West Deptford Township Public Schools: Physics Curriculum Map based on NGSS(2014 Version) Author: M. Pustie
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COURSE	MP1 Units	MP2 Units	MP3 Units	MP4 Units
CP Physics	1-2	3-5	6-7	8-9
AP Physics 1	Scientific Thinking(Unit 1), Constant Velocity Kinematics(Unit 2) , Constant Acceleration Kinematics(Unit 3), Balanced Force Particle Model(Unit 4)	Dynamics(Unit 5), Circular& Gravitation(Unit 8), Vertical 1D and 2D Kinematics(Unit 6)	Energy(Unit 7), Impulse,Momentum(Unit9), Simple Harmonic Motion(Unit 11)	Rotational Motion and Conservation of Angular Motion(Unit 10); Electrostatics; DC Circuits(Unit 15); Mechanical Waves and Sound(Unit 19)
AP Physics C	1st Semester-Mechanics 1-8	1st Semester-Mechanics 9-11	2nd Semester-Electricity & Magnetism 12-14	2nd Semester-Electricity & Magnetism 15-18

Time Interval/ Content	*Standards/ Strands*	*Essential Questions*	*Knowledge*	*Skills*	*Assessment*	*Resources*
Unit 1: Scientific Thinking in Experimental Settings	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net	What information do I have? What information do I need? How do I get that information?	Scientific inquiry progresses through a continuous process of questioning, data collection, analysis, and interpretation. By varying just one condition at a time, scientists can hope to identify its exclusive effects on	Build a qualitative model, identify and classify independent variables, and make tentative qualitative predictions	2 Quizzes – measurement and linear models Unit 1 Test Lab Practicum- Model a cart traveling down an inclined	CP & AP Physics 1 (Rutgers PUM(Physics Unified Mathematics) Curriculum &Modeling

	force on a macroscopic object, its mass, and its acceleration. both qualitative and quantitative evaluations of devices.	How do I collect and record data to remember what is important? When do I have enough data to establish a trend/draw a valid conclusion? How do I use data to support my thinking? How does the way I work affect the quality of the results? Do the results make sense? What effect does	what happens. Scientists analyze data to determine what evidence is valid.	about the relationships between variables in understanding a simple pendulum. Design an experiment based on available measuring tools, consider the tools accuracy. Maximize the range of experimental data. Work safely in lab. Develop a mathematical model for the linear relationship. Validate the mathematical model.	plane. Note: Each course has a unique unit test.	Physics Curriculum from AMTA, Rutgers Worksheets, quizzes, sample tests AP Physics 1 Text : College Physics 1st^{d} Edition by Etknia, Gentile, Van Heuvelen 2014. AP Physics C Text: Halliday & Resnick, Fundamentals of Physics 10th ed Jearl Walker. 2014 AP CollegeBoard Course descriptions for AP Physics 1 and AP Physics C:

		changing the variable have on the result?		Use dimensional analysis to convert between units. Use significant figures and scientific notation to accurately calculate an answer.		Mechanics and AP Physics C: Electricity & Magnetism Resources from American Modeling Teachers Association website. AP Physics C laboratory experiments from CollegeBoard Practicums for Physics Teachers 2nd Edition. Michael Crofton Exploring Physics in the Classroom, George Amann

						Science Laptops and Vernier Probes for data acquisition. Logger Pro software for Data analysis. Pendulum lab materials
Unit 2: Particle moving with Constant Velocity	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is	In what ways can objects move? How many ways can an objects motion be represented ?	Define motion relative to a frame of reference. Distinguish between vector and scalar concepts (displacement vs distance, velocity vs speed). Define the following relationships from position vs time graphs. Introduce use of motion map and vectors to represent motion.	Determine the average velocity of an object in two ways: slope or equation. Determine the displacement of an object in two ways: find the area of a v vs t graph and use the displacement equation. Given an x vs t graph: Describe the motion of	Unit 2 Test Homework Checks Warm Ups Quizzes Buggy Lab Report Lab Practicums: 1) Determine where two buggies will collide. 2) Take a fan cart and a buggy. Learn everything you can about their motions. Put the buggy at a fixed distance. Using your knowledge of	Modeling worksheets Or AP Physics C: problems from summer homework assignment Constant velocity buggies with two speeds Logger Pro , LabPro, motion sensors, and laptops.

	conserved when there is no net force on the system. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that		Relate graphical, algebraic, and diagrammatic representations. Use dimensional analysis and appropriate units to describe kinematic properties.	the object, draw the corresponding v vs t graph, draw a motion map for the object, determine the average velocity of the object(slope), and write the mathematical model which describes the motion. Given a v vs t graph: Describe the motion of the object, draw the corresponding x vs t graph, determine the displacement of the object (area under curve), draw a motion map, and write a	error analysis, where should you start the fan cart so it has a glancing collision with the buggy. Provide a range where the buggy will collide.	

