Course Description
Guided by the National Research Council and National Science Foundation, the College Board AP Program collaborated with college and university educators and AP teachers to develop AP Physics 1. In this course, students will develop critical thinking and reasoning skills, as defined by the AP Science Practices. Through inquiry-based learning, students will cultivate their understanding of physics and science practices as they explore the following topics: kinematics, dynamics, circular motion, harmonic motion, impulse, momentum, collisions, work, energy, rotational motion, circuits, mechanical waves, and sound. The AP Physics 1 course is designed to be taught over the course of a full academic year and may be taken as a first-year physics course with no prior physics coursework necessary. Students should have completed geometry and be concurrently taking algebra II, or an equivalent course. Although the AP Physics 1 course includes basic use of trigonometric functions, this understanding can be gained either in the concurrent math course or in the AP Physics 1 course itself. Students may choose to purchase the textbook in the course at the beginning of the school year so that they may write and take notes in the text. Many students find the text an excellent reference as they enter college. Any student who enrolls in an AP course is required to take the AP exam in May of the school year.

Course Content	Science Practices
The AP Physics 1 course is organized into seven units arranged in a logical sequence. Students will spend about 25% of instructional time engaged in hands-on, inquiry-based investigations. ■ Unit 1: Kinematics ■ Unit 2: Dynamics ■ Unit 3: Circular Motion and Gravitation ■ Unit 4: Energy ■ Unit 5: Momentum ■ Unit 6: Simple Harmonic Motion ■ Unit 7: Torque and Rotational Motion	■ **Modeling**: Use representations and models to communicate and solve scientific problems ■ **Mathematical Routines**: Use math appropriately ■ **Scientific Questioning**: Engage in scientific questioning to extend thinking ■ **Experimental Methods**: Plan and implement data collection strategies in relation to a particular scientific question ■ **Data Analysis**: Perform data analysis and evaluation of evidence ■ **Argumentation**: Work with scientific explanations and theories ■ **Making Connections**: Relate knowledge across various scales, concepts, and representations

Big Ideas
▪ 1. **Systems** – Objects and systems have properties such as mass and charge and may have internal structure. ▪ 2. **Fields** – Fields existing in space can be used to explain interactions. ▪ 3. **Force Interactions** – The interactions of an object with other objects can be described by forces. ▪ 4. **Change** – Interactions between systems can result in changes in those systems. ▪ 5. **Conservation** – Changes that occur as a result of interactions are constrained by conservation laws.

Textbook
Physics: Principles with Applications, by Douglas C. Giancol; published by Benjamin Cummings, Prentice-Hall, 1998

Subject: Physics 1 – AP

Units	Concepts / Skills	Key Activities May Include
Unit 1 **Measurement And Error Analysis** 2 weeks	▪ Review format for formal lab write-ups ▪ Fermi Problems ▪ Order of Magnitude Estimation ▪ Review Trigonometry ▪ Right angle Trigonometry ▪ Law of Sines, Law of Cosines ▪ How errors propagate in measurements ▪ Basic math operations involving numbers that contain uncertainty	▪ Computer Lab ▪ Graphing and Table Making ▪ Measurement - *see Laboratory Activities for an explanation of this lab*
Unit 2 **Kinematics in 1-Dimension and Graphing Motion** CR2a, CR2b Big Ideas 3, 4 3 weeks	▪ Kinematic equations of one dimensional motion: average velocity, instantaneous velocity ▪ Students to develop understanding of the foundational principles of 1D kinematics in the context of the big ideas that organize the curriculum framework. ▪ Using graphing calculator to find slope and area	▪ Galileo's Experiment with a Car and Ramp - *see Laboratory Activities for an explanation of this lab* ▪ Free Fall Lab - *see Laboratory Activities for an explanation of this lab*
Unit 3 **Vectors and Vector Algebra** 3 weeks	▪ Purely a mathematical description of vectors and how simple vector algebra is performed ▪ Kinematics in 2-Dimensions and Vectors ▪ Vectors vs Scalars ▪ Graphical representation of a vector ▪ Add, subtract, vectors graphically ▪ Component representation of a vector	▪ Vector Addition (online lab)
Unit 4 **2-Dimensional Kinematics and Dynamics** CR2a, CR2b Big Ideas 1, 2, 3, 4 3 weeks	▪ Newton’s Laws and Friction	▪ Forces - *see Laboratory Activities for an explanation of this lab* ▪ Friction Lab (online lab) - *see Laboratory Activities for an explanation of this lab*

