2019-20 AP Physics 1

Course Description: This is an advanced placement physics course designed to prepare all students for the AP Physics exam on Tuesday, May 8th 2018 at 12:00 PM. The course is designed to meet the requirements of a full year, college general physics class. The course is a rigorous math-based course, with a strong laboratory component. It is intended for students who have demonstrated a willingness to commit considerable time to studying and completing assignments outside of class and who have successfully completed prior courses in biology, chemistry, algebra, and geometry during high school.

Text and Materials:

- College Physics a strategic approach – Knight 3rd Edition (2015)

Students are regularly assigned reading in this text and take reading quizzes on their out of class reading to practice and assess their ability to comprehend a college-level text in independent study.

Instruction Method:

- Guided inquiry laboratory activities
- Lecture
- Classroom discussion
- Inquiry Laboratory Activities
- Reading (textbooks & outside resources)
- Writing (labs, problem solving, etc

Materials:

- 2-3 Spiral or Composition Notebooks: These notebooks will become your very own Interactive Notebook and will contain notes, handouts, assignments, and other class materials.
- Scientific/Graphing Calculator
- Basic Classroom Materials: Pencil, Pen, Hi-ligher, Ruler, etc.

Grading Scale:

A	**=**	**100%-90%**
B	**=**	**80%-89%**
C	**=**	**70%-79%**
D	**=**	**60%-69%**
F	**=**	**59% & below**

Grading Procedures: To earn credit this semester, the student must have a minimum class average of 60%. The grade will be calculated based on points earned in four categories:

- **Major Exams** (65% of grade): Students take one timed test every two-three weeks and approximately two units are covered on each test. Each test consists of approximately 20 multiple choice questions and 2 free response questions (both sections taken from old AP exams). The test is timed and the students have 50 minutes to complete it. They also take free response and multiple choice quizzes throughout the unit. These have also been drawn from old AP questions.

- **Labs Reports** (25% of grade): Graded as purpose, procedure, data, data analysis, error analysis and conclusion.

- **Daily Grades** (10% of grade): Classwork and homework will be assigned. The online homework system Mastering Physics is used as the means of assigning and grading homework problems. Students work through a combination of chapter questions from the Knight text, as well as supplemental problems made by the teacher that are similar to old free-response problems. During each unit, the problems assigned are mostly specific to the unit topic, but may also include review problems.

Course Outline:

The following is a course content outline along with the time spent on each unit. The chapters listed relate to the Knight textbook. Labs for each unit are also listed along with the purpose of each lab.

Physics Principals Outline and Connection to Big Ideas (BI):

Physics Principals	BI 1	BI 2	BI 3	BI 4	BI 5	BI 6
Kinematics			X			
1D kinematics			X			
2D kinematics			X			
Dynamics	X	X	X	X		
Newton's Laws	X	X	X	X		
Gravitation and Circular Motion	X	X	X	X		
Simple Harmonic Motion			X		X	
Mass and Spring system			X		X	
simple Pendulum			X		X	
Linear Momentum			X	X	X	
Impulse			X	X	X	
momentum			X	X	X	
conservation of momentum			X	X	X	
Energy			X	X	X	
work			X	X	X	
energy			X	X	X	
power			X	X	X	
conservation of energy			X	X	X	
Rotational motion			X	X	X	
rotational kinematics			X	X	X	
torque			X	X	X	
rotational dynamics			X	X	X	
rotational energy			X	X	X	
conservation of angular momentum			X	X	X	
Electrostatics	X		X		X	
electric charge	X		X		X	
conservation of charge	X		X		X	
Coulomb's law	X		X		X	
Electric Circuits	X				X	
Ohm's law	X				X	
Kirchoff's laws	X				X	
Waves and Sound						X

<u>LABS:</u> Outline of AP Physics 1 Labs and investigations with correlating Science Practices

<u>Motion in One Dimension</u>

	Lab/*Demo*	Purpose	Science Practices
1	**Constant Velocity**	To derive an equation of motion for an object traveling with a constant velocity. ***Guided Inquiry***	1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.1
2	**Constant Acceleration**	To derive an equation of motion for an object traveling with a constant acceleration. ***Guided Inquiry***	1.5, 2.2, 2.5, , 4.2,5.1
3	**Graph Matching**	To predict, sketch, and test s vs. t and v vs. t graphs with a CBL for the motion of a student walking across the room.	1.2, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
4	**Free Fall**	To determine the type of motion exhibited by a freely falling body. ***Open Inquiry***	1.5, 2.2, 2.5, , 4.2,5.1

