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
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.	4
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.	5
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.	5
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.	7
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 curriculum framework.	6
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.	5
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.	6
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.	7
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.	8
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 the curriculum framework.	7
CR3 The 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 the laboratory investigations.	4-8
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.	4, 5, 6
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.	2, 3
CR6a The laboratory work used throughout the course includes investigations that support the foundational AP Physics 1 principles.	2
CR6b The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.	2
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.	2
CR8 The course provides opportunities for students to develop written and oral scientific argumentation skills.	3

Course Overview

This course introduces the concepts of modern physics, aligned to seven fundamental themes of the nature of matter and energy called the Big Ideas, as shown in parentheses below **[CR2]** :

- 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.

Topics include

Instructional Resources

Students are required to obtain the following text **[CR1]**:

- *Physics: Principles with Applications,* 7th edition (2013) Douglas Giancoli. Students may purchase hardcover or electronic versions of the text.

Instructional Context

Class meets two times a week in online live chat sessions of 90 minutes each. Both sessions are used to discuss assigned text readings and web-hosted lecture materials. Sessions make extensive use of internet resources including simulations, pictures, diagrams and animations, short videos, and current events, as well as the textbook publisher's companion site. Chat logs are available as soon as chat ends for students who missed class or need to review discussions.

A third weekly hour-long session is used to analyze posted lab results, improve student lab techniques, data analysis and presentation skills. These quasi-tutorial sessions provide materials that bridge the high school-to-college gaps in student backgrounds and cover selected topics in greater depth than the text, and include review of representative questions from previous AP courses.

**Students who have previously demonstrated mastery of scientific practices in honors or AP level courses and who are have taken or are concurrently taking pre-calculus may, with the instructor's permission, opt to complete AP Physics 1 and AP Physics 2 in a single academic year plus one summer.*

Investigative Laboratory Component

Students are required to obtain lab equipment to perform a minimum of 16 labs, spending 3-5 hours for each on lab setup, execution, and reporting, for a total commitment of 25% of their course time **[CR5]**.

Labs are selected from a bank of lab exercises that have been designed by the teacher to demonstrate foundational AP Physics 1 principles for individual students working outside a school laboratory **[CR6a]**. Labs early in the sequence require students to build their own equipment, helping them develop an understanding of the relationship between the measuring device and the quantity measured, as well as challenging their creative skills. Subsequent labs provide skill-building in all seven scientific practices. Each student must maintain a laboratory notebook as evidence of his or her work. **[CR6b]**.

Students review the lab purpose and techniques in chat, and also identify specific learning objectives for each lab before attempting the lab. After completing the lab activities, students upload formal laboratory reports to a common bulletin board for teacher and peer review. Each report includes the title, an abstract (under 200 words), a list of materials and equipment used, and a description of the procedure followed. These must be in sufficient detail that another student can repeat the experiment. The rest of the report includes data tables, sample calculations demonstrating the data reduction methods used, including statistical error analysis, all derived or calculated organized appropriately in list or tabular format, and clearly identified conclusions. Students may also be required to answer specific questions and upload further evidence (photos or videos) to prove they conducted the lab as stipulated **[CR7]**.

Live-chat and asynchronous bulletin-board discussions of lab exercise processes, individual adaptations required by local conditions, and data analysis techniques allow students to develop skill in precisely communicating lab experiences, and to work together to identify successful strategies for current and subsequent laboratory work.

Teaching Strategies

All our school courses are designed to take advantage of our asynchronous environment and based on a "flipped classroom" approach. This course uses a Physics content site developed by the teacher and a Moodle course content delivery system, along with standard email, to support asynchronous access to course materials, including web-based lecture notes, course calendars and lecture schedule, quizzes, forums, and wikis. The latter two techniques allow students to enter materials at their own convenience and share their homework assignments and study notes with each other, supporting a cooperative learning environment. In the content site, along with general study aids, there is a homework assignment page for each chat session, with study notes for the day's reading assignment, a teacher-written web-based lecture that provides additional material and explains many concepts in more detail, and instructions for the lab associated with that unit.

