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

Course overview
The content in this course will cover the concepts in both AP Physics C Mechanics and AP Physics C Electricity and Magnetism. Students will perform inquiry lab experiments, participate in discussions, and complete AP available material to prepare for both forms of the AP Exam. Please see the approved AP Course Syllabus below for the concepts to be covered.

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.

SAMPLE SYLLABUS #1

AP® Physics C: Mechanics

Curricular Requirements

CR1	Students and teachers have access to college-level resources including a college-level textbook and reference materials in print or electronic format.	*See page:* 3
CR2	The course provides opportunities to develop student understanding of the required content outlined in each of the Unit Guides of the AP Course and Exam Description (CED).	*See page:* 3
CR3	The course provides opportunities for students to develop the skills related to Science Practice 1: Visual Interpretation.	*See page:* 6
CR4	The course provides opportunities for students to develop the skills related to Science Practice 2: Question and Method.	*See page:* 6
CR5	The course provides opportunities for students to develop the skills related to Science Practice 3: Representing Data and Phenomena.	*See page:* 6
CR6	The course provides opportunities for students to develop the skills related to Science Practice 4: Data Analysis.	*See page:* 6
CR7	The course provides opportunities for students to develop the skills related to Science Practice 5: Theoretical Relationships.	*See page:* 7
CR8	The course provides opportunities for students to develop the skills related to Science Practice 6: Mathematical Routines.	*See page:* 7
CR9	The course provides opportunities for students to develop the skills related to Science Practice 7: Argumentation.	*See page:* 7
CR10	The course provides students with opportunities to apply their knowledge of AP Physics concepts to real-world questions or scenarios to help them become scientifically literate citizens.	*See page:* 7

CR11	Students spend a minimum of 25 percent of instructional time engaged in a wide range of hands-on laboratory investigations with an emphasis on inquiry-based labs to support the learning of required content and development of science practice skills throughout the course.	*See pages:* 7, 9
CR12	The course provides opportunities for students to record evidence of their scientific investigations in a portfolio of lab reports or a lab notebook (print or digital format).	*See page:* 9

Advanced Placement Physics C: Mechanics Sample Syllabus #1

Textbook

The main textbook for this course, which will be supplemented with other online resources, is:

Halliday, David, Robert Resnick, and Jearl Walker, *Fundamentals of Physics,* 10th ed. New York: John Wiley & Sons, 2015. This is a calculus-based, college-level textbook. **CR1**

CR1
The syllabus must cite the title, author, and publication date of a calculus-based, college-level textbook.

Student Practice

Throughout each unit, **Topic Questions** will be provided to help students check their understanding. The Topic Questions are especially useful for confirming understanding of difficult or foundational topics before moving on to new content or skills that build upon prior topics. Topic Questions can be assigned before, during, or after a lesson, and as in-class work or homework. Students will get rationales for each Topic Question that will help them understand why an answer is correct or incorrect, and their results will reveal misunderstandings to help them target the content and skills needed for additional practice.

At the end of each unit or at key points within a unit, **Personal Progress Checks** will be provided in class or as homework assignments in AP Classroom. Students will get a personal report with feedback on every topic, skill, and question that they can use to chart their progress, and their results will come with rationales that explain every question's answer. One to two class periods are set aside to re-teach skills based on the results of the Personal Progress Checks.

The following units will be included in this AP Physic C Mechanics course: **CR2**

CR2
The syllabus must include an outline of the course content using any organizational approach that demonstrates the inclusion of all required course topics and big ideas listed in the AP Course and Exam Description (CED).

Unit Description	Topics	Science Practice	Textbook
Unit 1: Kinematics (14%–20%) ~22 days. Big Idea CHA	1.1 Motion in One Dimension	1.A 1.B 3.A 4.A 4.C 5.A 7.A	Chapters: 2, 3, 4
	1.2 Motion in Two Dimensions	1.C 5.B 6.A 7.B	

Complete **Personal Progress Check MCQ** for Unit 1.

Complete **Personal Progress Check FRQ** for Unit 1.

Take **Unit 1 Test**.

Unit Description	Topics	Science Practice	Textbook
Unit 2: Newton's Laws of Motion (17%–23%). Big Idea INT ~24 days	2.1 Newton's First and Second Law	1.A 2.D 3.B 4.B 5.A 7.A 7.B	Chapters: 5, 6
	2.2 Circular Motion	1.B 5.C 6.B	
	2.3 Newton's Third Law	1.C 5.C 5.D 7.C 7.D	

Complete **Personal Progress Check MCQ** for Unit 2.

Complete **Personal Progress Check FRQ** for Unit 2.

Take **Unit 2 Test**.

