Syllabus: AP Physics 1

Curricular Requirements	Page(s)
CR 1. Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.	2, 3
CR 2a. The course design provides opportunities for students to develop understanding of the foundational principles of kinematics in the context of the big ideas that organize the curriculum framework.	3, 6
CR 2b. The course design provides opportunities for students to develop understanding of the foundational principles of dynamics in the context of the big ideas that organize the curriculum framework.	3, 7
CR 2c. The course design provides opportunities for students to develop understanding of the foundational principles of gravitation and circular motion in the context of the big ideas that organize the curriculum framework.	4, 8
CR 2d. The course design provides opportunities for students to develop understanding of the foundational principles of simple harmonic motion in the context of the big ideas that organize the curriculum framework.	4, 8
CR 2e. The course design provides opportunities for students to develop understanding of the foundational principles of linear momentum in the context of the big ideas that organize the curriculum framework.	3, 7, 8
CR 2f. The course design provides opportunities for students to develop understanding of the foundational principle of energy in the context of the big ideas that organize the curriculum framework.	3, 7, 8
CR 2g. The course design provides opportunities for students to develop understanding of the foundational principles of rotational motion in the context of the big ideas that organize the curriculum framework.	4, 8
CR 2h. The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.	5, 9
CR 2i. The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.	5, 9
CR 2j. The course design provides opportunities for students to develop understanding of the foundational principles of mechanical waves in the context of the big ideas that organize the curriculum framework.	4, 8, 9
CR 3. 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.	10, 11
CR 4. The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.	10, 11
CR5. Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.	5, 10
CR 6a. The laboratory work used throughout the course includes investigations that support the foundational AP Physics 1 principles.	5, 6, 10
CR 6b. The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.	2, 5, 6, 10
CR 7. The course provides opportunities for students to develop their communication skills by recording evidence of their research of literature or scientific investigations through verbal, written, and graphic presentations.	6, 10
CR 8. The course provides opportunities for students to develop written and oral scientific argumentation skills.	2, 6, 10, 11

Resources:

Textbook:

Cutnell, Johnson, Young, Stadler. *Physics*, 10e (Physics 1).10th ed. Wiley. **[CR 1]**

CR1— Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.

Teaching Resources: [CR 1]

Hewitt, Paul. *Conceptual Physics* 10th edition. Upper Saddle River, NJ. Prentice Hall, 2006.
Serway, Raymond. *College Physics* 7th edition. USA, Brooks / Cole, 2006.
Knight, Randall D., Brian Jones, and Stuart Field. *College Physics: A Strategic Approach* Second Edition. Boston MA. Pearson, 2013.
Serwat, Raymond and Faughn, Jerry. *Holt Physics*. New York, NY. Holt, Rinehart and Winston, 2006
PASCO Software and Technology, 2016.

Course Introduction

AP Physics 1 is an algebra-based course in general physics that meets three times for 54 minutes per four day cycle with an additional 54 minute lab once per cycle for the entire school year. Lab work is integral to the understanding of the concepts in this course. General physics topics presented during the course closely follow those outlined by the College Board and also mirror an introductory level university physics course.

AP Physics 1 is organized around six big ideas that bring together the fundamental science principles and theories of general physics. These big ideas are intended to encourage students to think about physics concepts as interconnected pieces of a puzzle. The solution to the puzzle is how the real world around them actually works.

Big Ideas for AP Physics 1

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.
Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.
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.

Instructional Strategies

Students will participate in inquiry-based explorations **[CR 6b]** of these topics to gain a more conceptual understanding of these physics concepts. Students will spend time in traditional formula-based learning and will be directed to develop critical thinking and reasoning skills. Problem solving techniques and strategies are fine tuned throughout the year, and students are continually tasked with connecting physics applications learned in different units in order to synthesize solutions to complex problems. Students will complete physics projects to make connections with real-world applications. Students have the opportunity to work cooperatively to solve challenging problems and to present their solutions to the class. Many of the problem solving sessions will be cooperative efforts. Students are encouraged and required to present and defend their solutions to the class. The rest of the class in encouraged to constructively challenge solutions that are not in agreement with theirs. **[CR 8]**.