<u>Motion in Two Dimensions</u>

	Lab/*Demo*	Purpose	Science Practices
5	**Dart Gun**	To determine how range varies with angle, and derive an equation expressing this relationship.	1.4, 2.1, 2.2, 3.3, 4.1, 4.2, 4.3
6	*Monkey and Hunter*	To determine at what angle the hunter must aim his gun so that he will hit a monkey just dropping out of a tree.	3.1,3.2,3.3
7	**Marble Launch I**	To predict the impact point of a marble launched from the top of a table at a horizontal initial angle. ***Guided Inquiry***	1.1, 1.4, 2.1, 2.2, 3.3, 5.1, 6.1

<u>Forces and Newton's Laws</u>

	Lab/*Demo*	Purpose	Science Practices
8	*Tablecloth*	To demonstrate Newton's First Law by pulling a tablecloth out from underneath a set of objects.	3.1
9	*Toilet-Paper Pull*	To demonstrate Newton's First Law: if you pull toilet paper slowly, the paper unrolls, but if you pull quickly, you overcome inertia and tear a sheet of paper off.	3.1
10	**Constant Force**	To determine the type of motion that occurs from the application of a constant force. ***Guided Inquiry***	1.4, 2.1, 2.2, 3.3, 5.1, 5.2, 6.2

11	**Changing Force**	To determine the relationship between the force on an object and the resulting acceleration. Derive an equation expressing this relationship. ***Guided Inquiry***	1.4, 2.1, 2.2, 3.3, 5.1, 5.2, 6.2
12	**Friction Blocks**	To examine the force of friction on a sliding block, especially the relationship between the force of friction and the normal force. ***Guided Inquiry***	1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2
13	**Inclined Plane**	To find the parallel component of weight that pulls a cart down a plane at a certain angle. Derive an equation that relates the weight force, angle, and the parallel component. ***Open Inquiry***	1.4, 2.1, 2.2, 3.1, 4.2, 5.1, 5.2, 6.1, 7.2

Circular Motion and Gravitation

	Lab/*Demo*	Purpose	Science Practices
14	**Flying Toy**	To determine the tension in the string and the centripetal acceleration of the flying toy. ***Open Inquiry***	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2
15	**Stopper Lab**	A. To determine the relationship between the radius of circular motion and the period of circular motion, speed, and acceleration while keeping velocity constant. B. ***Guided Inquiry*** C. To determine the relationship between the acceleration of the stopper and the centripetal force. ***Guided Inquiry***	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 4.2, 4.3, 4.4, 5.1, 6.1, 6.2, 6.4
16	*Water in the Bucket*	To show that water will not fall out of a bucket that is swung in a vertical circle if the angular velocity of the bucket is large enough.	1.2, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
17	*Centripetal Force Apparatus*	To demonstrate the properties of centripetal motion using these jars with fishing bobs on both ends of a transverse bar which are rotated about a vertical axis.	1.5, 2.2, 2.5, , 4.2,5.1
18	**Galileo Ramps**	To use ramps raised to different heights to study the acceleration of balls.	1.1, 1.4, 2.1, 2.2, 3.2, 4.1, 5.1, 5.2, 6.2, 7.2
19	**Jupiter's Moons**	To do research on Jupiter and four of its moons. Based on this research, students will mathematically come up with the mass of Jupiter. They will compare this information to the accepted value.	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 4.2, 4.3, 4.4, 5.1, 6.1, 6.2, 6.4, 7.1

Work, Power, Energy

	Lab/*Demo*	Purpose	Science Practices
20	**Hooke's Law**	To determine the relationship between distance stretched and force. ***Open Inquiry***	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.2, 7.2
21	**Roller Coaster Energy**	To use multiple representations to show the kinetic, potential, and total energy for a marble at various positions while it is moving down the ramp and around the loop of a wooden track.	1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.2, 6.4, 7.2

Impulse and Momentum

	Lab/*Demo*	Purpose	Science Practices
20	**Colliding Pendulum**	To use conservation of momentum to determine the unknown mass of a ball involved in a collision with a ball of known mass.	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.2
21	*Roller Blade Momentum*	To demonstrate a combination of explosive collisions and inelastic collisions. Each roller blader gains momentum with each toss and catch of a pillow.	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.2
22	*Double Ball Bounce*	To demonstrate conservation of momentum, momentum is transferred to a small ball from a large ball moving upward, causing the small ball to experience a huge change in velocity.	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.2
23	**Conservation of Momentum**	To demonstrate conservation of momentum, students will observe seven different collisions using a track and collision carts and make conclusions about momentum conservation in real life situations. ***Open Inquiry***	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 4.2, 4.3, 4.4, 5.1, 6.1, 6.2, 6.4, 7.2
24	**Bumper Design**	To design a paper bumper that will soften the impact of the collision between a cart and a fixed block of wood. Their designs are evaluated by the shape of an acceleration-versus-time graph of the collision. ***Open Inquiry***	1.4, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.2, 6.4, 7.2