Unit Description	Topics	Science Practice	Textbook
Unit 3: Work, Energy and Power (14%– 17%) Big ideas INT, CON ~20 days	3.1 Work-Energy Theorem	2.A 7.C	Chapters: 7, 8
	3.2 Force and Potential Energy	1.D 4.B 6.A	
	3.3 Conservation of Energy	2.E 4.D 5.C 6.C 7.E	
	3.4 Power	5.D	

Complete **Personal Progress Check MCQ** for Unit 3.

Complete **Personal Progress Check FRQ** for Unit 3.

Take **Unit 3 Test**.

Unit Description	Topics	Science Practice	Textbook
Unit 4: Systems of Particles and Linear Momentum (14%–17%). Big Ideas CHA, INT and CON ~20 days	4.1 Center of Mass	6.B	Chapter 9
	4.2 Impulse and Momentum	1.C 2.C 5.D	
	4.3 Conservation of Linear Momentum (Collisions)	1.E 5.E 7.D 7.E 7.F	

Complete **Personal Progress Check MCQ** for Unit 4.

Complete **Personal Progress Check FRQ** for Unit 4.

Take **Unit 4 Test**.

Unit Description	Topics	Science Practice	Textbook
Unit 5: Rotation (14%–20%). Big Ideas INT, CON ~20 days	5.1 Torque and Rotational Statics	2.D 3.B	Chapters: 10, 11
	5.2 Rotational Kinematics	2.B 5.B 6.C	
	5.3 Rotational Dynamics and Energy	1.E 3.C 4.D 5.D	
	5.4 Conservation of Angular Momentum	1.E 5.E 6.D 7.D	

Complete **Personal Progress Check MCQ** for Unit 5.

Complete **Personal Progress Check FRQ** for Unit 5.

Take **Unit 5 Test**.

Unit Description	Topics	Science Practice	Textbook
Unit 6: Oscillations (6%–14%) Big Idea INT ~10 days	6.1 Simple Harmonic Motion (Springs and Pendulums)	1.E 2.B 2.F 4.C 4.E 5.E 7.F	Chapter 15

Complete **Personal Progress Check MCQ** for Unit 6.

Complete **Personal Progress Check FRQ** for Unit 6.

Take **Unit 6 Test**.

Unit Description	Topics	Science Practice	Textbook
Unit 7: Gravitation (6%–14%) Big Ideas FLD, CON ~10 days	7.1 Gravitational Forces	3.D 4.E 5.E	Chapter 13
	7.2 Orbits (Planets and Satellites)	3.C 5.D 6.C 7.F	

Complete **Personal Progress Check MCQ** for Unit 7.

Complete **Personal Progress Check FRQ** for Unit 7.

Take **Unit 7 Test**.

Big Idea	Description	aka
1	Interactions produce changes in motion	CHANGE
2	Forces characterize interactions between objects or systems	FORCE INTERACTIONS
3	Fields predict and describe interactions	FIELDS
4	Conservation laws constrain interactions	CONSERVATION

Throughout this AP® Physics C Mechanics course, students will be provided with opportunities to develop important skills in the following Science Practices:

1. **SP1: Visual Representations**: Analyze and/or use [non-narrative/non-mathematical] representations of physical situations, excluding graphs (1A–1E).
   a. Bungee Jump Design Activity (Students must explain the motion and energy transformations during the descent of a bungee jumper during each stage of their fall.)
   b. Students will draw and analyze free-body diagrams for a variety of scenarios. CR3
2. **SP2: Question and Method**: Determine scientific questions and methods (2A–2F).
   a. Mu of Shoe Lab (Students develop 2 different methods to find the coefficients of friction between a shoe and 2 different surfaces)
   b. Flying Pig Lab (Students must devise a method to accurately find the angle at which the pig is flying as well as a method for accurately taking data.) CR4
3. **SP3: Representing Data and Phenomena**: Create visual representations or models of physical situations (3A–3D).
   a. How is Motion Recorded Lab (Students utilize motion detectors to discover the mathematical and graphical relationships between position, velocity, and acceleration graphs.)
   b. Projectile Motion Video Analysis Lab (Students utilize Logger Pro Video Analysis software to collect data and create horizontal and vertical motion graphs.) CR5
4. **SP4: Data Analysis**: Analyze quantitative data represented in graphs (4A–4E).
   a. Projectile Motion Video Analysis Lab (Students collect data, create graphs, and discover that the horizontal motion of a projectile is constant while vertical motion changes due to gravity.)
   b. Ballistic Pendulum Lab (Students collect data and utilize their knowledge of energy, collisions, and projectile motion in order to predict the landing location of a sphere projected using the ballistic pendulum.) CR6

CR3
The syllabus must include one activity or lab describing how students analyze and/or use nonnarrative/nonmathematical representations of physical situations, excluding graphs. The activity or lab must be labeled with the relevant skill(s) (e.g. "1.B") associated with Science Practice 1.