CR6b— The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.

CR8— The course provides opportunities for students to develop written and oral scientific argumentation skills.

Students will perform laboratory experiments, calculate and analyze data, and draw conclusions by way of critical thinking through traditional methods. In some labs, the students use probe-ware technology in data acquisition to enrich their understanding of physics concepts. In the classroom, they use graphing calculators and digital devices for interactive simulations by computer and app-based exercises **[CR 1]**, collaborative activities, formative and summative assessments.

CR1— Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.

<u>Course Syllabus</u>

Unit 1: Kinematics	Curricular Requirement: **[CR 2a]**
Topics:	-Kinematics in one-dimension: constant velocity and uniform accelerated motion -Vectors: vector components and resultant -Kinematics in two-dimensions: projectile motion
Chapter(s):	1, 2, 3
Big Idea(s):	3
Learning Objectives:	3.A.1.1, 3.A.1.2, 3.A.1.3, 4.A.2.1, 4.A.2.3

CR2a— The course design provides opportunities for students to develop understanding of the foundational principles of kinematics in the context of the big ideas that organize the curriculum framework

Unit 2: Dynamics	Curricular Requirement: **[CR 2b]**
Topics:	-Forces and their representation (FBD) -3 Laws of Motion -Applications of Laws of Motion to systems -The role of Friction
Chapter(s):	4
Big Idea(s):	1, 2, 3, 4
Learning Objectives:	3.A.3.2, 3.A.3.3, 3.A.2.1, 3.A.3.1, 3.C.4.1, 3.C.4.2, 4.A.3.1, 4.A.3.2, 4.A.1.1, 2.B.1.1, 3.B.1.1, 3.B.1.3, 3.A.4.1, 3.A.4.3, 3.B.2.1, 4.A.2.2, 5.D.3.1

CR2b— The course design provides opportunities for students to develop understanding of the foundational principles of dynamics in the context of the big ideas that organize the curriculum framework.

Unit 3: Work –n- Energy	Curricular Requirement: **[CR 2f]**
Topics:	-Work -Work Energy Theorem -Conservation of Mechanical Energy -Conservation of Energy -Power
Chapter(s):	6
Big Idea(s):	3, 4, 5
Learning Objectives:	3.E.1.1, 3.E.1.2, 3.E.1.3, 3.E.1.4, 4.C.1.1, 4.C.1.2, 4.C.2.1, 4.C.2.2, 5.B.1.1, 5.B.1.2, 5.B.2.1, 5.B.3.1, 5.B.3.2, 5.B.4.1, 5.B.4.2, 5.B.5.1, 5.B.5.3, 5.B.5.4, 5.B.5.5

CR2f— The course design provides opportunities for students to develop understanding of the foundational principle of energy in the context of the big ideas that organize the curriculum

Unit 4: Momentum	Curricular Requirement: **[CR 2e]**
Topics:	-Momentum -Impulse Momentum Theorem -Conservation of Momentum

CR2e— The course design provides opportunities for students to develop understanding of the foundational principles of linear momentum in the

	-Collisions
Chapter(s):	7
Big Idea(s):	3, 4, 5
Learning Objectives:	5.D.1.1, 5.D.1.2, 5.D.1.3, 5.D.1.5, 5.D.2.1, 5.D.2.3, 5.D.2.4, 5.D.2.5, 3.D.1.1, 3.D.2.1, 3.D.2.2, 3.D.2.3, 4.B.1.2, 4.B.2.1, 4.B.2.2, 4.B.1.1

Unit 5: Universal Gravitation & Circular Motion	Curricular Requirement: **[CR 2c]**
Topics:	-Uniform Circular Motion (UCM) -Dynamics of Circular Motion -Law of Universal Gravitation
Chapter(s):	5
Big Idea(s):	1, 2, 3, 4
Learning Objectives:	2.B.2.1, 2.B.2.2, 3.A.3.1, 3.C.1.1, 3.C.1.2, 3.C.2.1, 3.C.2.2