	account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.			mathematical **model to describe the motion.**		
Unit 3: Uniformly Accelerating Particle Model	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a	How is accelerated motion different from constant velocity motion? Would you feel lighter or heavier in an elevator accelerating upward? Why?	Determine the instantaneous velocity and the displacement of an object each in three ways. Determine the acceleration of an object in five ways. Given an x vs t graph, students will be able to: i. describe the motion of the object(starting position, direction of motion, velocity) ii. draw the corresponding v vs t graph iii. draw the corresponding a vs t graph iv. draw a motion map for the object(including v and a vectors) v. determine the instantaneous velocity of the object at a given time.	Develop a model for constant acceleration. Apply the model graphically, algebraically, and diagrammatically. Using domain and kinematic properties, develop and apply the classic kinematic equations. Use model and equations to analyze free motion. Distinguish between instantaneous and average	Unit 3 Test Homework Checks Quizzes Lab-pasco car on inclined ramp Lab report. Lab Practicum-Cart on Inclined Plane versus constant velocity buggy. If start at same position, where do they meet. Lab Practicum #2: Take 2 Pasco carts each with their track. Incline them – 1st at 15®and the 2nd at 30®. If you place the 30 at	Modeling worksheets Or AP Physics C: problems from summer homework assignment Constant velocity buggies with two speeds. Logger Pro, LabPro, Laptops, and photogates, Smart pulley, and motion sensors.

	collision. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.		Repeat for a given v vs t graph.	velocity. AP Physics: Use the calculus technique of differentiation to find v(t) and a(t) given x(t). Later in the semester, use the technique of integration to obtain v(t) from a(t) and x(t) from v(t).	the top, where should you start 15 degree on its' ramp so both carts reach the bottom at the same time. AP Physics C: Model the air resistance of falling coffee filters	
Unit 4:		How does a	A force is required to change	Use force	Unit 4 Test	Modeling

Development of Free Particle Model- Inertia and Interactions.	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a	force affect motion? Can an object continue to move if no forces act on the object? How can you use a broom to make a moving bowling ball move in a circle? Your little brother and you stand facing each other on the skating rink. You push off each other. Who experiences the greater force? Who accelerates more?	velocity, not to produce motion. Constant velocity does not require an explanation. A force is an interaction between an agent and an object. Choose a system to include objects, not agents. Newton's 3rd Law is best explainied in terms of paired forces.	diagrams to correctly represent forces as vectors originating on object (point particle). Use the superposition principle to show that the net force is the vector sum of the forces. In Statics, $\sum F = 0$ produces same effect as no force acting on an object. Introduce and apply graphical and trigonometric methods of force vector decomposition into components. State Newton's 3rd Law; apply it in situations in	Homework Checks Unit 4 Quizzes Labs-Broom bowling in the aux gym Lab-Hoover craft to demonstrate Newton's 1st law Lab practicum: two carts of different mass connected by a string on an A frame track. Find the unknown mass to satisfy conditions of static equilibrium.	worksheets Or AP Physics C: problems from summer homework assignment Use a laser pointer and a heavy desk to show the presence of a normal force. Vernier Force Sensors, LoggerPro, LabPro, carts, tracks, and friction blocks, logger pro and laptops

	collision. HS-PS2-4 Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic force between objects. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a			which you are trying to determine all the forces acting on an object. All forces come in pairs; paired forces are equal in magnitude, opposite in direction and act on separate bodies. $F_{AB} = -F_{BA}$ (5.2.12.E.3)		

	range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.					
Unit 5: Constant Force Particle Model – Newton's 2nd Law.	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.	How do objects move and what makes objects move the way they do? How would the universe be different if one or more of Newton's Laws were suspended? Is air resistance always undesirable? What are some applications of air resistance?	Develop themathematical models from graphs of acceleration vs force and acceleration vs mass for Newton's 2nd Law. Introduce mathematical notation for a proportion and introduce joint variation. $a = k\frac{F_{net}}{m} \Rightarrow k = \frac{ma}{F_{net}}$ $a_g = 9.8\frac{m}{s^2} \Leftrightarrow g = 9.8\frac{N}{kg}$	Deduce motion from an understanding of forces. Use graphical method of vector addition to find unbalanced force. Develop model for frictional forces into a frictional force law for static and kinetic friction. $F_s = \mu_s F_N$ $F_k = \mu_k F_N$	Unit 5 Test Homework Checks Quizzes Paradigm lab -Hanging Mass Lab Lab Report 2nd Lab with report- Determine relationship between normal force and frictional force. Lab Practicum – "An Up Hill Climb" Predict the time a given mass released from rest at a known height will take to reach the floor, when it is pulling	Modeling worksheets Or AP Physics C: problems from summer homework assignment Vernier Force Sensors, Logger Pro, LabPro, carts, tracks, and friction blocks. Atwood machine demonstration. Frank Nochese Youtube Video: When a heavy cart