Students are expected to demonstrate a high level of self-discipline and self-motivation in preparing for our limited discussion time. All preparation work (reading text, completing exercises in the study guide, posting assigned essays must be completed prior to chat sessions. In particular, materials normally presented by a teacher standing in front of a class and lecturing are presented instead as teacher-written web lectures, read at the student's own convenience. These may employ teacher-designed animations, or refer to animation and simulations on the web to better explain processes.

Sstudents are assigned individual problems to solve for each their homework, and required to present solutions that include the rational for formula choice, variable identification and substitution, mathematical calculations, and justification for final units for each problem. These solutions, as well as lab data and lab reports, must be posted to the Moodle forum for peer review and comment [CR8]. Students are also encouraged to contribute definitions of terms and concepts or historical notes to the Moodle wiki pages. Chat logs, solved homework problems, lab reports, and wiki entries become part of the course content, accessible to all class participants, supporting a student-centered, cooperative learning environment.

The flexibility of the Moodle environment, real-time online chat, ten years of previous chat records, and access to the Internet allow the teacher to respond quickly to specific interests or learning needs of the student, tailoring the presentation of material to compensate for differences in background and to challenge gifted students with additional material by creating alternate presentations on the fly, or (where a traditional classroom teacher might use a blackboard or slides), leading students on "Web tours" to sites that contain descriptions of research, animations, and simulations of the topic raised by the student.

Students are encouraged to view science as a complex human endeavor, and examine the benefits and limitations of current scientific methodologies. Supplemental historical, philosophical, and religious materials from books, articles, and current events are used to help students understand the interaction of scientific theories with human societies, especially where theories involve ethical and religious issues, such as appropriate use of natural resources and possibilities of environmental damage.

Syllabus

Text Unit/ Chapters	Text/Lecture/Discussion Topic	Opportunities to achieve specific Learning Objectives using textbook readings (TB), teacher written web lectures (WL), class discussion CD), homework assignments (HW), or selected AP Free Exercise questions (AP).	Coordinated Lab Exercises may be Confirmation (C), Structured Inquiry (SI), Guided Inquiry (GI), or Open Inquiry (OI), or a combination. Key (but not all) scientific practices emphasized in each lab are indicated as (SP#).	Big Idea, Enduring Understanding
None	**Introduction to Course** • Course methods and expectations • Online course delivery processes (Moodle, forum use, posting homework, quizzes, email) • Textbook (hardcopy and/or eCopy), publisher website helps, teacher's web lecture content, lab resources • Overview of Big Ideas	**Note: all HW assignments require students to publish and defend their results to their fellow students.**	NO LAB	
1: 1-8	**Basic Methods of Observation** • Measurement • Units (metric vs. British), conversion • Accuracy, Precision, Error • Estimation	TB, HW, CD: Students individually analyze generalized scenarios (such as how much energy does a city use in a day?), which require them to make assumptions, estimate amounts, calculate results, express their results in appropriate units and scientific notation to the correct significant figures, and estimate error ranges. They must then present their analysis and calculations to the rest of the class, and defend their assumptions and results. **[CR8]**	**Basic LAB techniques: Building and Calibrating Equipment (C, SI)** Students build an equal arm balance, calibrate its scale using reference masses, and determine percent error. (SP 2.3) **Density (SI)** Students devise volumentric measurement of irregular solid and use balance to determine mass, calculate density, and identify unknown metal. (SP 2.2, 2.3)	
2: 1-5	**Motion in one dimension** (1D kinematics) • Distance vs. time: speed and velocity • Average vs. instantaneous quantities • Constant Acceleration	TB and WL present the derivation of useful formulae for 1D kinematics under constant acceleration, which students apply to HW problems defended in class. Students must explain how falling body calculations assume constant gravitational force (relates to Big Idea 3). LO: 1A1, 1A51, 3A11, 3A12, 3A13, 4A11, 5A1, 5A21, 5A3, 5A4, 4A21, 4A22, 4A23	**Falling Bodies 1 (SI)** Students conduct multiple trials using object of different masses to compare acceleration when dropped simultaneously. (SP 1.1, 1.2)	**Big Ideas 1, 3, 4, 5** **[CR2a]** **1D Kinematics** **EU 1A, 3A, 4A, 5A** **[CR3]**
2: 6-8	**Constant Acceleration** • Constant acceleration • Falling bodies		**Falling Bodies 2 (GI)** Students design timing mechanisms and conduct multiple trials using balls dropped from different heights to determine acting acceleration. (SP 5.1, 5.2, 5.3)	
3: 1-4	**Vectors** • Vector math • Vector quantities: velocity, acceleration, force, momentum	CD: Students use computer and mobile device apps to manipulate vectors and share results. LO: 2A1	**Projectiles Challenge** (OI)	