Units	Concepts / Skills	Key Activities May Include
Unit 5 **Projectile Motion** Big Ideas 3 3 weeks	▪ Projectile Motion ▪ Students will develop understanding of the foundational principles of 2D kinematics in the context of the big ideas that organize the curriculum framework	▪ Projectile Lab 1 - Ball in Cup - *see Laboratory Activities for an explanation of this lab* ▪ Projectile Lab 2 - Strike a Target - *see Laboratory Activities for an explanation of this lab*
Unit 6 **Circular Motion and The Universal Law of Gravity** CR2c, CR2g Big Ideas 1, 2, 3, 4, 5 3 weeks	▪ Circular Motion and Gravity ▪ Centripetal Acceleration ▪ Centripetal Force ▪ Students will develop an understanding of the foundational principles of gravitation and circular motion ▪ Universal Law of Gravity	▪ Centripetal Force (online lab) - *see Laboratory Activities for an explanation of this lab* ▪ Kepler's Law Activity - *see Laboratory Activities for an explanation of this lab*
Unit 7 **Momentum, Collisions and Impulse and Center of Mass** CR2e, CR2f Big Ideas 1, 3, 4, 5 3 weeks	▪ Conservation of momentum ▪ Elastic collisions ▪ Inelastic collisions ▪ Impulse	▪ Collisions in 2 D - *see Laboratory Activities for an explanation of this lab* ▪ Reference Frame (online lab) ▪ Center of Mass (online lab) ▪ Momentum (online lab) ▪ Collisions (online lab)
Unit 8 **Work and Energy** CR2f Big Ideas 3, 4 3 weeks	▪ Work, ramps, pulleys, springs ▪ Mechanical advantage ▪ Force vs distance graphs ▪ Work-Energy-Theorem ▪ Power, calories, kilowatt-hours ▪ Potential Energy ▪ PE of gravity, PE of springs ▪ Conservative Forces	▪ Work Lab - collaborative ▪ Pendulum - *see Laboratory Activities for an explanation of this lab*
Unit 9 **Rotational Motion and Static Equilibrium** CR2g, CR2f, CR2a, CR2b Big Ideas 3, 4, 5 3 weeks	▪ Rotational Motion ▪ Torque and Rotational Statics ▪ Moment of Inertia ▪ Conservation of angular momentum ▪ Bodies in Equilibrium	▪ Torque Lab - *see Laboratory Activities for an explanation of this lab* ▪ Rotation lab ▪ Rotational Inertia Lab - *see Laboratory Activities for an explanation of this lab*

Units	Concepts / Skills	Key Activities May Include
Unit 10 **Oscillations, Waves and Sound** CR2d, CR2j Big Ideas 1, 3, 4, 5 3 weeks	▪ Vibrations and Waves ▪ Simple Harmonic Motion ▪ Mass on a spring ▪ Simple pendulum ▪ Transverse Longitudinal Waves ▪ Standing Waves ▪ Resonance ▪ Constructive and Destructive Interference ▪ Sound ▪ Strings and standing waves ▪ Open and closed pipes	▪ Standing Waves Lab - *see Laboratory Activities for an explanation of this lab*
Unit 11 **Static Electricity and Charge, Electric Field and Electric Potential** CR2f, CR2h, CR2i Big Ideas 1, 3, 4, 5 3 weeks	▪ Coulombs Law ▪ Electric charge ▪ Conservation of charge ▪ Conduction, Induction ▪ Electric Force ▪ Electric Fields ▪ Electric potential energy ▪ Capacitance	▪ Static Electricity Lab - *see Laboratory Activities for an explanation of this lab* ▪ Electric Field of Dreams (online lab) ▪ Electric Field Hockey (online lab)
UNIT 12: Electric Current, Resistors, Ohms Law, Electric Power, DC Circuits **CR2i** Big Ideas 1, 2, 5 3 weeks	▪ Electric Current ▪ Batteries ▪ Resistance ▪ Ohm's Law applied to DC circuits ▪ DC Circuits ▪ Resistors in series and parallel ▪ Kirchoff's Rules applied to series and parallel DC circuits	▪ Circuits Construction (online lab) ▪ Light Bulb Lab - *see Laboratory Activities for an explanation of this lab* ▪ Ohm's Law Lab - *see Laboratory Activities for an explanation of this lab*

Laboratory Activitiy	Short Description
Measurement Lab	The purpose of this laboratory is for students to become familiar with the treatment of errors in measurements. Students will also be introduced to two instruments used to make length measurements, the vernier caliper and the micrometer.
Galileo's Experiment with a Car and Ramp	Students will test Galileo's hypothesis that free falling objects will accelerate at a constant rate. This hypothesis is tested as Galileo did. Instead of a ball rolling down a ramp you will use a small toy car and roll it down a ramp.