CR2c— The course design provides opportunities for students to develop understanding of the foundational principles of gravitation and circular motion in the context of the big ideas that organize th

Unit 6: Rotational Motion	Curricular Requirement: **[CR 2g]**
Topics:	-Torque -Center of mass -Rotational kinematics -Rotational dynamics and rotational inertia -Rotational energy -Angular momentum -Conservation of angular momentum
Chapter(s):	8, 9
Big Idea(s):	3, 4, 5
Learning Objectives:	3.F.1.1, 3.F.1.2, 3.F.1.3, 3.F.1.4, 3.F.1.5, 3.F.2.1, 3.F.3.1, 3.F.3.2, 4.D.1.1, 4.D.2.1, 4.D.3.1, 4.D.3.2, 5.E.1.1, 5.E.1.2, 5.E.2.1

CR2g— The course design provides opportunities for students to develop understanding of the foundational principles of rotational motion in the context of the big ideas that organize the curriculum framework.

Unit 7: Simple Harmonic Motion	Curricular Requirement: **[CR 2d]**
Topics:	-Linear restoring forces and simple harmonic motion -Simple harmonic motion graphs -Simple pendulum -Mass-spring systems
Chapter(s):	10
Big Idea(s):	3, 5
Learning Objectives:	3.B.3.1, 3.B.3.2, 3.B.3.3, 3.B.3.4

CR2d— The course design provides opportunities for students to develop understanding of the foundational principles of simple harmonic motion in the context of the big ideas that organize the curriculum framework.

CR2j— The course design provides opportunities for students to develop

Unit 8: Mechanical Waves & Sound	Curricular Requirement: **[CR 2j]**
Topics:	-Traveling waves -Wave characteristics -Sound -Superposition -Standing waves on a string -Standing sound waves
Chapter(s):	16, 17
Big Idea(s):	6
Learning Objectives:	6.A.1.1, 6.A.1.2, 6.A.3.1, 6.B.1.1, 6.B.5.1, 6.D.1.1, 6.D.3.4, 6.D.4.1, 6.D.4.2, 6.D.5.1, 6.D.2.1, 6.D.3.2, 6.A.2.1, 6.A.4.1, 6.B.2.1

CR2h— The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.

CR2i— The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.

Unit 9: Electrostatics	Curricular Requirement: **[CR 2h]**
Topics:	-Electric charge and conservation of charge -Electric force: Coulomb's Law
Chapter(s):	18
Big Idea(s):	1, 3, 5
Learning Objectives:	1.B.1.1, 1.B.1.2, 1.B.2.1, 1.B.3.1, 3.C.2.2

CR5— Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.

Unit 10: DC Circuits	Curricular Requirement: **[CR 2i]**
Topics:	-Electric resistance -Ohm's Law -DC circuits -Series and parallel connections -Kirchhoff's Laws
Chapter(s):	20
Big Idea(s):	1, 5
Learning Objectives:	1.E.2.1, 5.B.9.1, 5.B.9.2, 5.B.9.3, 5.C.3.1, 5.C.3.2, 5.C.3.3

CR6b— The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.

<u>Laboratory Work</u>

Students spend 25% of the instructional time engaged in laboratory work **[CR 5]**. Experiments designed by the instructor are used to demonstrate procedural guidelines and to learn how to use specific laboratory equipment. The majority of labs are inquiry-based **[CR 6b]** where students are given an objective and a set of materials. They are tasked with designing a procedure and collecting data to determine specific quantities, determine the relationship between variables, and/or to derive fundamental physics equations **[CR 6a]**. Laboratory design, experimentation, data gathering, data presentation, analysis, drawing conclusions, and experimental error analysis are elements in these lab activities.

CR6a— The laboratory work used throughout the course includes investigations that support the foundational AP Physics 1 principles.

