Course:	AP Physics 1
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AP® Physics 1 Syllabus - 2021 - 2022

AP Physics 1: Curricular Requirements

- Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.
- The course design provides opportunities for students to develop understanding of the AP Physics 1 foundational physics principles in the context of the big ideas that organize the curriculum framework.
- 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.
- 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.
- 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.
- Students are provided the opportunity to engage in inquiry-based laboratory investigations that support the foundational principles and apply all seven science practices defined in the curriculum framework.
- 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.
- The course provides opportunities for students to develop written and oral scientific argumentation skills.

Course Introduction

AP® Physics 1 is an algebra-based, introductory college-level physics course that explores Newtonian mechanics (including rotational motion); work, energy, and power; mechanical waves and sound; and introductory, simple circuits. These topics will be organized around six big ideas that are intended to allow students to see physics as interconnected pieces of a puzzle. Through inquiry-based laboratory investigations, projects, and teacher demonstrations students will see for themselves the big ideas and how they describe the world around them. This will serve to develop scientific critical thinking and reasoning skills that will make them better informed citizens as consumers and voters. When performing laboratory investigations, students will use probeware technology for data acquisition. They will use graphing calculators and/or graphical analysis software to perform data analysis such as curve fits and percent error. Students should have completed Geometry and be concurrently taking Algebra II. Students who have taken Biology and Geometry with a grade of "C" or better and have scored proficient or advanced on their science CSTs are encouraged to take AP Physics 1. AP Physics 1 replaces College Preparatory Physics. **No prior coursework in Physics is necessary.**

Six Big Ideas

Big Idea 1: Objects and systems have properties such as mass and charge.
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.
Big Idea 7: The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems.

Seven Science Practices

Science Practice 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.
Science Practice 2: The student can use mathematics appropriately.
Science Practice 3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
Science Practice 4: The student can plan and implement data collection strategies in relation to a particular scientific question.
Science Practice 5: The student can perform data analysis and evaluation of evidence.
Science Practice 6: The student can work with scientific explanations and theories.
Science Practice 7: The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

Textbook

Giancoli, Douglas C. Physics: Principles with Applications, 7/e AP, 2014. Englewood Cliffs, NJ: Prentice Hall

Course Outline

Unit	Topic	Ch
1 Kinematics & Vectors [CR2a] (Big Idea 3)	Kinematics	2
	Falling Objects	2
	Graphical Analysis	2
	Vectors	3
	Projectiles	3
2 Dynamics [CR2b] (Big Ideas 1, 2, 3, & 4)	Newton's Laws (no friction)	4
	Newton's Laws (no friction)	4
	Newton's Laws (no friction)	4
	Newton's Laws (friction)	4
	Newton's Laws (friction)	4
3 Circular Motion & Gravitation [CR2c] (Big Ideas 1, 2, 3, & 4)	Dynamics of Circular Motion (horizontal)	5
	Dynamics of Circular Motion (horizontal)	5
	Dynamics of Circular Motion (vertical)	5
	Universal Gravitation	5
	Satellites & Weightlessness	5

4 Work & Energy [CR2f] (Big Ideas 3, 4, & 5)	Work Done by Constant Force & Varying Force	6
	Work-Kinetic Energy & Potential Energy	6
	Conservation of Mechanical Energy	6
	General Conservation of Energy	6
	Power	6
5 Momentum [CR2e] (Big Ideas 3, 4, & 5)	Momentum & Conservation of Momentum	7
	Collisions & Impulse	7
	Elastic Collisions (1-dim)	7
	Inelastic Collisions (1-dim)	7
	Inelastic Collisions (2-dim)	7
6 Rotational Motion [CR2g] (Big Ideas 3, 4, & 5)	Angular Quantities	8
	Constant Angular Acceleration & Rolling (no slip)	8
	Torque	8
	Rotational Dynamics	8
	Rotational Kinetic Energy	8
	Angular Momentum and its Conservation	8

Teaching Strategies: Scope and Sequence

Discussion-Lecture

Each discussion begins with a demonstration of a physical principle. This approach gets students "hooked" and they stay focused as the principle is discussed and the mathematical formalism is presented. Very often, students will be asked to discuss amongst themselves the demonstration and/or the mathematics behind it. Students are then encouraged to give their interpretation of the principle. With all this accomplished, the students are then ready to try solving some example problems given by the instructor or in the textbook. Students will work in groups to solve the problem and will then be called upon at random to present their solution to the class. Homework problems are assigned which give students more opportunity to hone their skills at critical reasoning.