Laboratory Activitiy	Short Description
Free Fall Lab	The purpose of this experiment is to measure the acceleration due to gravity of a free falling object. Students will measure this acceleration and compare it to the accepted value of 9.8 m/sec^2.
Vector Addition Lab	Students will explore how vector add graphically using a computer simulation found at: http://phet.colorado.edu/simulations/sims.php?sim=Vector_Addition
Forces Lab	The purpose of this lab is to verify Newton's first law and to demonstrate how forces add using vectors. Students will also become familiar with some common arrangements of pulleys, cords and weights.
Friction Lab	Students will explore the effects of static and kinetic friction using a computer simulation: https://www.thephysicsaviary.com/Physics/Programs/Labs/ForceFriction/
Projectile Lab - Ball in Cup	The purpose of this lab is for students to use what has been learned in class about projectiles. Based on their knowledge of calculating the path of a projectile a prediction shall be made of the landing point of such a projectile.
Centripetal Force Lab	The purpose of this experiment is to experimentally determine how the centripetal force, as measured on a spring scale, varies with frequency, mass, and radius.
Kepler's Laws Activity	Students will look up astronomical data about any four moons Jupiter. The Data should include Distance from the planet and period of orbit around the planet. The students then should use Kepler's Laws to calculate the mass of Jupiter and Check their predictions against other astronomical data.
Collisions in 2-D Lab	Students will investigate the properties of inelastic and elastic collisions by colliding marbles of various masses made of glass and steel.
Center of Mass and Momentum Lab	In this computer simulation students will explore how changing a reference frame affects the velocity of the center of mass between two colliding objects. Students will also investigate the effects a change of reference frame has on the law of conservation of mass. https://surendranath.org/GPA/Kinematics/ReferenceFrames/ReferenceFrames.html
Pendulum Lab	In this lab students will use the law of conservation of energy to predict the time it will take a pendulum bob to pass by an electric eye timer. This lab requires no formal write-up but does require accurate calculations and measurements in order to get good results.
Torque Lab	There are three primary purposes to this lab: 1. To learn to calculate the torque applied by a force about a point. 2. To demonstrate that the sum of the torques on an object at rest is zero (Newton's 1st Law). 3. To use torques to find the center of mass of an object.

Laboratory Activitiy	Short Description
Rotation Lab	Students will use the online site to investigate the use of the kinematic equations of rotation.
Rotational Inertia Lab	In this experiment, students will: ▪ Collect angular acceleration data for objects subjected to a torque. ▪ Determine an expression for the torque applied to a rotating system. ▪ Determine the relationship between torque and angular acceleration. ▪ Relate the slope of a linearized graph to system parameters. ▪ Make and test predictions of the effect of changes in system parameters on the constant of proportionality.
Harmonic Oscillator Lab	In this lab students will examine graphical displays of the motion of a mass hanging from a spring in terms of displacement, velocity and acceleration.
Standing Wave Lab	In this experiment students will study transverse standing waves in a stretched string (for transverse waves the oscillations of the particles of the medium are perpendicular to the direction of propagation of the wave). Students will propagate travelling waves of fixed frequency into the string and adjust the speed of propagation in the string until standing waves are observed.
Static Electricity Lab	Much of the qualitative behavior of electric charges was discovered during the eighteenth century. Common materials like glass were rubbed with different kinds of cloth to produce electric charges. Students will be able to discover for themselves the behavior of electric charges by performing similar experiments.
Electric Field Lab	In this experiment students will determine the forms of the electric field produced by pairs of conductors held at a constant potential difference. The electric fields will be deduced from measurements of the positions of equipotential surfaces.
Circuits Lab	Students will investigate how simple circuits are formed with batteries and light bulbs. https://phet.colorado.edu/en/simulations/circuit-construction-kit-dc-virtual-lab
Light Bulb Lab	Students will be given different sets of light bulbs wired in combinations of series and parallel. They must deduce the series without look at the wiring but solely through bulb brightness and exploration.
Ohm's Law Lab	In this lab students will use Ohm's law to: ▪ Determine the resistivity of a piece of wire ▪ Determine how well Ohm's law is obeyed for a light bulb ▪ Investigate how resistors add in series ▪ Investigate how resistors add in parallel ▪ Use KVL and KVC to analyze a multi-loop circuit

Content Standards (referenced in units)	
CR1	Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.
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.
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.
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.
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.
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.
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 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.
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.
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.
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.
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.
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.
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.