Laboratory work is recorded in a laboratory notebook or folder **[CR 7]**, and students will have opportunities to present their laboratory work to their peers **[CR 8]**. All aspects of the laboratory work including any pre-lab work, question/hypothesis, experimental procedure, data, analysis, graphs, conclusion, and error analysis will be recorded **[CR 7]**. Students will work in lab groups, but each student will write an individual lab report in their organized lab notebook. This lab notebook will be kept by the students for the entire year and must include the completed labs reports as well as raw data tables ad any notes made during the execution of the labs done in the course. **[CR 7]**.

CR7— The course provides opportunities for students to develop their communication skills by recording evidence of their research of literature or scientific investigations through verbal, written, and graphic presentations.

CR8— The course provides opportunities for students to develop written and oral scientific argumentation skills.

Labs to be performed

UNIT	Lab Investigation: Curricular Requirement for Activity: Type **[CR 6b]** GI – Guided Inquiry OI – Open Inquiry Description: Science Practices: **[CR 6a]**
UNIT 1: Kinematics	
	2. Car Project: **[CR 2a]**: OI Research and build a wind-up rubber band cardboard car under certain conditions and restrictions that will move a certain distance Calculate velocity and average velocities of the three trials Science Practices: 1.4, 1.5, 2.1, 2.2, 4.2, 4.3, 5.1, 5.2, 5.3, 6.2, 6.3
	3. Motion Sensor Lab: **[CR 2a]**: GI Different motions are captured and recorded graphically by a motion sensor and software. Then students predict the motion of objects from provided graphs. Science Practices: 1.4, 1.5, 2.2, 4.4, 5.1, 6.4
	4. Acceleration due to gravity: **[CR 2a]**: OI Determination of the acceleration due to gravity of an object released from height. Comparison of different types of objects and their motion while falling (objects with air resistance) Science Practices: 1.3, 1.4, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3, 5.1, 5.2, 6.4
	5. Marble Launch: **[CR 2a]**: OI Calculation of the launch velocity of a vertically launched projectile. Science Practices: 1.4, 2.1, 2.2, 4.1, 4.2, 4.3
	6. Horizontal Launch Lab: **[CR 2a]**: OI Prediction of where a horizontally launched projectile will land. Science Practices: 2.1, 2.2, 4.1, 4.2
	7. Catapult Project: **[CR 2a]**: OI Research and build a catapult to fire a gum drop under certain conditions and restrictions Science Practices: 1.4, 1.5, 2.1, 2.2, 4.2, 4.3, 5.1, 5.2, 5.3, 6.2, 6.3

CR6b— The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.

CR6a— The laboratory work used throughout the course includes investigations that support the foundational AP Physics 1 principles.

CR2a— The course design provides opportunities for students to develop understanding of the foundational principles of kinematics in the context of the big ideas that organize the curriculum framework

UNIT 2: Dynamics	8. Force Table Lab (vectors): **[CR 2b]**: GI Force tables are used to calculate the resultant vector of a series of other vectors. Science Practices: 1.4, 2.2, 2.3
	9. Bridge Project: **[CR 2b]**: OI Research and build a newspaper bridge/table under certain conditions and restrictions that will hold a certain amount of mass Design free-body diagram of structure and analyze weakest part of structure (where did the bridge 'give') Science Practices: 1.4, 1.5, 2.1, 2.2, 4.2, 4.3, 5.1, 5.2, 5.3, 6.2, 6.3
	10. Skateboard Lab: **[CR 2b]**: OI Students are pushed on a skateboard. Masses, forces, and motion are measured. The relationship between Force, mass and acceleration will be derived. Science Practices: 1.1, 1.4, 2.2, 2.3, 4.1, 4.2, 4.3, 6.2
	11. Sneaker Lab: **[CR 2b]**: GI A sneaker is pulled across different surfaces. Various masses in the sneaker are tested. The coefficient of friction between the sneaker and the surfaces will be determined. This data is compared to other students' results to analyze what shoe has the best traction. Science Practices: 1.1, 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1
	12. Friction on a Ramp: **[CR 2b]**: OI Using a ramp and a block determine the coefficient of friction between the two objects. Design an experiment to find the coefficient of friction in an alternative method using other provided science equipment Science Practices: 1.1, 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1

CR2b— The course design provides opportunities for students to develop understanding of the foundational principles of dynamics in the context of the big ideas that organize the curriculum framework.