	HS-PS2-4 Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic force between objects. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of	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? 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.			a cart of known mass(not frictionless) up a ramp of a given angle.	collides horizontally with a light cart, how do the impact forces compare in magnitude? Logger Pro, sensors, and laptops Camera with 30 fps video capture.

	constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.					
Unit 6: Two Dimensional (2-D) Particle Model	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.	How can we describe motion in two dimensions? What changes occur to 2-D motion when forces are involved? 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?	Free fall is motion when the only force acting on the object is gravity. Motion in two dimensions is decomposed into two one dimensional (1-D) motions: a horizontal motion(free particle model) and a vertical motion(constant force particle model). This motion can be analyzed graphically using motion maps and analytically using the appropriate one dimensional motion equations.	Use video analysis techniques to produce position-time and velocity-time graphs which represent the behavior of an object moving in two dimensions. Determine which model (free or constant force particle model) is appropriate to describe the horizontal and vertical motion of an object.	Unit 6 Test Homework Checks Quizzes Paradigm Lab: Examine Logger Pro Data of a basketball thrown in an arc. Example the horizontal and vertical velocity components. Lab Practicum: Predict where a marble rolling down an incline will land?	Modeling worksheets Or AP Physics C: problems from summer homework assignment Logger Pro and Laptops

	HS-PS2-4 Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic force between objects. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering	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?		Draw a motion map for an object undergoing parabolic motion, with velocity and acceleration vectors for both dimensions. Draw a force diagram for an object undergoing parabolic motion. Given information about the initial velocity and height of a projectile determine i. the time of flight, ii. the point where the projectile lands iii. velocity at impact.		

				Explain what effect the mass of a projectile has on its time of flight. AP Physics C: Solve relative velocity and rocket flight(changing mass) problems.		
Unit 7: Energy	HS-PS3-2 Develop and use models to illustrate that energy at the microscopic scale can be accounted for as a combination of energy associated with the motion of particles(objects) and energy associated with the relative positions of particles(objects). HS-PS3-1 Create a computational model to	How can the total amount of energy and matter remain constant in a closed system, even though their form and location undergo continual change? How does energy cause change? Where does energy come from? Where	Energy is a conserved, substance-like quantity with the capability to produce change. "Work" is de-emphasized, andis more accurately called "working", indicating the nature of "work" as a process of transferring energy into or out of a system via external forces. The 1st Law of Thermodynamics is used as the primary means of analysis of mechanical systems because of its fundamental, universal nature. All energy interactions can be characterized as energy transfer mechanisms or energy storage	Make the distinction between energy storage and transfer. Be able to recognize and identify energy storage mechanisms: gravitational, kinetic, elastic, dissipated. Recognize the universal, fundamental nature of energy as opposed to	Unit 7 Test Homework Checks Quizzes: Hookes Law and solving energy problem using conservation. Labs- i. Finding Hookes Law ii) find a method for explaining why a car attached to a weak spring will travel farther than a car attached to a weak spring, when both springs stretched to	Modeling worksheets Or AP Physics C: Chapter 7 & Chapter 8 problems from syllabus Logger Pro, LabPro and Laptops, springs, Pasco cars, tracks, and motion sensor.

	calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and	does it go? How does energy flow and how is it transmitted? Doesn't friction violate the conservation of energy?	modes. Energy storage modes are kinetic, potential, and internal energies, designated as ΔE. Energy transfer mechanisms are Working(W), heating(Q), and radiating(R).	different form of energy. Use Hooke's Law to analyze elastic energy systems. Recognize and identify modes of energy transfer: working, heating, radiating. Use representational tools (pie charts, bar graph/schema diagrams) to analyze a system in terms of energy storage and transfer. Analyze a system of energy interactions appropriately according to the system	produce the same force. Lab Reports(2) Lab Practicum: Place an egg under a suspended mass that, when released, stretches a spring as it falls, so that the egg is just touched or cracked, but not smashed. Lab Practicum: Two masses attached to a string wrapped around a pulley. What's the velocity of the heavy mass when it hits the ground?	

	constraints for solutions that account for societal needs and wants. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.			designation. View friction as a mechanism for dissipating energy. Determine the quantity of energy transferred between the various accounts (kinetic, elastic potential, gravitational potential, and internal energy) during an interaction. (5.2.12.D.4) J. Explain working as: energy transfer to/from system via external force, FΔx (parallel to motion)		

	HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.			Relate work done by a force to the area under a graph of force as a function of position. Analyze situations in which a body's mechanical energy is changed by friction or by a specifically applied external force. Apply 1st law of thermodynamics in analyzing the motion of bodies that move under the influence of springs. Calculate the power required to maintain the motion of a		

				body with constant acceleration. AP Physics C Use integration to calculate work done by a variable force *F(x).* Calculate a potential energy function associated with a one-dimensional force *F(x)*. Given the potential energy, *U(x)*, calculate the force vector.		

