AP Physics 1 Syllabus 2015 - 16
Abraham Lincoln High School, Los Angeles CA
Instructor: Allen Cox
Course Overview

Text:
Halliday, David, Resnick, Robert, and Walker, Jearl. 2004. *Fundamentals of Physics. 7th Edition*. John Wiley & Sons, Inc. Hoboken, New Jersey.

AP® Physics 1 is a one-year, algebra-based course in general physics, equivalent to the first and second semester of an introductory, algebra-based college physics course.

In this course students will develop their ability to reason about the physical phenomena they see in every-day experiences. They will do this by practicing skills in applying physics and mathematical concepts to inquiry based activities and labs. Students will perform and design experiments to show their mastery of physics concepts. Students will prepare themselves for study of advanced topics in future college courses in science by honing their skills in analyzing data, designing experiments and making connections between different concepts that they will be exposed to in this course.

Lab and Inquiry Activities
At least twenty five percent of the class time will be labs and inquiry activities. All data will be kept in a lab notebook. Labs and Inquiry Activities will make up thirty percent of the total grade.
Students will be working collaboratively on Labs and Inquiry Activities.
Inquiry Activities will include a brief report showing the students' objectives, data analysis, and determination of relationships between variables. Each Lab will also include a formal lab report to be turned online. The lab report will have the following sections:
I. PURPOSE
What is the question that your experiment is trying to answer or what was the purpose of this experiment?
II. THEORETICAL
What are the physics concepts used in this lab and how do they relate to your lab? Include diagrams to help explain concepts, equations used for concepts, list variables in each equation showing what each means
III. EXPERIMENTAL
What was the design of your experiment? What materials did you use. Include annotated picture of the experimental set-up and a caption explaining the photograph.
IV. ANALYSIS
What measurements and calculations did you make? Show data in properly formatted tables. Show sample calculations. Present all data using correct significant figures and with error analysis. Graphs created from data and calculations will be presented here.

V. CONCLUSION
Restate the purpose of the experiment. Explain what did you find out and back this up with your final, numerical results. Relate what you found out to the theoretical section. What would you change in the procedure and/or what are your ideas for further experiments?

Each lab or activity will fall into one of the following categories:

Structured Inquiry:
The instructor provides parameters and procedures of investigation.

Guided Inquiry:
The instructor provides the problem or question and students devise their own procedure to solve the problem or answer the question.

Design Challenge
Students are challenged to design procedures for a specific output.

The following table contains the units of study, the Big Ideas included in each unit, a list of the concepts, the inquiry activities, and labs.

Unit 1: Kinematics **Big Idea 3:** *The interactions of an object with other objects can be described by forces* **Big Idea 4:** *Interactions between systems can result in changes in those systems.*	
Concepts	**Inquiry Activities and Labs**
Describing Motion	Activity: Categorizing Motion *Open Inquiry. Students collaboratively categorize different examples of motion presented to them by demonstrations and formulate questions about motion.*
Measurement and Significant Figures Conventions	Lab: Measurements and Significant Figures *Guided Inquiry. Students are introduced to measurements, significant figures, and error analysis in a structured lab. Lab format and online instructions are also introduced.*
Describing Motion – Graphs	Activity: Matching Graphs *Structured Inquiry. Students match their movement to preset position-time graphs using motion sensors.* Activity: Matching Position, Velocity, and Acceleration Graphs *Guided Inquiry. Students are given*

	position, velocity, and acceleration graphs on cards to match.
Describing Motion - Velocity & Acceleration	Lab: Toy Car – Constant Velocity and Accelerated Motion *Guided Inquiry. Students design a lab to create position-time graphs of two cars: one with constant motion and one with accelerated motion.* Activity: Lamborghini Motion *Structured Inquiry. Students view a dash-cam video of a car on the German Autobahn. Students will qualitatively and quantitatively describe the motion. Students will create a velocity-time graph using data taken from the video.* Activity: Matching Position, Velocity, and Acceleration Graphs *Guided Inquiry. Students are given position, velocity, and acceleration graphs on cards to match.*
Describing Motion - Kinematic Equations	Activity: Free Fall *Guided Inquiry. Students devise a procedure to use motion sensors to find the free fall acceleration.* Activity: How Far Up Is It? *Guided Inquiry. Students devise a procedure to use the kinematic equations to find the height of various locations around the campus.* Lab: Reaction Time *Guided Inquiry. Given only a meter-stick and kinematic equations, students will design a lab to determine their reaction time.*

<table>
<tr><td>Describing Motion - Vectors</td><td>Activity: PhET Vectors Simulation
Guided Inquiry. Students determine the relationships that determine how to add vectors using online simulation.

Activity: PhET Motion in 2D – Linear Acceleration I & II
Guided Inquiry. Students use motion simulations to devise description of 2D velocity and acceleration vectors.