CR2f— The course design provides opportunities for students to develop understanding of the foundational principle of energy in the context of the big ideas that organize the curriculum

UNIT 3: Work & Energy	13. Conservation of Mechanical Energy: **[CR 2f]**: GI A cart is timed as it slides down a ramp elevated at an angle. It speed at the bottom is determined and compared to a value calculated by applying the law of conservation of energy. The experiment is repeated using a heavier cart on a ramp. Values for the two carts are compared. Science Practices: 1.1, 1.4, 2.2, 3.1, 3.3, 4.1, 4.2, 5.1, 6.2, 7.1, 7.2
	14. Roller Coaster Project: **[CR 2f]**: OI Research and build a marble roller coaster in a collaborated effort under certain conditions and restrictions and analyze/reflect on energy transformations. Science Practices: 1.4, 1.5, 2.1, 2.2, 4.2, 4.3, 5.1, 5.2, 5.3, 6.2, 6.3

CR2e— The course design provides opportunities for students to develop understanding of the foundational principles of linear momentum in the context of the big ideas that organize the

UNIT 4: Momentum	15. Conservation of Momentum: **[CR 2e]**: OI Carts of different masses will be made to collide in different types of collisions. Motion before and after the collisions will be analyzed and

	compared. Science Practices: 1.4, 3.1, 5.1, 6.2, 7.1, 7.2
	16. Troll's Bungee Jump: **[CR 2e]**: GI Using PASCO equipment determine the forces on a Troll doll when bungee jumping with a string and then with rubber bands. Analyze data to determine the relationship between time and force on an object of changing momentum Science Practices: 1.4, 3.1, 5.1, 6.2, 7.1, 7.2

UNIT 5: Circular Motion	17. Centripetal Force Take 1: **[CR 2c]**: GI A mass connected to a spring scale is spun in a horizontal circle on the ground. The relationship between velocity, radius, force and the effects on friction is investigated. Science Practices: 1.1, 2.1, 2.2, 4.1, 4.3, 5.1, 7.2
	18. Centripetal Force Take 2: **[CR 2c]**: OI A rubber stopper is swung in a horizontal circle. It will pull masses hanging from the bottom of the string upwards. The relationship between velocity, radius and force is investigated. Science Practices: 1.1, 2.1, 2.2, 4.1, 4.3, 5.1, 7.2

UNIT 6: Rotation	19. Torque: **[CR 2g]**: GI Spring scales, masses and meter sticks are used to test the relationship between torque, force and radius. Science Practices: 1.1, 1.2, 1.4, 3.1, 3.2, 3.3, 4.2, 4.3, 5.1, 6.1, 7.2
	20. Flying Pig: **[CR 2g]**: OI A flying pig is used as a conical pendulum. The relationship between velocity, radius, force and angle is investigated. Science Practices: 1.1, 1.2, 1.4, 2.2, 3.1, 3.2, 4.1, 4.2, 4.3, 5.1, 6.1, 7.2
	21. Rotational Motion: **[CR 2g]**: GI A rotary motion sensor is used to develop the relationship between moment of inertia, torque and angular acceleration. Science Practices: 1.2, 1.4, 2.2, 4.2, 4.3, 5.1, 6.1, 7.2