3: 5-8	**Motion in two dimensions** (2D kinematics) • Projectile motion • Problem solving techniques	CD: Students apply 1D and 2D kinematics determine whether movie "physics" is realistic ((how far does Athos fall in *The Three Musketeers* and would a well be that deep? *C*an a bus traveling 70 mph make the 50ft jump shown in *Speed*). This is usually a fun exercise; a more serious one occurs when we study chapter 9. **[CR4]** LO: 2A11, 3A11, 3A12, 3A13	Students design and build catapults, then collect data from multiple trials launching a constant mass at different to determine angle for maximum range, then use that angle to collect data for varying masses launched at a constant angle. Goal is to maximize range * mass delivered. (SP 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 4.4)	**Big Idea 2, 3** **[CR2a]** **2D Kinematics**
4: 1-4	**Forces: Newton's First and Second Laws** • Inertia • Force and Mass	CD: Students compare Galileo's and Newton's definition of inertia to distinguish weight and inertial mass. LO: 1C11, 3A11, 3A21 3A31, 3A32	**Force Vectors** **(GI)** Students build and use a force table to map equilibrium scenarios in systems with 2, 3, and 4 suspended masses, and compare analytic and graphical methods of vector analysis. (SP1.1, 1.2, 1.3, 1.4)	**Big Ideas 1-4** **[CR2b]** **Newton's laws** **EU 1C, 3A** **EU 3A, 3B, 3C** **[CR3]**
4: 5-7	**Forces: Newton's Third Law** • Gravity, weight, and mass • Normal forces	TB, WL, CD & HW: Students draw free body diagrams and use basic trigonometry to break forces into right-angle components to analyze situations involving projectiles, falling bodies, forces on inclined planes. Students work individually to design a combination tool (one or more simple tools) from a limited set of materials, calculate their mechanical advantage based on force laws. They present their designs to the class, which then determins the best designs on the basis of cost, time to manufacture, and effectiveness. [**CR4, CR8]** LO: 3A33, 3A34, 3A41, 3A42, 3A43, 3C11, 3C12; 3B11, 3B12, 3B13, 3B14; 3B21, 3C41, 3C42	**Inertial vs Gravitational Mass** **(GI)** Students develop methods to measure and compare inertial mass and gravitational mass. (SP 6.1, 6.2, 6.3)	
4: 8-9	**Forces: Applications** • Free body diagrams and analysis • Friction systems • Inclined planes		**Inclined Planes** (GI) Students determine acceleration dependence on steepness of slope for block moving down (near frictionless) slope. (SP2.1, 2.2, 2.3) **Inclined Planes** 2 (OI) Students investigate forces required to balance and move block up inclined plane using variable (near frictionless) slope and masses. (SP 3.1, 3.2, 3.3)	
5: 1-3	**Uniform Circular Motion** • Kinematics and dynamics of circular motion	CD, HW: Students identify size and speed of rotation required for space ship designs using rotation to simulate gravity. LO: 1C3	**Centripetal force**: (OI) Students devise apparatus to measure centripetal force from gravitational force necessary to sustain object in circular motion and determine dependences on mass of object, radius of circle and revolutions per time period. (SP 2.3, 3.1, 3.2, 3.3)	**Big Ideas 1-4** **[CR2c]** **Circular motion** **Newton's law of gravity** **EU 1C, 2B, 2E, 3G** **[CR3]**
5: 4-8	**Gravitation and Weightlessness** • Non-uniform circular motion • Universal law of gravitation	CD, WL: Derivation of Kepler's laws from Newton's law of gravity and law of centripetal force for planets in	**Pendulum 1** (GI) Students determine the gravitational acceleration from pendulum swing observations. (SP 2.2, 2.3) **Pendulum 2** (OI)	