Problem Assignments

Exercises from the main text book are assigned almost every day. Some of the assigned exercises were selected on the basis of giving students practice using general physics principles such as the conservation of energy to mathematically model a specific problem and then find a solution. Other exercises involve only a single memorized formula to be used in finding a solution; and even then, the students will know the origin or derivation of the formula. Some class time is used for students to pair up and start their textbook assignments, which often consists of five exercises. This allows their progress to be monitored so immediate assistance can be provided, helping to minimize the frustration level that many students face when attempting to do homework on their own. The next day, the assignments are stamped to check for reasonable attempts at solving the problems. Students can then ask for solutions to be put on the board either by the instructor or by another student who will then explain the method of attack. Additionally students can get extra practice at home by doing textbook exercises not assigned or by downloading exercises from the web. Throughout the course, the point will be stressed that memorizing solution recipes is of little value since it is unlikely that a question on the AP Physics 1 exam will be exactly like the ones memorized.

Lab Experiments

Calculation of Laboratory Time

One laboratory investigation will be performed roughly each 2 weeks. Part of a period will involve a pre-lab discussion and an entire period will be devoted to data collection and part of another period will be devoted to post-lab discussion at which time students will present their findings to the class. This will constitute at least 20% of total instruction time.

Curricular Purpose of Laboratory Investigations

The labs are hands-on and provide an opportunity for students to work collaboratively in small groups of three or four. Each student will be expected to keep a lab composition book for all write-ups. Students are given an objective such as: "Determine how voltage is related to current." Students are expected to work together to design their own experiment to meet the objective. To this end, students will state the problem, form a hypothesis such as 'voltage varies directly with current', write a procedure, make observations, take measurements, record data, perform statistical data analysis, and write a conclusion. In writing the procedure, students will make a decision as to which variable to manipulate (independent variable) and which variable changes as a result (dependent variable) and which variables are to remain fixed (control variables). Analysis of the data includes performing calculations, constructing graphs of independent variable vs. dependent variable and writing the appropriate equation of the graph. This can be done by using a graphing calculator, Excel©, the LabQuest™, and/or Logger Pro. Students then look at the equation and the units of the slope to conclude that the slope must be resistance in the example above.

The labs will mostly be "guided-inquiry" which means students investigate a teacher-presented question using student-designed procedures.

Generally, you will:

- Plan in small groups prior to lab day to determine how you will manipulate the equipment to accomplish the goal and how you will process the data. This may involve some initial play with the equipment. Write down your predictions and assumptions.
- Conduct the experiment and then develop and record your analysis. The analysis should include a discussion of your prior predictions and assumptions as well as possible sources of uncertainty.
- Present your findings in a written report and be prepared to present to the class for critique.

Specifically, you will:

- be given a question to be tested and then form a hypothesis that answers the question
- design an investigation which is a plan for collecting the data you need. Here, you will identify the variables including controls, independent, and dependent.
- follow your procedure to collect and present data to be inserted into a data table.
- analyze and interpret results such as the meaning of your graphs, how your design could be improved to limit errors, and conclusion.

Possible Investigations

Kinematics (Constant Acceleration)

1. Cart on a Ramp (GI)

- Use a Motion Detector to collect position, velocity, and acceleration data as a cart rolls up and down a ramp.
- Analyze the position vs. time, velocity vs. time, and acceleration vs. time graphs.
- Determine the best fit equations for the position vs. time and velocity vs. time graphs.
- Determine the mean acceleration from the acceleration vs. time graph.

(Science Practices 1.4, 2.1, 2.2, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1)

Kinematics (Constant Acceleration)

2. Determining g on an Incline (GI)

- Use a Motion Detector to measure the speed and acceleration of a cart rolling down an incline.
- Determine the mathematical relationship between the angle of an incline and the acceleration of a cart rolling down the ramp.
- Determine the value of free fall acceleration, g, by extrapolating the acceleration vs. sine of track angle graph.
- Determine if an extrapolation of the acceleration vs. sine of track angle is valid.

(Science Practices 1.4, 2.1, 2.2, 4.1, 4.2, 5.1, 5.3, 6.1)

Kinematics (Constant Acceleration)

3. Picket Fence Free Fall (OI)

- Use a Picket Fence and a photogate to measure the acceleration of a freely falling body (g) to better than 0.5% precision.

(Science Practices 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 5.1, 6.1)

Kinematics (Constant Acceleration)

4. Ball Toss (GI)

- Use a Motion Detector to collect position, velocity, and acceleration data as a ball travels straight up and down.
- Analyze the position vs. time, velocity vs. time, and acceleration vs. time graphs.
- Determine the best-fit equations for the position vs. time and velocity vs. time graphs.

(Science Practices 1.4, 2.1, 2.2, 4.1, 4.2, 5.1, 6.1)

Kinematics (Constant Acceleration)

5. Target Shoot (GI)

- Measure the velocity of a ball using two photogates.
- Apply concepts from two-dimensional kinematics to predict the impact point of a ball in projectile motion.