Unit 8: Uniform Circular Motion	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-4 Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic force between	How can we predict the outcomes of a reaction 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? While riding a carousel at Six Flags, Is the fastest seat on the outside of the carousel? If gravitational attraction were to	Connect Circular Motion to Newton's 2nd Law. While the speed of an object undergoing uniform circular motion is constant, its velocity is constantly changing. The force causing this change in velocity, directed toward the center of the circle, is called centripetal force. For heavenly bodies undergoing uniform circular motion, the Law of Universal Gravitation is set equal to the centripetal force.	Graph and state the relationships between velocity and mass, velocity and radius, and velocity and period for an object undergoing uniform circular motion. State the mathematical expression that describes the relationship between force, mass, radius and velocity. Given three of the variables, be able to solve for the missing quantity. Distinguish between centripetal and centrifugal force.	Unit 8 Test Homework Checks Quizzes Labs: find the relationship between velocity and mass, velocity and radius, and velocity and period for an object undergoing uniform circular motion. Use whirly bob stoppers and weights. Lab Report. Lab Practicum: Watch a toy plane moving at constant speed in a horizontal circle. Predict the stopwatch reading to make 30 revolutions.	Modeling worksheets Or AP Physics C: Chapter 6 homework problems from syllabus Logger Pro and Laptops

	objects. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering	suddenly disappear, what would happen to our earth and the solar system? 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? How is this speed limit on road curves calculated by road engineers?		Construct force diagrams that display the forces acting on an object undergoing uniform circular motion. Apply the Law of Universal Gravitation to solve satellite motion problems. AP Physics C: Estimate the escape velocity of a satellite launched from earth.		
Unit 9 Impulsive Force Model	HS-PS2-2: Use mathematical representations to support the	How have automobile safety bags	Students learn how a time varying force affects motion. Momentum is a conserved	Define momentum; distinguish	Unit 9 Test Homework Checks	Modeling worksheets Or AP Physics

	claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-ETS1-2	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. Why does this	quantity that is constant unless subject to an outside force. Impulse is a quantity that produces a change in momentum when the outside force varies. While the momentum of individual bodies in the system may change, the sum of these momenta remains constant, barring interactions with external agents. Students learn to distinguish between elastic collisions(kinetic energy is conserved) and inelastic collisions.	between momentum and velocity. Distinguish between elastic and inelastic collisions. Use conservation principles to solve problems involving elastic and inelastic collisions for initial velocity, final velocity or mass, given the other values. Define impulse; distinguish between impulse and force. Determine the impulse acting on an object a. given a F vs t graph b. given the	Quizzes Labs: deduce the conservation of momentum from a series of 1-D collisions: inelastic, sticky, and perfectly elastic. Lab Practicum: Ballistic Pendulum or have 2 carts with different but known masses. Where do you place the carts on a 2 meter track such that after experiencing an elastic collision, the carts reach the ends of the track simultaneously. AP Physics C: Show the conservation of momentum in 2-D inelastic collisions	C: Chapter 9 homework problems from syllabus Logger Pro, LabPro, Laptops, Pasco cars and tracks.

	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.	make sense? 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?		change in momentum. Determine the force acting on an object, given its change in momentum. AP Physics C: Use integration to find the center of mass of a thin rod of non-uniform density, of a plane lamina of uniform density, or of a solid of revolution of uniform density. Locate the center of mass between two rigid bodies. State, prove, and apply the relation between center-of-mass velocity		

				and linear momentum, and between center-of-mass acceleration and net external force for a system of particles.		
Unit 10 Rotational Motion and Torque (AP Physics C and AP Physics 1)	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.	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	Understand a rigid body rotating in space whose axis is not fixed, known as rolling motion. Angular momentum of a rigid object is always conserved if no external torques act on the object. Like the conservation of momentum, the law of conservation of angular momentum is a fundamental law of physics, equally valid for relativistic and quantum systems. Understand rotational kinetic energy.	Calculate the torque of a specified force about an arbitrary origin. Calculate the angular momentum vector for a moving particle. Calculate the angular momentum vector for a rotating rigid body when this vector lies parallel to the angular velocity vector. Recognize the conditions under which the law of conservation is	Unit 10 Test Homework Checks Quizzes Lab: Use moment of inertia and rotational motion concepts to determine the mass of a rotating, non-uniform object	Modeling worksheets Or AP Physics C: Chapters 10 & 11 homework problems from syllabus Logger Pro , LabPro and Laptops Introduce dot and cross products from vector calculus.

	HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering	hinges? How would you balance a seesaw with several children of different weights sitting on it?		applicable and relate this law to one and two particle systems such as satellite orbits. State the relation between the net external torque and angular momentum, and identify situations in which angular momentum is conserved. Analyze problems in which the moment of inertia is changed as it rotates freely about a fixed axis. Analyze a collision between a moving particle and a rigid body that can rotate about a fixed axis or about its		

				center of mass. Determine by inspection which of a set of symmetric bodies of equal mass has the greatest rotational inertia. Compute the rotational inertia of a collection of point masses, a tin rod of uniform density, a thin cylindrical shell, and a solid sphere about an axis through center. State and apply the parallel axis theorem. Determine the angular acceleration with which a rigid body is accelerated about a fixed axis when subjected to a		

				specified external torque or force. Apply the equations of translational and rotational motion simultaneously in analyzing rolling with slipping.		
Unit 11 Oscillatory Motion and Gravitation (AP Physics C and AP Physics 1)	HS-ESSS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. HS-PS2-4 Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic force between objects. HS-PS3-1 Create a	How does rolling motion differ from sliding motion? Does the same force that causes an apple to fall from a tree cause the moon to orbit the earth? How does satellite TV work with a dish antenna?	When the force acting on a body is proportional to the displacement of the body from some equilibrium position, repetitive back-and-forth motion occurs about this position. Such motion is called periodic motion, harmonic motion, or oscillation. Simple Harmonic motion occurs when an object oscillates such that its position is specified by a sinusoidal function of time with no loss in mechanical energy. The laws of planetary motion developed from Johannes Kepler follow from the law of gravity and the concept of conservation of angular	Sketch or identify a graph of displacement as a function of time, and determine from such a graph the amplitude, period, and frequency of the motion. Use the expression A sin(wt) and A cos(wt) with ease. State and apply the relation between acceleration and displacement and between frequency and period.	Unit 11 Test Homework Check Quizzes Lab: find the period of a physical pendulum	Modeling worksheets Or AP Physics C: Chapter 13 & 14 homework problems from syllabus LabPro, Logger Pro and Laptops

	computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.		momentum	Recognize the system obeys a differential equation and know how to solve problems using that equation through integration techniques. State how the total energy of an oscillating system depends on the amplitude of the motion, sketch or identify a graph of kinetic or potential energy as a function of time, and identify points in the motion where this energy is all potential or all kinetic. Calculate the kinetic and potential energies of an oscillating		

				system. Derive and apply the expression for the period of a simple pendulum. Analyze the motion of a torsional pendulum or physical pendulum in order to determine the period of small oscillations. Determine the strength of the gravitational field at a specified point outside a spherically symmetrical mass. Describe the gravitational force inside and outside a uniform sphere, and calculate how the field at the surface		

				depends on the radius and density of the sphere. and period of revolution in such an orbit. Apply conservation of angular momentum to determine the velocity and radial distance at any point in the orbit. Apply energy conservation in analyzing the motion of a body that is projected straight up from a planet's surface or that is projected directly toward the planet from far above the surface.		
Unit 12	HS-PS2-5 Plan	A balloon that	Develop the charge model and	Distinguish	Unit 12 Test	Modeling

Electric Charge and Field	and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through	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	atomic model to account for observations attraction, repulsion, polarization, induction, conductors, and insulators. Develop Coulomb's Law and that field is a property of the quantity of the charge producing the field and of the position relative to the charge. Field is a force per unit of charge. AP Physics C: Use vector addition to determine the electric field by two or more point charges. Determine the electric potential in the vicinity of one or more point charges. Calculate the electrostatic potential energy of a system of two or more point charges, and calculate how much work is required to move a set of charges into a new configuration. Calculate by integration the electric field of a straight, uniformly charged wire.	between the two kinds of particles that are responsible for electric interactions. Distinguish between conductors and insulators. Explain charging by conduction, induction and polarization in terms of the movement of electrons. Use Coulomb's Law to represent the relationship between electric force, charge and distance of separation. Given information about the quantity of charge on two	Homework Check Quizzes Lab Activity: Show how to induce a positive charge on a sphere.	worksheets Or AP Physics C: Chapter 23 homework problems from syllabus Logger Pro and Laptops, Van der Graff Generator, insulating rods.

	engineering. HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	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	Calculate by integration the electric field and potential of a thin ring of charge on the axis of the ring, or of a semicircle of charge at its center.	bodies and the separation distance, determine the electrostatic force acting on the bodies. Recognize the similarities and differences between Coulomb's Law and the Law of Universal Gravitation. Recognize that an electric charge produces an electric field. Calculate the force exerted by a uniform electric field on a charged particle. Use the superposition principle to calculate the		