5: 9-10	**Kepler's Laws** • Derivation of Kepler's laws from Newtonian mechanics	circular orbits. LO: 1C11, 1C2, 1C3, 2B11, 2B21, 2E11, 2B22, 3G11	Students use dimensional analysis methods to determine dependence of period on gravitational acceleration, mass, and length of pendulum. (SP 4.1, 4.2, 4.3, 4.4)	**[CR3]**
6: 1-4	**Work and Energy** • Work • Constant and varying forces • Kinetic energy • Potential energy	CD: Students must identify KE and PE examples and discuss processes for conversion from one for to the other. LO: 3E11, 3E12, 3E13, 3E14,5B11, 5B21	**Inclined Planes and Friction** (GI) Students use inclined plane setup to determine coefficient of friction dependence on mass (none) and steepness of slope, and predict behavior on other slope angles. (SP 6.1, 6.2, 6.3, 6.4)	**Big Ideas 3, 4, 5** **[CR2f]** **Energy** **Work** **Power** **Conservation of Energy** **EU 3E, 5B** **EU 4C, 5B** **[CR3]**
6: 5-7	**Conservation and Non-Conservative Forces** • Conservative and nonconservative forces • Mechanical energy • Work-energy theorem	CD of AP free exercise analyzing a roller coaster containing a loop. Students must identify forces acting at different points (including friction) and resulting velocities using conservation of energy. LO: 4C11, 4C12, 4C21, 4C22, 5B31, 5B32, 5B33, 5B41, 5B42, 5B51 -5B56, 5B21	**Spring constant (GI)** Students measure the spring constant for similar springs and dissimilar springs; and determine error and deviation in measurements. (SP 5.1, 5.2, 5.3)	
6: 8-10	**Conservation of Energy** • Energy transformation • Power • Dissipative forces		**Atwood's machine (GI)** Students determine energy dissipated by friction in Atwood system. (SP 3.1, 3.2, 3.3)	
7: 1-4	**Momentum** • Definition of vis viva and momentum • Definition of impulse, relation of momentum to force • Conservation of energy and linear momentum in collisions	CD on the differences between vis viva (mv^2), energy ($1/2$ mv^2), and momentum (mv). HW: Students apply conservation of energy and momentum to perform analysis of collision situations, including application of quadratic equations. LO: 3A32, 3D11, 3D21-3D24, 4B11, 4B12, 4B22	**Collision kinematics (GI)** Students use air pucks to measure velocities, demonstrate conservation of momentum and kinetic energy. (SP 1.1, 2.1, 3.1, 4.1, 5.1, 6.1)	**Big Ideas 3-5** **[CR2e]** **Momentum** **Impulse** **Conservation of Linear Momentum** **EU 3A, 3D, 4B** **EU 3D, 4A, 5D** **[CR3]**
7: 5-10	**Elastic and Inelastic Collisions** • Elastic and Inelastic collisions • Collisions in two dimensions • Center of mass and translational motion	CD of AP free exercise involving amusement park bumper cars. HW: Students must analyze data and determine speed and directions of the cars after collisions, as well as whether the collisions are elastic or not. LO: 3D23, 3D24, 4A31, 4A32, 4A215D11-5D15, 5D21-5D25, 5D31	**Collision kinematics 2 (OI)** Students must a way to measure elasticity of collisions between objects of different composition and suggest methods of "cushioning" elastic collisions. (Suggested methods include using ballistic pendulum, or comparing return bounce heights of sad-and-happy balls.) (SP 7.1, 7.2)	
8: 1-3	**Angular Motion and Acceleration** • Angular quantities (velocity, acceleration) • Relation of angular to linear quantities	TB, WL and CD comparing linear and angular concepts of displacement, velocity, and acceleration, which students then apply to HW exercises. LO: 3F11-3F15; 5E11, 5E12, 5E21	**Torsion pendulum 1 (OI)** Students build a torsion pendulum and use dimensional analysis to determine period dependency on rod length, mass, and diameter. (SP 4.1, 4.2, 4.3, 5.1, 5.2)	