(Science Practices 1.4, 2.1, 2.2, 2.3, 4.3)

Kinematics (Variable Acceleration)

6. Bungee Jump (GI)

•Use an Accelerometer to analyze the motion of a toy bungee jumper from just prior to the jump through a few oscillations after the jump.

•Determine where in the motion the acceleration is at a maximum and at a minimum.
(Science Practices 1.2, 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3)

Newton's 2^{nd} Law (F = ma)

7. Forces and Accelerations of a Cart (OI)

•Use a Force Sensor and Accelerometer to collect force and acceleration data for a cart as it is moved back and forth.

•Compare force vs. time and acceleration vs. time graphs.

•Analyze a graph of force vs. acceleration.

•Determine the relationship between force, mass, and acceleration
(Science Practices 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3)

Newton's 2^{nd} Law (F = ma)

8. Atwood's Machine (OI)

•Use a Photogate to study the acceleration of an Atwood's machine.

•Determine the relationships between the masses on an Atwood's machine and the acceleration.
(Science Practices 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 6.1)

Newton's 2^{nd} Law $\left(F = \frac{m}{r}v^2\right)$

9. Flying Toy (OI)

•Use a stopwatch and ruler to determine the speed of a toy space shuttle attached to a string flying in circles.

•Analyze the forces acting on the shuttle to determine the speed of the shuttle.

•Find percent difference between the two speeds.
(Science Practices 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3)

Newton's 3^{rd} Law (Every Action has a Reaction)

10. Newton's 3^{rd} Law (OI)

•Use two Force Sensors to observe the directional relationship between force pairs.

•Observe the time variation of force pairs.

•Explain the weight of the earth as related to the weight of you.
(Science Practices 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 5.1, 7.2)

Newton's 2^{nd} Law (F = ma in Disguise)

11. Impulse and Momentum (GI)

•Use a Photogate and a Force Sensor to measure a cart's momentum change and compare to the impulse it receives.

•Compare average and peak forces in impulses.

•Draw conclusions about crashes in real life as related to impulse and momentum
(Science Practices 1.1, 1.2, 1.3, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 5.1, 5.3, 6.1, 7.2)

Newton's First Law (Objects Rest or Move at Steady Velocity Unless Net Force is Present)

12. Static and Kinetic Friction (OI)

- Use a Force Sensor to measure the force of static friction.
- Determine the relationship between force of static friction and the weight of an object.
- Measure the coefficients of static and kinetic friction for a particular block and track.
- Use a Motion Detector to independently measure the coefficient of kinetic friction and compare it to the previously measured value.
- Determine if the coefficient of kinetic friction depends on weight.

(Science Practices 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 6.1)

Rotation (Special Case Of Physical Pendulum)

13. Pendulum Periods (GI)

- Use a Photogate to measure the period of a pendulum as a function of amplitude.
- Use a Photogate to measure the period of a pendulum as a function of length.
- Use a Photogate to measure the period of a pendulum as a function of bob mass.

(Science Practices 1.2, 1.4, 2.1, 2.2, 4.1, 4.2, 4.3, 5.1, 5.3)

Rotation (Conservation of Angular Momentum)

14. Conservation of Angular Momentum (GI)

- Use a Rotary Motion Sensor to collect angle vs. time and angular velocity vs. time data for rotating systems.
- Analyze the θ-t and ω-t graphs both before and after changes in the moment of inertia.
- Determine the effect of changes in the moment of inertia on the angular momentum of the system.

(Science Practices 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 4.1, 4.2, 4.3, 5.1)

Rotation (Rotational Dynamics)

15. Rotational Dynamics (GI)

- Use a Rotary Motion Sensor to 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.

(Science Practices 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 4.1, 4.2, 4.3, 5.1)

Real World Activity [CR4]

To encourage students to become scientifically literate students, they will be required to use their acquired knowledge of physics to analyze a real-world problem. Students choose from the following:

1. Select a movie and describe at least three instances of inaccurate physics. This will be presented to the class as scientific-based evidence in the context of a peer review and critique.
2. Go to the Insurance Institute of Highway Safety website (iihs.org) and find the safest cars in a crash. Be prepared to present scientific-based evidence in the context of a peer review and critique.