Simple Harmonic Motion and Oscillations

	Lab/*Demo*	Purpose	Science Practices
20	**Hooke's Law and Parallel and Series Springs**	To determine the spring constant of an unknown spring, the relationship between distance stretched and force, and then using a second spring of different spring constant; determine how spring constants are affected when springs are placed in parallel and series. ***Open Inquiry***	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.2, 7.2
21	**Graphs of an oscillating system**	To analyze graphs of position, velocity, and acceleration versus time for an oscillating system to determine how velocity and acceleration vary at the equilibrium position and at the endpoints.	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
22	**Simple Pendulum Investigation**	To investigate the factors that affect the period of a simple pendulum and test whether the period is proportional to the pendulum's length, the square of its length, or the square root of its length. ***Open Inquiry***	1.2, 1.4, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2

Rotational Kinematics and Dynamics

	Lab/*Demo*	Purpose	Science Practices
23	**Torque lab**	To determine factors that affect the rotational motion of an object. ***Open Inquiry***	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.2,
24	**Rolling Cylinders**	To determine how the type of cylinder affects how long it takes a cylinder to roll.	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 5.1, 6.2,
25	**Rotational Inertia**	To determine the rotational inertia of a cylinder from the slope of a graph of an applied torque versus angular acceleration. ***Guided Inquiry***	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
26	**Conservation of Angular Momentum**	To investigate how the angular momentum of a rotating system responds to changes in the rotational inertia. ***Guided Inquiry***	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2

Waves and Sound

	Lab/*Demo*	Purpose	Science Practices
27	**Mechanical Waves**	To model the two types of mechanical waves with a spring toy to test whether or not these characteristics affect the speed of a pulse: frequency, wavelength, and amplitude.	1.2, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.2, 6.4, 7.2
28	**Speed of Sound**	To design two different procedures to determine the speed of sound in air.	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2
29	**Wave Boundary Behavior**	To compare what happens to the phase of a transverse wave on a spring toy when a pulse is reflected from a boundary and when it is reflected and transmitted from various boundaries (spring to string).	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
30	**Standing Waves**	To predict the length of the string necessary to generate the first two harmonics of a standing wave on the string, given a specified tension. Then they perform the experiment and compare the outcome with their prediction.	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
31	**Harmonics on a String**	To determine the relationships between frequency, wavelength, length of string, and harmonic number. Derive equations expressing these relationships.	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2

Electrostatics

	Lab/*Demo*	Purpose	Science Practices
27	**Static Electricity Interactions**	To use sticky tape and a variety of objects to make qualitative observations of the interactions when objects are charged, discharged, and recharged.	1.2, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.2, 6.4, 7.2
28	**Coulomb's law Lab**	To determine the charge stored on a pair of charged balloons that are repelling each other.	1.1, 1.4, 2.1, 2.2, 3.3, 4.1, 4.2, 4.3, 4.4, 5.1, 6.1, 6.2, 6.4

DC Circuits

	Lab/*Demo*	Purpose	Science Practices
29	**Brightness Investigation**	To make predictions about the brightness of light bulbs in a variety of series and parallel circuits when some of the bulbs are removed. ***Open Inquiry***	1.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2
30	**Voltage and Current**	To determine the relationship between the current through a resistor and the voltage across the resistor. ***Open Inquiry***	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
31	**Resistance and Resistivity**	To investigate the effects of cross-sectional area and length on the flow of current through a roll of PlayDoh and using different drinking straws. ***Open Inquiry***	1.2, 1.4, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
32	**Series and Parallel Circuits**	To investigate the behavior of resistors in series, parallel, and series-parallel circuits. The lab should include measurements of voltage and current. ***Open Inquiry***	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.4, 7.2

Additional Course Information

Labs & Classwork

Labs are all "hands-on" and placed throughout the instructional year. Students will spend at least 25% of class time in laboratory investigations. Labs can be either teacher directed or student directed/open-ended. During a teacher-directed lab, the students are given instruction on the operation of lab equipment and guidance in the process of the experiment. Student-directed labs are when the students are given an objective, e.g. "Determine the acceleration due to gravity on Earth," and standard materials needed to conduct a lab. Students are allowed to create their own experimental design and collect data, which can be analyzed through graphical methods. These inquiry-based investigations or student-directed labs have an extra element that is added to some lab reports. After these labs, each student group will present their results to the class and defend their results. They will also evaluate one other group's approach to the problem and offer a critique of their procedures and results.