8: 4-5	**Rotational Dynamics** • Torque and rotational inertia	TB, WL, and CD comparing torque to force, and angular to linear momentum. Class discussion determines torque on pitcher's elbow when throwing a 90mph fastball ans an example of the physics of the human body. LO: 3F21, 3F22, 4D11, 3F12	**Torsion pendulum 2 (OI)** Students use their torsion pendulum to determine dependency on suspended mass, shape, and size. (SP 6.1, 6.2, 6.3, 6.4, 6.5)	**Big Ideas 3-5 [CR2g]** **Torque Rotational Kinematics** **Rotational Dynamics Conservation of Angular momentum** **EU 3F, 4D [CR3]**
8: 6-9	**Rotational Kinetic Energy** • Rotational kinetic energy • Conservation of angular momentum	HW: Students calculate the rate of linear increase in moon's distance as Earth's rotation slows, CD: Student teams use rotational kinematics and conservation of angular momentum to design trajectories using sling-shot gravitational boost to reduce time to target for spacecraft missions, and compare their results to determine the most effective design. **[CR4]** LO: 3F31-3F33, 4D21, 4D22, 4D31, 4D32	**Rolling bodies on inclined plane (GI)** Students revise Galileo's experiment to justify claims that rolling bodies will accelerate more slowly than sliding bodies, and determine the rotational kinetic energy of rolling bodies.(SP 4.1, 4.2, 4.3, 5.1, 5.2, 6.1, 6.2, 6.3, 6.4, 6.5)	
9: 1-3	**Static Equilibrium** • Equilibrium conditions • Application to body mechanics • Balance	**HW:** Students establish the fundamentals of equilibrium and demonstrate how torque and linear forces must balance. LO: 5A21	**Equilibrium (OI)** Students build a structure using only string and dry spaghetti to maximize height and support fixed mass. (SP 3.1, 3.2, 3.3)	
9: 4-7	**Elasticity, Stress, and Strain** • Materials science and engineering • Shear, strain, stress	HW: Students analyze two different examples of building collapse from the 2001 Nisqually Earthquake or other recent events, and identify the most likely factors (such as direction of forces, magnitude of forces, compression and elasticity of materials) contributing to the collapse. The students then divide into teams to create proposals to address the factors identified. Each group must then present and defend the effectivity of their proposal for increasing building safety during a live chat session, using calculations, charts, and graphical tools. Proposals are judged on their feasibility, including cost. **[CR4, CR8]** LO: 1A1, 5B21, 3C41, 3C42	**Structural integrity (OI)** Students build a structure using only sheets of paper and fixed amount of tape, to maximize mass that can be supported. (SP 3.1, 3.2, 3.3)	