Activity to Cross Enduring Understandings [CR3] [CR8]

Using an accelerometer app for a smart phone or Vernier's LabQuest with an accelerometer, students will collect data for the accelerations they experience daily. This means: walking running, riding in a car (someone else driving), bus, amusement park ride etc. Students will present a graphical description of their motion including acceleration, velocity, and displacement. Findings will be presented in a scientific-based manner to the class for peer-review and critique. (1.C.1.1, 3.A.1.1, 3.A.1.3)

Evaluation and Grading

Student understanding of the content will be assessed by the following formats:

- Multiple-Choice and/or Free-Response Exams*
- Multiple-Choice and/or Free-Response Quizzes*
- Laboratory write-ups
- Projects and Presentations
- Chapter Practice Problems
- Daily Participation

* The multiple-choice questions usually involve the use of a single equation or concept. The free-response questions involve the use of several equations or concepts to solve multi-part problems or can be based on a lab investigation done in class. Course grades are based on weighted averages between labs and exams.

Grade Distribution:

- A+ 97.0% or higher
- A 93.0% - 96.9%
- A - 90.0% - 92.9%
- B + 87.0% - 89.9%
- B 83.0% - 86.9 %
- B - 80.0% - 82.9%
- C + 77.0% - 79.9%
- C 73.0% - 76.9%
- C - 70.0% - 72.9%
- D + 67.0% - 69.9%
- D 63.0% - 66.9 %
- D - 60.0% - 62.9%
- F 59.9% or lower

Components of the Grade:

Assessments/Projects	70%
Labs/Coursework	30%

If you have a concern about a grade, please visit Google Classroom to submit a form to bring this to my attention. This is the best method in communicating concerns.

Student Responsibilities:

Students are expected to be prepared and ready to participate in class activities on a daily basis. This participation includes, but is not limited to, completion of class-assigned homework to be turned in, possession of pencils/pens, participation in class and group discussions, and behaving in a respectful and professional manner.

Academic Dishonesty

Any student(s) found exhibiting academic dishonesty, which include but not limited to, plagiarism, use of unauthorized material(s), prohibited communication, etc. will be subject to failure of assignment and/or course without the possibility of a retake or remake of assignment, project, assessment, or course credit.

Assignment Submissions:

Students are expected to turn in all course work by the assigned deadline. I ask that students who are having challenges with submitting assignments by the deadline to communicate to me well before the deadline so we can explore a possible resolution. Assignments submitted late may be accepted for credit with a possibly reduced marked score. Regardless of submission, all students will receive some feedback either individually or as a group on the assignment.

Late and Absent Work

Any student who misses a day of school due to a school approved reason (sick, bereavement, etc.) has **three days after returning** to complete the assignment and/or exam, and **five days to complete a lab** before or after school. Any student turning in late work will without an approved reason may receive reduced credit for the assignment.

Technology Used by the Students

The primary use of technology will be in the laboratory. Students will gather data by using various types of electronic equipment such as the Pasco® Smart Timer™ or the Vernier® LabQuest™ Data Collection Interface together with Vernier's Logger Pro© software package. Students can then use Logger Pro©, Excel© or TI® graphing calculators to perform calculations on their data for analysis. Students will also use TI® graphing calculators ranging from the 83 up to the 89 model to compute numerical answers to textbook problems. Occasionally, students will use computers in class to access websites such as AP Central, Google Classroom, G-Suite, and PHET that feature Java Applets©/HTML5 which simulate physical situations, allowing them to vary one variable to see the effect on another variable.

Digital Etiquette:

All students are to conduct themselves in accordance with district and school policies in all forms of digital communication and student learning management systems (i.e. Google Classroom, Zoom, Google Meets, etc.). Students are expected to attend each class virtually when applicable and check Google Classroom daily for the most up-to-date information and assignments in the course.

Technology Used by the Instructor

The instructor will use much of the equipment described in the student technology section to perform demonstrations of principles that are otherwise difficult to grasp. The instructor will use Google Classroom and G-Suite as an aide in lecturing and delivering curriculum to the students.

Office Hours

The instructor will be available 30 minutes before first period and during snack. Students can request for appointments to meet.

AP Exam Review

There will be roughly three weeks to review for the exam. Students are given free-response questions from several of the prior AP exams. These questions are separated by unit such as 'Mechanical Waves and Sound' or 'Work, Energy, and Power'. The multiple choice questions from one AP Physics 1 released exam are also given. Several problems are assigned each day. The first part of each class day is used to answer any questions students may have about the previously assigned problems. With whatever time remains in a period, students are to work independently on free-response questions.

Parents/Guardians:

I encourage every student's parents and/or guardians to be actively engaged with their student's progress. Please feel free to reach out to me via email and I highly recommend joining your student's Google Classroom to receive weekly progress updates.

Please see the Student Handbook for detailed school policies.

Syllabus Disclaimer

The syllabus is a statement of intent and serves as an implicit agreement between the instructor and the student. Every effort will be made to avoid changing the course schedule but the possibility exists that unforeseen events will make syllabus changes necessary. Remember to check your BOHS email and Google Classroom site often.