Students work in lab groups, but each student must record raw data in their lab notebook. Once a semester each student will submit a formal lab report. The report must include the following components:

- **Statement of the problem**
- **Hypothesis**
- **Discussion or outline of how the procedure will be carried out**
- **Data collected from the experiment**
- **Data analysis**
- **Conclusion including error analysis, and extension/outside application**
- **Peer review (if included in this lab)**

Students are required to keep an organized lab notebook. This lab notebook will kept by the students for the entire year and must include the raw data for completed lab reports as well as the raw data tables and any notes made during the execution of the labs done in the course.

Several lab investigations during the year are extended projects that require using data collected by outside sources. Students will utilize this data to find out answers to questions posed by the instructor and also questions they formulate themselves.

Real World Investigations:
In order for students to become scientifically literate citizens, students are required to use their knowledge of physics while looking at a real world problem. Students may pick one of the following solutions:

- Students will pick a Hollywood movie and will point out three (or more) instances of bad physics. They will present this information to the class, describing the inaccuracies both qualitatively and quantitatively.
- Students will research a thrill ride at an amusement park. They will present information to the class on the safety features of the ride, and why they are in place.
- Students will present information to the class on noise pollution, and it's danger to both human and animal life. They will also propose solutions to noise pollution problems.
- Students will go to the insurance institute of highway safety website (iihs.org) and will look at the safest cars in a crash. They will present information as to why these cars are safer and how the safety features keep people safe.

Real World Activities:
Throughout the course, the students engage in a variety of activities designed to build the students' reasoning skills and deepen their conceptual understanding of physics principles. Students conduct activities and projects that enable them to connect the concepts learned in class to real world applications and support the connection to more than one Learning Objective.
Examples of activities are described below.

Car Crash Physics: This past year a lawyer approached me with a problem. His client was hurt in a crash, but the insurance company was claiming there was not enough force generated in the crash to cause injuries. The students will be given the same problem and asked to come up with an answer to the insurance company. They will research information needed and write a report detailing their conclusions. Each group will present their findings to the class and also review and critique another group's conclusions and methods used to come up with their answer. While one group presents their expert findings, the other group will be acting as the insurance company trying to find holes in their argument.

Kepler Telescope Exoplanet Discovery: The Kepler telescope has been discovering evidence about new planets around other stars for the last few years. Some of this data is posted on the Internet and we will use it to determine properties of these planets. Students will have a new planet to investigate and determine as many physical properties about that planet as possible form the data set. The investigation requires the students to utilize
Learning Objective 2B 2.1 The student is able to apply *Newton's Law of Universal Gravitation* to calculate the gravitational field due to an object with mass *M*, where the field is a vector
directed toward the center of the object of mass *M*.
Learning Objective 3 A 2.1 The student is able to represent forces in diagrams or
mathematically using appropriately labeled vectors with
magnitude, direction, and units during the analysis of a situation.
Learning Objective-3A 4.2 The student is able to use Newton's third law to make claims and
predictions about the action-reaction pairs of forces when two
objects interact.
Learning Objective-3B 2.1 The **4A 1** student is able to create and use free-body diagrams to
analyze physical situations to solve problems with motion
qualitatively and quantitatively.
Learning Objective-4A 1 The linear motion of a system can be described by the displacement, velocity, and acceleration of its center of mass.

ACTIVITY: Torque and the Human Arm [CR4]
CR3— Students have opportunities to apply AP Physics 1 learning objectives connecting across enduring understandings as described in the curriculum framework. These opportunities must occur in addition to those within laboratory investigations.

DESCRIPTION: This activity provides an opportunity for students to make an **interdisciplinary connection** to biological systems by investigating the structure and function of a major muscle (biceps) in the human body. Students design and build an apparatus that replicates the forearm and biceps muscle system. The objective is to determine the biceps tension when holding an object in a lifted position. Students may use the Internet to research the structure of the biceps muscle. They can use readily available materials in the classroom, such as a meter stick, a ring stand, weight hangers, an assortment of blocks, and a spring scale. In their lab notebook, students are required to document the different stages of their design. Required elements include design sketches, force diagrams, mathematical representations of translational and rotational equilibrium, and numerical calculations.

Learning Objective 3.F.1.1
The student is able to use representations of the relationship between force and torque.

Learning Objective 3.F.1.2
The student is able to compare the torques on an object caused by various forces.

Learning Objective 3.F.1.3
The student is able to estimate the torque on an object caused by various forces in comparison to other situations.

Learning Objective 3.F.1.4
The student is able to design an experiment and analyze data testing a question about torques in a balanced rigid system.

Learning Objective 3.F.1.5
The student is able to calculate torques on a two-dimensional system in static equilibrium, by examining a representation or model (such as a diagram or physical construction).