11: 1-6	**Simple Harmonic Motion** • Harmonic Oscillators • Spring-mass systems • Pendulums	CD: Students use online spring system simulators to perform "experiments" and acquire experience analyzing harmonic motion, which they then use to solve HW problems. LO: 3B31, 3B32, 3B33, 3B34	**Spring oscillation (GI)** Students devise a spring oscillator (using springs with known spring constants) and determine dependence of oscillation on initial amplitude and mass load. (SP 4.1, 4.2, 4.3, 5.1, 5.2, 5.3)	**Big Ideas 3 and 5 [CR2d]** **Simple harmonic motion** **Springs** **Pendula** **EU 3B, 6B** **[CR3]**
11: 7-16	**Wave Motion** • Transverse and longitudinal waves • Wave length, speed, amplitude, frequency • Interference • Resonance, Reflection, Refraction, Diffraction	CD uses web simulations to help students visualize and identify examples of transverse and longitudinal waves. LO: 3B32, 6B11, 6B21, 6B41, 6B51	**String standing waves (OI)** Students devise standing wave generation on a string with variable tension to measure wavelength dependency on tension and string length. (SP 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3)	
12: 1-5	**Sound** • Intensity and compression • Sources of sound • Interference and beats	TB, HW, and CD: Students discuss and calculate wave transmission and reflection on strings and within tubes, and compare the application of wave mechanics to the specific instruments they play (e.g., clarinet vs piano). **[CR4]** LO: 5A11, 5A12, 6A21, 5A31	**Speed of Sound (GI)** Students predict and measure speed of sound in air under varying conditions of temperature and humidity. (SP 2.1, 2.2, 2.3, 4.1, 4.2, 4.3)	**Big Idea 6** **[CR2j]** **Mechanical Waves** **EU 5A, 6A** **EU 6C, 6D** **[CR3]**
12? 6-9	**Sound** • The Doppler effect • Shock Waves	CD: Students use web simulations such as those at www.physicsclassroom.com to visualize Doppler effects on wave transmission, then apply concepts to HW. LO: 6C11, 6C12, 6C13, 6D21, 6D31-6D34; 6D41, 6D42, 6D51	**Doppler Shift (GI)** Students devise a way to determine speed of an approaching object using pitch change. (SP 4.1, 4.2, 4.3, 5.1, 5.2, 5.3)	
16: 1-6	**Electrical Charge** • Electrical charge • Charge conservation • Insulation and conduction • Coulomb's law	CD: Students use Coulomb's law and vector analysis to analyze situations involving multiple point charges at fixed distances from each other and determine net force on test charges. LO: 1B11, 1B12, 1B21, 1B22, 1B23, 1B31, 3C21, 3C22	**Electroscope I (GI)** Students build a simple electroscope and calibrate for objects with different levels of static electrical charge; determine nature (positive, negative) of charge. (SP 3.1, 3.2, 3.3)	**Big Ideas 1, 3, 5** **[CR2h]** **Electric charge** **Conservation of charge** **Electric force** **EU 1B, 3C** **[CR3]** Text
16: 7-12	**The Electric Field** • Electric force • Electric fields	CD: Students compare gravitational and electrical force field concepts and magnitudes using the classing balloon-hair rubbing demonstration to determine the amount of electrical charge required to counter gravitational pull. LO: 5A21	**Electroscope II (OI)** Students use their electroscope to measure strength of charge as a function of distance. (SP 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3)	

17: 1-6	**Electric Potential** • Potential and the electric field • The Electron Volt • Point charge potentials	CD: Students compare the concepts of gravitational potential and electrical potential and the implications when a force is always attractive (gravity) and when it is sometimes attractive and sometimes repulsive (electrical). LO: 1E21	**Simple Circuit (GI)** Students first diagram then build a simple series circuit, predict and measure voltage as they vary resistors in the series. (SP 1.1, 1.2, 1.3, 1.4)	**Big Ideas 1 and 5** **[CR2i]** **Potential Difference** **Current** **Resistance** **Ohm's Law** **Kirchhoff's law** **EU 5B, 5C** **[CR3]**
18: 1-6	**Power** • Electric Batteries • Ohm's Law • Resistivity	CD/HW: Students present and defend solutions for simple series circuits. LO: 1E21	**Simple Circuit 2 (GI)** Students a set of circuits, predict and measure current (amps) with varied arrangements of resistors in series and in parallel. (SP 2.1, 2.2, 2.3)	
19: 1-4	**DC Circuits and EMFs** • EMF • Resistors in circuits • Kirchhoff's rules	CD/HW: Students present and defend solutions for parallel circuits demonstrating Kirchhoff's rules. LO: 5B91, 5B91, 5BV93, 5C31, 5C32, 5C33	**Simple Circuit 3 (OI)** Students design, then build circuits from a fixed power source, resistor set, and load (lamp) set to maximize load and stability. (SP 1.1, 1.3, 2.2, 3.3, 4.2, 4.3, 5.3, 6.4, 7.2)	