		gravitationally shielded?		strength of the electric field produced by charge(s) at a given location.		
Unit 13 Gauss's Law (AP Physics C only)	HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	Consider the electric field due to a non-conducting infinite plane having a uniform charge density. Why doesn't the electric field depend on the distance from the plane? A person is placed in a large, hollow metallic sphere that is insulated from ground. If a large charge is placed on the sphere, will the person be harmed upon	Although a consequence of Coulomb's law, Gauss's Law is more convenient for calculating the electric fields of highly symmetric charge distributions. Electric flux is proportional to the number of electric field lines penetrating some surface.	Calculate the flux of E through a curved surface when E is uniform in magnitude and perpendicular to the surface. Understand Gauss's law to state it in integral form, apply it qualitatively, to relate flux and electric charge for a specified surface. Apply Gauss's Law, along with symmetry arguments, to determine the electric field near a large uniformly charged plane,	Unit 12 Test Homework Check Quizzes Lab Activity: Show how to induce a positive charge on a sphere.	AP Physics C: Chapter 24 homework problems from syllabus

		touching the inside of the sphere? What if the person has an initial charge whose sign is opposite that of the charge on the sphere?		inside or outside a uniformly charged long cylinder or cylindrical shell, and inside or outside a uniformly charged sphere or spherical shell. Apply Gauss's Law to determine the charge density or total charge on a surface in terms of the electric field near the surface. Graph the electric field and potential function by the calculus method of finding maxima and minima.		
Unit 14 Electric Energy, Electric Potential and Capacitance (AP Physics	HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a	A proton and electron are simultaneously released between the plates of a parallel plate capacitor.	The interaction between particle and field is viewed primarily from an energy perspective. Specifically, changes in potential energy occur when particles are displaced along field lines. The size of the change in potential	Draw parallels between gravitational and electrical: force, field, energy & potential. Write formulas for each expression.	Unit 14 Test Homework Check Quizzes Lab Activity:	Modeling worksheets Or AP Physics C: Chapter 25 and Chapter 26 (capacitance

C Only)	changing magnetic field can produce an electric current. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	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? 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? If you were asked to design a	energy depends on three properties: a field property (strength), a "spatial" property (displacement parallel to field), and an intrinsic property of the particle (charge or mass). Examine potential in uniform and non-uniform fields. Show that if there is a potential difference and there is a conducting pathway, charge will flow. Further refinement of the potential concept is accomplished by defining lines (or surfaces, in the three dimensional case) of equal potential: equipotential lines. Electric potential difference is defined as change in potential energy per unit charge, and the unit of "volt" (J/C) is introduced. Capacitors store energy not charge as will be shown in a capacitor lab. AP Physics C: Understand the nature of electric fields in and around conductors so that they can explain the mechanics responsible for the absence of electric field inside a conductor, and why all excess charge must reside on the	Solve for units for each quantity. Map equipotential lines, explain their significance in terms of the field. Use the volt as the unit of electric potential; use two different equations for potential. Distinguish between electric potential and electric potential energy. Explain how a capacitor works. Relate capacitance to plate area and separation.	Build a RC capacitor circuit for three time constants: fast, slow, and middle of the road.	and dielectrics) homework problems from syllabus Logger Pro and Laptops, voltmeters, batteries, capacitors, and resistors(1/4 watt)

		capacitor for which small size and large capacitance were required, what factors would be important in your design?	surface of the conductor. Explain why a conductor must be equipotential, and apply this principle in analyzing what happens when conductors are connected by wires. Prove and apply the relationship between the surface charge density on a conductor and the electric field strength near its surface. Describe and sketch a graph of the electric field and potential inside and outside a charged conducting sphere. Explain qualitatively why the electric field outside a closed conducting surface cannot depend on the precise location of charge in the space enclosed by the conductor, and identify consequences of this result. 10. Understand the physics of a parallel-plate capacitor so they can describe the electric field inside the capacitor, and relate the strength of this field to the potential difference between	Relate energy storage by a capacitor to charge and potential. Use relationships among potential, field, charge and energy to solve for missing quantities.		

			the plates and the plate separation. Derive and apply expressions for the energy stored in a parallel-plate capacitor and for the energy density in the field between the plates. Analyze situations in which capacitor plates are moved apart or moved closer together, or in which a conducting slab is inserted between capacitor plates, either with a battery connected between the plates or with the charge on the plates held fixed. Describe how the insertion of a dielectric between the plates of a charged parallel-plate capacitor affects its capacitance and the field strength and voltage between the plates.			
Unit 15 DC Circuits	HS-PS2-5 Plan and conduct an	Newspapers often have	The material developed here is an attempt to strongly bridge	Define current as "charge flow	Unit 15 Test	Modeling worksheets

