sciweb/applets.html, Links by topic to websites that have computerized simulations of physics principles.
- http://www.surendranath.org/Applets.html, General Physics JAVA Applets by Surendranath Reddy
- http://www.walter-fendt.de/ph11e/, 42 simulations by Walter Fendt.
- http://micro.magnet.fsu.edu/electromag/java/, Electricity and Magnetism JAVA Tutorials
- http://micro.magnet.fsu.edu/primer/lightandcolor/java.html, Optics Interactive Tutorials
- http://physics.bu.edu/~duffy/classroom.html, Physlets by Andrew Duffy of Boston University
- http://physicsweb.org/resources/Education/Interactive_experiments/, Very extensive collection of links for college level of physics.

Text Resources:

- **Physics, 6th Edition**, John D. Cutnell, Kenneth W. Johnson, Copyright ©2004 John Wiley & Sons Inc.
- **Cracking the AP Physics B & C Exams** 2006-2007 Edition, Steven A. Leduc, Copyright © 2006 by the Princeton Review Inc.
- **Barron's How to prepare for the Advanced Placement Exam Physics B, 3rd Edition,** Jonathan S. Wolf, © Coyright 2003, 1999, 1995, by Barron's Educational Series Inc.
- **APAdvantage, Physics B Exam,** James Mooney, Copyright © 2005 Peoples Publishing Group.
- **AP Physics B& C Multiple Choice Questions In Preparation for the AP Physics ("B" & "C") Examination, 2nd Edition,** Manu Patel ***Ph.D.,*** © 1995 by D & S Marketing Systems Inc.