Activity #: PhET Projectile Motion
Guided Inquiry. Students devise a procedure to predict the range of objects in projectile motion.</td></tr>
<tr><td colspan="2">Unit 2: Dynamics & Newton’s Laws of Motion

Big Idea 1: Objects and systems have properties such as mass and charge. Systems may have internal structure.
Big Idea 2: Fields existing in space can be used to explain interactions.
Big Idea 3: The interactions of an object with other objects can be described by forces
Big Idea 4: Interactions between systems can result in changes in those systems.</td></tr>
<tr><td colspan="2">Project: Balsa Airplane
Students use the concepts of Newton’s Laws of Motion to design and build an airplane out of balsa and tissue with the challenge of maximizing the time aloft.</td></tr>
<tr><th>Concepts</th><th>Inquiry Activities and Labs</th></tr>
<tr><td>Newton’s 1st Law: Inertia</td><td>Activity: Inertia Stations
Guided Inquiry. Students find and describe inertia in various situations at different lab stations.

Lab: Equilibrium
Guided Inquiry. Students determine the additional force needed to reach equilibrium on a “force table”. Students produce a formal lab report.</td></tr>
<tr><td>Newton’s 2nd Law

Free Body Diagrams
Equilibrium</td><td>Activity: Terminal Velocity
Guided Inquiry. Students use coffee filters to find a relationship between mass, surface area, and terminal velocity.</td></tr>
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	Activity: Weight of the Worlds *Structured Inquiry. Studenst find mass and weight of various object on other planets. Students research exo-planets and devise equations to find the weight of these object on exo-planets.* Lab: Constant Force/Changing Mass, Constant Mass/Changing Force *Structured Inquiry. Students create graphs of acceleration vs. mass and acceleration vs. force using a cart and a mass connected across a pulley. Students create a formal lab report.* Activity: Projectile Motion Revisited Demo *Knowledge from Newton's 2nd Law and projectile motion is used to predict the motion of a ball launched from a moving cart.* Lab: Atwood Machine *Guided Inquiry. Students use an Atwood Machine to devise an experiment to show the relationship between the hanging masses and acceleration. Students create a formal lab report.* Activity: PhET: Ramp Forces and Motion *Guided Inquiry. Students use computer simulations to identify and explore direction and magnitude of forces of an object on an inclined plane.* Lab: Modified Inclined Plane *Guided Inquiry. Students take knowledge from Atwood Machine and Inclined Plane to devise a procedure to complete a design challenge on an inclined plane with a motion cart attached to a mass over a pulley.*

Newton's 3rd Law	Lab: Static and Kinetic Friction + Inclined Plane *Students will create a procedure to meet a design challenge using an inclined plane, masses, pulleys, motion sensors, and friction carts.* Roadrunner Physics: *Students will view and discuss various cartoons and identify situations where Newton's Laws of Motion are not followed.*
Unit 3: Circular Motion and Gravitation **Big Idea 1:** *Objects and systems have properties such as mass and charge. Systems may have internal structure.* **Big Idea 2:** *Fields existing in space can be used to explain interactions.* **Big Idea 3:** *The interactions of an object with other objects can be described by forces* **Big Idea 4:** *Interactions between systems can result in changes in those systems.*	
Concepts	**Inquiry Activities and Labs**
Circular Motion	Activity # PhET Motion in 2D – Circular Motion *Guided Inquiry. Students use a computer simulation to identify velocity and acceleration vectors for objects moving in uniform circular motion* Lab: Circular Motion: *Students design a experiment using given materials to show direct proportionality between centripetal force and the square of the tangential velocity. Students create a formal lab report.*
Universal Gravitation	Activity: PhET Forces and Gravitation Simulation: *Students use computer simulation to show direct proportionality between force of gravity and mass and inverse proportionality between the force of gravity and the square of the distance between the center of mass of two masses.*

Unit 4: Momentum and Energy

Big Idea 3: *The interactions of an object with other objects can be described by forces*
Big Idea 4: *Interactions between systems can result in changes in those systems.*
Big Idea 5: *Changes that occur as a result of interactions are constrained by conservation laws.*

Project: Rube Goldberg Machine
Students design and build a "Rube Goldberg" machine to perform a simple task.

Concepts	Inquiry Activities and Labs
Momentum & Impulse Collisions and Conservation of Momentum	Lab: Conservation of Momentum *Guided Inquiry. Students design a lab to show that momentum is conserved in elastic and inelastic collisions. Students create a formal lab report.*
Work	Activity: Levers & Pulleys *Guided Inquiry. Students show that the work input of a simple machine is always less than the work output.*
Power	Activity: Stair Power *Guided Inquiry. Students design a procedure to measure their own power output while climbing a set of stairs.*
Energy	Activity: PhET Energy Skate Park: Basics *Guided Inquiry. Students use a computer simulation to devise a relationship between the total energy, kinetic energy, potential energy, and thermal energy of a system.* Lab: Hot Wheels Energy *Guided Inquiry. Students design a procedure to show that mechanical energy is conserved when a "Hot Wheels" car goes down a ramp.*