(AP Physics C and AP Physics 1)	investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	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? One of the circuit breakers in your house is frequently tripped. What suggestion could you make to your	circuits with electrostatics. Starting with the ideas that a separation of charge (the presence of a net + or - charge) results in an electric field and in response to this field, mobile charge carriers move, students develop a more consistent model of circuits. In a circuit, the battery (or other emf source) does work to maintain a charge separation, and thus creates an electric field within the conducting elements ("conductors" or wires, and resistors). Resistance in effect restricts the area through which charge can flow. Thus, the restricted area through which charge can flow effectively "evens out" the current. Students develop a mathematical model for resistance by conducting a more-or-less "typical" Ohm's Law Lab. They vary voltage supplied to a circuit containing an ohmic (ceramic power resistor) and from the linear graph of V vs. I derive the mathematical model for resistance. Finally, students explore more complex circuits,	rate" or quantity of charge per unit time passing a cross-sectional area in the conductor. Distinguish between "flow rate" and "drift velocity." By use of examples and activities, define and apply equation $I = \Delta q/\Delta t$ ii. Use the ammeter as a device to measure flow rate. Qualitatively describe reasons for deviations from ohmic behavior (e.g. thermal motion of atoms causing temperature-dependence on resistance). Use ammeter	Homework Check Quizzes Lab Activities: Ohm's Law lab. Create a model for series and parallel circuits using a 6 v lantern battery and 6.3 lantern bulbs. Lab Practicum: Determine the wiring circuit of a 4 bulb bathroom incandescent light bar. AP Physics C: Understand and apply the properties of ideal and real batteries so they can calculate the rate at which a battery is supplying energy to a circuit or is being charged up by a circuit. Apply Ohm's Law and Kirchoff's rules to direct-current circuits in order to set up and	Or AP Physics C: Chapter 27 and Chapter 28 , homework problems from syllabus Logger Pro and Laptops, voltmeters, batteries, capacitors, Breadboards, Voltmeters, ammeters, and resistors(1/4 watt)

	HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	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?	containing two or more resistors in series and/or parallel arrangement. Students are challenged to identify patterns relating an overall quantity (e.g. voltage supplied) to resistor-specific quantities (e.g. voltage drop across each resistor). With the ammeter and voltmeter, they collect data, and through whiteboarding and discussion, the patterns are delineated. AP Physics C: Kirchoff's Current and VoltageLaws are used to solve for current and voltage in multi-loop circuits.	and voltmeter measurements to develop Ohm's Law. Use light bulbs to show an example of a non-ohmic system (V proportional to I^2). Solve series and parallel circuits for current and voltage. Find the total equivalent resistance and current in a single battey circuit.	solve simultaneous equations to determine two unknown currents. Understand the behavior of capacitors connected in series or parallel so they can calculate the equivalent capacitance of a series or parallel combination. Understand capacitor energy storage in capacitors so they can relate voltage, charge and stored energy for a capacitor. Calculate the voltage or stored charge, under steady-state conditions, for a capacitor connected to a circuit consisting of a battery and resistors. Understand the discharging and charging of a capacitor through a resistor so they can calculate and	

					interpret the time constant of the circuit. Sketch or identify graphs of stored charge or voltage for the capacitor, or of current or voltage for the resistor, and indicate on the graph the significance of the time constant. Develop skill in analyzing the behavior of circuits containing several capacitors and resistors so they can determine voltages and currents immediately after steady-state conditions have been established. Identify graphs that correctly indicate how voltages and currents vary with time.	

Unit 16 Magnetism and Magnetic Fields (AP Physics C Only)	HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into	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	Magnetic fields act in a distinctly different fashion from electric fields. Field lines are observed to be circular, and follow the right-hand curl rule. If moving charge creates a magnetic field, it is also affected by (experiences a force due to) a magnetic field. Force on conductor laboratory leads students to see that the force exerted on a current-bearing wire is directly proportional to the current in the wire, the strength of the external magnetic field, and the length of wire in the field. From this, the mathematical representation of the magnitude of magnetic field strength $\lvert B\rvert = \frac{\lvert F\rvert}{I\Delta l_{\perp}}$ can be derived. Through an analysis of the variables involved, it is shown that the most fundamental representation of the magnitude of the magnetic field strength is $\lvert B\rvert = \frac{\lvert F\rvert}{qv_{\perp}}$. It is observed that a	Recognize that moving charge is necessary for a magnetic field to be present. Represent the magnetic field around a conductor or moving charge using the right curl rule. Distinguish between magnetic fields and the electric fields in terms of their origin (moving and static charge respectively) as well as their patterns (loops and lines, respectively). Recognize that like the electric field, the	Unit 16 Test Homework Check Quizzes Lab Activity: Investigate the magnetic field of the earth and a current carrying wire. Build an electromagnet that can lift 5 paperclips.	Modeling worksheets Or AP Physics C: Chapter 29 and Chapter 30 , homework problems from syllabus