UNIT 7: Simple Harmonic Motion	22. Simple Harmonic Motion: **[CR 2d]**: OI Pendulums are created with varying masses, lengths and release angles. Oscillators are created with different springs and masses. Factors affecting period for each type of simple harmonic motion are tested. Science Practices: 1.4, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 6.1, 7.2
	23. Hooke's Law: **[CR 2f]**: GI Various springs are stretched by hanging from them multiple masses. A plot of Force vs. displacement is created and used to find work done on the spring and the k value of the spring. The spring constants will be found through other methods and the results will be compared and contrasted. Science Practices: 1.1, 1.2, 1.4, 2.2, 2.3, 4.1, 4.3, 5.1, 5.2, 7.1, 7.2

UNIT 8: Mechanical	19. "Slinky" Lab: **[CR 2j]**: GI A coiled spring is used to test how tension in the medium, frequency,

CR2c— The course design provides opportunities for students to develop understanding of the foundational principles of gravitation and circular motion in the context of the big ideas that organize the curriculum framework.

CR2g— The course design provides opportunities for students to develop understanding of the foundational principles of rotational motion in the context of the big ideas that organize the curriculum framework.

CR2d— The course design provides opportunities for students to develop understanding of the foundational principles of simple harmonic motion in the context of the big ideas that organize the curriculum framework.

CR2f— The course design provides opportunities for students to develop understanding of the foundational principles of energy in the context of the big ideas that organize the curriculum framework.

Waves & Sound	wavelength and velocity interact for wave motion. Science Practices: 1.4, 2.1, 4.1, 4.2, 4.3, 5.1, 6.1, 7.2
	20. Speed of Sound: **[CR 2j]**: GI Students will determine the speed of sound using different methodology. They may use resonance in a closed pipe resonator, the timing of an echo, or lag time between a drum being struck and sound reaching them. Science Practices: 1.2, 1.4, 2.1, 2.2, 3.1, 3.2, 4.2, 4.3, 6.2, 7.1, 7.2

UNIT 9: Electrostatics	21. Conductor and Insulator: **[CR 2h]**: GI Students will explore the conductive nature of different materials. Students will be asked to find patterns and exceptions regarding the conductive nature of said materials. Science Practices: 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.4, 7.2
	22. Electrostatics: **[CR 2h]**: OI Scotch tape, Van de Graaff generator and other various materials will be tested for their electrical mature. Predictions regarding electrostatic repulsion and attraction will be hypothesized and tested. Science Practices: 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.4, 7.2

UNIT 10: DC Circuits	23. Light Bulb: **[CR 2i]**: GI Students will test to determine what connections need to be made for electrical current to flow through a light bulb filament. Science Practices: 1.1, 1.2, 1.3, 1.4, 2.2, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 7.2
	24. Ohm's Law: **[CR 2i]**: GI Voltage and current will be tested in a simple circuit in order to determine the relationship between them. Compare and contrast to a non-ohmic circuit device. Science Practices: 1.1, 1.2, 1.3, 1.4, 2.2, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 7.2
	25. Series and Parallel Circuits: **[CR 2i]**: GI Circuits will be built using resistors. Comparisons between single resister, series and parallel circuits will be drawn. Science Practices: 1.1, 1.2, 1.3, 1.4, 2.2, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 7.2
	26. Pizza Box Project: **[CR 2i]**: OI Build a complex circuit under certain conditions and restrictions using a pizza box and cut holiday lights. Students will analyze their complex circuit for use of switches, current and potential differences. Science Practices: 1.4, 1.5, 2.1, 2.2, 4.2, 4.3, 5.1, 5.2, 5.3, 6.2, 6.3

CR2j— The course design provides opportunities for students to develop understanding of the foundational principles of mechanical waves in the context of the big ideas that organize th curriculum framework.

CR2h— The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize th curriculum framework.

CR2i— The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the contex of the big ideas that organize the curriculum framework.

Laboratory Work
Students spend 25% of the instructional time engaged in laboratory work **[CR 5]**. Experiments designed by the instructor are used to demonstrate procedural guidelines and to learn how to use specific laboratory equipment. The majority of labs are inquiry-based **[CR 6b]** where students are given an objective and a set of materials. They are tasked with designing a procedure and collecting data to determine specific quantities, determine the relationship between variables, and/or to derive fundamental physics equations **[CR 6a]**. Laboratory design, experimentation, data gathering, data presentation, analysis, drawing conclusions, and experimental error analysis are elements in these lab activities.