Unit 5: Rotation **Big Idea 3:** *The interactions of an object with other objects can be described by forces* **Big Idea 4:** *Interactions between systems can result in changes in those systems.* **Big Idea 5:** *Changes that occur as a result of interactions are constrained by conservation laws.*	
Rotational kinematics Angular Displacement Angular velocity Angular Acceleration	Activity: PhET: Ladybug Revolution *Guided Inquiry. Students use computer simulations to find the relationship between tangential acceleration and tangential velocity.*
Moment of inertia Parallel axis Theorem	Activity: PhET:Torque: Moment of Inertia *Guided Inquiry. Students use a computer simulation to find the relationship between moment of inertia, mass, and radius from the center of rotation* Activity: Rotation Race *Guided Inquiry. Students are shown various rolling objects and predict which object will win in a race down an inclined plane.*
Torque Torque vectors Cross product of vectors Right hand rule	Activity: PhET:Torque: Torque *Guided Inquiry. Students use a computer simulation to find the relationship between applied force, radius, and torque.* Lab: Torque *Guided Inquiry. Students create a procedure to show rotational equilibrium. Students create a formal lab report.*

Unit 6: Simple Harmonic Motion and Waves **Big Idea 6:** *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.*	
Project: Musical Instrument *Students design and build a musical instrument using physics concepts.*	
Concepts	**Inquiry Activities and Labs**
Simple Harmonic Motion Period and frequency	Lab: Pendulum Design *Guided Inquiry. Students design a procedure to show the relationship between the period of a pendulum and the length of the pendulum.*
Hooke's Law	Activity: PhET: Mass & Springs : Introduction to Oscillations *Guided Inquiry. Students use computer simulation to find the relationship between mass of a spring, spring constant, frequency, and period of an oscillation.* Lab: Hooke's Law and Spring Constant *Guided Inquiry. Students create a procedure to measure the spring constant of various springs. Students create a formal lab report.*
Dependence on medium for mechanical waves Mechanical waves Transverse waves Waves on a string Wavelength	Activity: Slinky *Guided Inquiry. Students investigate frequency, period, wavelength, and wave speed using a "slinky".* Activity: PhET Waves on a String *Guided Inquiry. Students us a computer simulation to investigate frequency, period, wavelength, wave speed, and standing waves.* Lab: Standing Waves on a String *Students explore measurement and the relationships between string density, frequency, period, wavelength, and wave speed. Students create a formal lab report.*

Longitudinal waves Interference Superposition Standing Waves Sound Amplitude	Activity: Musical Straws *Structured Inquiry. Students explore relationship between frequency, period, wavelength, and musical pitch of standing waves in open and closed tubes.* Activity: PhET Sound *Structured Inquiry. Students use a computer simulation to measure wavelength, wave speed, and frequency of sound waves.*
Reflection Beats Resonance Loudness Doppler effect	Activity: Resonance Demonstration *Students use knowledge of oscillations and waves to devise explanations of wave resonance.* Activity: Sound: Two Source Interference *Structured Inquiry. Students explore and measure wave interference.* Lab: Beats *Structured Inquiry. Students measure and record waveforms from two sound sources using an oscilloscope.* Activity: Doppler Effect Demonstration *Guided Inquiry. Students explain what they hear using Doppler equations.*

Unit 7: Electrostatics & Simple Electric Circuits

Big Idea 1: *Objects and systems have properties such as mass and charge. Systems may have internal structure.*
Big Idea 3: *The interactions of an object with other objects can be described by forces.*
Big Idea 5: *Changes that occur as a result of interactions are constrained by conservation laws.*

Concepts	Inquiry Activities and Labs
Charge Electric field Electric force Conductors and	Activity: "I see the Light" *Students are challenged to use one battery, one wire, and one light bulb to create a circuit. Students reflect on the nature of electricity, and the structure of the objects used to create the circuit.*

insulators Conservation of charge Charging Conduction	Inquiry Activity: PhET Balloons & Static Electricity/John Travoltage *Structured Inquiry. Students use a computer simulation to devise an explanation of static electricity.* Activity: Static Electricity Investigation Stations *Students find and describe situations involving static electricity at various activity stations.*
Current Batteries and EMF Resistance Ohm's Law Power Kirchhoff's Laws	Inquiry Activity: PhET Battery-Resistor Circuit/Circuit Construction *Guided Inquiry. Students use computer simulation to find a relationship between voltage, resistance, and current.* Lab: Ohm's Law *Structured Inquiry. Students show relationship between voltage, resistance, and current using a power source, rheostat, and ammeter. Students create a formal lab report.* Lab: Resistors in Series and Parallel *Guided Inquiry. Students create circuits to demonstrate resistors in series and parallel and a design challenge to create a circuit with specific voltages and currents.*