	smaller, more manageable problems that can be solved through engineering. HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	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?	continuous conducting loop in an eternal field experiences forces in opposite directions on the sides perpendicular to and external magnetic field, resulting in a torque which can be used to create an electric motor. AP Physics C: The law of Biot-Savart describes the contribution made to the magnetic field by an element of the wire dl carrying current i. When the expression is integrated, the entire B field is found. Ampere's Law uses a line path integral enclosing currents to find the B field inside and outside the path assuming the path is symmetric. Deduce the magnitude and direction of the contribution to the magnetic field made by a short straight current-carrying wire using the Biot-Savart Law. Using Biot-Savart, derive and apply the expression for the magnitude of *B* on the axis of a	amount of influence decreases with distance from the field's source. Recognize that bar and horseshoe magnets' fields are consistent with those around current-bearing conductors (that is, also form closed loops). Recognize that charge motion is necessary inside a permanent magnet, and that this motion is electron spin. Develop a domain model to explain permanent magnets: i. Students will reinforce the		

			circular loop of wire. Use Ampere's law, plus symmetry arguments and the right-hand rule, to relate magnetic field strength to current for a long straight wire, or for a hollow or solid cylinder.)	idea that there is an interaction between a current-carrying wire and a magnetic field. ii. Students will learn that the force is dependent on the amount of current, the length of wire in the magnetic field, and the magnetic field strength. iii. Students will learn that the direction of the force is perpendicular to both the direction of the current as well as the magnetic field lines (right hand palm rule).		
Unit 17 Faraday's Law (AP Physics C only)	HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current	A circular loop is located in a uniform and constant	The rate at which flux changes is just the induced voltage. This statement is known as Faraday's Law. The current	Understand magnetic flux so they can calculate the	Unit 17 Test Homework Check Quizzes	AP Physics C: Chapter 31 , homework problems from syllabus

	can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering	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 bar magnet is dropped toward a conducting ring lying on the floor. As the magnet falls toward the ring, is it in free fall?	created by the induced voltage will flow to oppose that change that caused it. This process is known as Lenz's Law.	flux of a uniform magnetic field through a loop of arbitrary orientation. Use integration to calculate the flux of a non-uniform magnetic field, whose magnitude is a function of one coordinate, through a rectangular loop perpendicular to the field. Understand Faraday's Law and Lenz's Law so they can recognize situations in which changing flux through a loop will cause an induced emf or current in the loop.	Lab Activity: 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.	Laptops and LabPro Vernier interface.

				Calculate the magnitude and direction of the induced emf and current in a square loop of wire in uniform and non-uniform magnetic fields.		
Unit 18 Inductance (AP Physics C Only)	HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	Why is the induced emf that appears in an inductor called a "back" emf? How can a long piece of wire be wound on a spool so that the wire has negligible self-inductance? For a series RL circuit, can the back emf ever be greater than the battery emf?	When current is established in an ideal solenoid, a uniform magnetic field will exist within the solenoid. This field cuts through the loops of the solenoid and creates a magnetic flux. Should the current change, there will be a change in the flux and a voltage will be induced. This process is called self-inductance. The behavior of current in a RL circuit is analogous to the behavior of the charge in an RC circuit. When an inductor is connected to a battery, the inductor resists the establishment of current. The battery must do work to eventually establish	Calculate the magnitude and sense of the emf in an inductor through which a specified changing current is flowing. Derive and apply the expression for the self-inductance of a long solenoid. Develop skill in analyzing circuits containing inductors and resistors so they can write and solve the	Unit 18 Test Homework Check Quizzes Lab Activity: Build an RL circuit and monitor its current and voltage using Vernier probes.	AP Physics C: Chapter 32 , homework problems from syllabus. Laptops and LabPro Vernier interface.

	HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering		the steady state current.	differential equation that relates current to time.		
Time Interval/ Content	Standards/ Strands	Essential Questions	Knowledge	Skills	Assessment	Resources
Unit 19: Mechanical Waves and Sound (AP Physics 1 Only)	HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	How do waves transport energy? How do waves from more than one source interfere to make waves of smaller or larger amplitude, depending on the location where the waves meet?	Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena. A periodic wave is one that repeats as a function of both time and position and can be described by its amplitude, frequency, wavelength, speed, and energy. Only waves exhibit interference and diffraction.	Design and implement an experiment to test whether the following characteristics affect the speed of a pulse: frequency, wavelength, and amplitude. Use representations of individual pulses and	Quizzes, lab practicum, ranking tasks, modeling worksheets, test.	College Physics 2014 by Etkina, Gentile, Van Heuvelen Practicums for Physics Teachers 2nd Edition. Michael Crofton Logger Pro and Sound Probes. Performing a vibrating

		How can wave boundary behavior be used to derive and apply relationships for calculating the characteristic frequencies for standing waves in strings, open pipes and closed pipes? Why do mechanical waves require a physical medium? What happens to a wave when it travels through different media?	Interference and superposition lead to standing waves and beats. Earthquakes can produce both transverse and longitudinal waves.	construct representations to model the interaction of two wave pulses to analyze the superposition of two pulses. Explore the properties of P-waves and S-waves and what they can tell about the Earth's composition.		string exercise.