Some Labs will require students to compare their data and conclusions with other students to agree on a common outcome **[CR 8]**. For example, in the Sneaker Lab, different groups of students test one of several different styles of shoes provided. Then all the students need to convene and present evidence to their peers as to which style is the best for varying sporting or recreational circumstances.

Laboratory work is recorded in a laboratory notebook or folder **[CR 7]**, and students will have opportunities to present their laboratory work to their peers **[CR 8]**. All aspects of the laboratory work including any pre-lab work, question/hypothesis, experimental procedure, data, analysis, graphs, conclusion, and error analysis will be recorded **[CR 7]**. Students will work in lab groups, but each student will write an individual lab report in their organized lab notebook. This lab notebook will be kept by the students for the entire year and must include the completed labs reports as well as raw data tables ad any notes made during the execution of the labs done in the course. **[CR 7]**.

Outside the Classroom Lab and Real World Experiences:
In addition, several of our labs require students to work independently or collaboratively outside the classroom **[CR 8]**. Four lab investigations during the year are extended projects which are similar to a Science Olympiad events. They require research, hypothesizing, collaboration (debate and consensus of design ideas) with their peers, prototype design, testing and redesign/adjustment for optimization of performance. These projects will require the students to apply all the explored concepts learned previously. Rules and limitations regarding materials and dimensions are set. Students are given the opportunity to test and refine their project. The finished products are then showcased in a competitive, yet friendly setting. **[CR 3, 4, 8]**.

The students are building the following: **[CR 3, 4, 8]**

A car from cardboard, tape, and elastic bands that will be self propelled and travel a maximum straight displacement. It has to carry a required amount of mass. In addition, the average velocity of the car must be determined.
(L.O.'s 1.C.1, 3.A.1, 3.F.1, 4.A.2, 5.A.1, 5.B.2)

A catapult made from a variety of materials including wood, plastic, metal, springs, elastic bands, and fasteners. The goal is for it to launch a gumdrop as far as it can without hitting the ceiling of a long hallway. Using a radar gun and the range, the angle of launch and maximum height is to be confirmed.
(L.O.'s 1.C.2, 3.A.1, 4.A.2, 5.B.2)

CR5— Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with emphasis on inquiry-based investigations.

CR6a— The laboratory work used throughout the course includes investigations that support the foundational AP Physics 1 principles.

CR6b— The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.

CR8— The course provides opportunities for students to develop written and oral scientific argumentation skills.

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.

CR4- The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate

The students are building the following (cont.): **[CR 3, 4, 8]**

A 4-legged table/structure made of only newspaper and packing tape that can support as much weight as possible without bending, folding, torqueing, or collapsing. The students are to predict where (what members of) the structure will fail and then compare their predictions to the actual cause of collapse. The external and internal forces will also be represented by force diagrams. (L.O.'s 1.C.2, 2.A.1, 2.B.1, 3.A.2, 3.A.4)

A marble roller coaster made of only paper and packing tape that must incorporate at least two loops, a jump, and two hills. At minimum, the last meter of the roller coaster is a flat track where the final speed of the marble can be determined. This actual speed is compared and contrasted to the theoretical final speed. The students are to the account for differences in energy, if any.
(L.O.'s 1.C.1, 3.A.1, 3.C.4, 3.E.1, 4.C.1, 4.C.2)

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. **[CR4]** Students will create a 10-minute presentation on the application of physical concepts that occur in the real world. (examples could be the following: the physics of various sports, musical instruments or physics in media) These presentations must be researched, scientifically sound, and tie in multiple aspects of physics. Their peers will critique and question the research presented. **[CR 4]**

CR8— The course provides opportunities for students to develop written and oral scientific argumentation skills.

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.

CR4- The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.