CR4
The syllabus must include one activity or lab describing how students determine scientific questions and methods. The activity or lab must be labeled with the relevant skill(s) associated with Science Practice 2.

CR5
The syllabus must include one activity or lab describing how students create visual representations or models of physical situations. The activity or lab must be labeled with the relevant skill(s) associated with Science Practice 3.

CR6
The syllabus must include one activity or lab describing how students analyze quantitative data represented in graphs. The activity or lab must be labeled with the relevant skill(s) associated with Science Practice 4.

5. **SP5: Theoretical Relationships**: Determine the effects on a quantity when another quantity or the physical situation changes. (5A–5E).
   a. Twirly Lab (Students explore the effects of changing mass, radius and centripetal force of a rotating object.)
   b. Air Resistance Lab (Students explore the effects of air resistance on a falling object as mass changes.)
   c. Simple Harmonic Motion Problems (Students will describe simple harmonic motion and predict the period using Hooke's law.) CR7
6. **SP6: Mathematical Routines**: Solve problems of physical situations using mathematical relationships. (6A–6D)
   a. Practice Free-Response and Multiple-Choice Questions (Students will use mathematical routines to solve unknown physical quantities.)
   b. PHET Solar System Activity (In this online activity, students will utilize data collected from the simulation to perform calculations related to Gravitational Force, Period, Escape Velocity, etc.)
   c. Bungee Design Lab (In the laboratory, students will use mathematical routines to determine unknown physical quantities using experimentally measured quantities.) CR8
7. **SP7: Argumentation**: Develop an explanation or a scientific argument. (7A–7F)
   a. In the lab report students will explain how experimental error affects results, outcomes, and conclusions. In addition, students propose ways to reduce experimental errors in future investigations.
   b. In the lab students will verify laws by doing inquiry-based investigations. For example, conservation of momentum will be verified using the Ballistic Pendulum lab to determine the velocity of a projectile, and later the landing distance of said projectile. CR9

In this AP Physic C Mechanics course, students will be provided with opportunities to apply their knowledge to real-world questions and scenarios to help them become scientifically literate citizens by focusing on the following topics in problems, lab investigations, and design challenges:

- Roller Coaster Loop Problems
- Engineering Road Design (banked curves) and the importance of speed limits.
- Car Crashes (Newton's Law, Momentum, Impulse)
- The Physics of Bungee Jumping and Design
- The Physics of Toys (Cars, Nerf guns, Yo-Yo, Toy Rockets)
- The Physics of Space (Satellites, Gravity, Space Travel, Kepler's Laws)
- Rotational inertia and sports (ice skating, gymnastics, etc.)
- Earthquake and Buildings (Simple Harmonic Motion, Natural Frequency, Stiffness, Resonance) CR10

Students will spend a minimum of 25% of their instructional time engaged in a wide variety of hands-on, inquiry-based laboratory investigations. A minimum of 20 of the labs listed below will be utilized in the class. Over 50% of these labs, activities, and design challenges listed below utilize some form of guided or open inquiry. CR11

Unit 1: Kinematics

1. Engineering Design and Cost Analysis project: Students practice their collaboration, communication, and creativity to design and build a structure while minimizing costs and taking into account structural integrity and time constraints.
2. How Motion Is Recorded: Prediction and Reproduction of Kinematics Graphs with Motion Detectors.

CR7
The syllabus must include one activity or lab describing how students determine the effects on a quantity when another quantity or the physical situation changes. The activity or lab must be labeled with the relevant skill(s) associated with Science Practice 5.

CR8
The syllabus must include one activity or lab describing how students solve problems of physical situations using mathematical relationships. The activity or lab must be labeled with the relevant skill(s) associated with Science Practice 6.

CR9
The syllabus must include one activity or lab describing how students develop an explanation or a scientific argument. This activity or lab must be labeled with the relevant skill(s) associated with Science Practice 7.

CR10
The syllabus must label and provide a description of at least one assignment or activity requiring students to apply their knowledge of AP Physics concepts to understand real-world questions or scenarios.

CR11
The syllabus must include an explicit statement that at least 25 percent of instructional time is spent engaged in hands-on laboratory investigations, with an emphasis on inquiry-based labs.

AND

Laboratory investigations must be listed with a title and brief description. Guided- and open-inquiry labs must be labeled.

3. Determination of Acceleration Due to Gravity: **Guided Inquiry** based lab in which students devise a way to determine acceleration due to gravity.
4. Projectile Motion Video Analysis: **Guided Inquiry** based lab in which students discover the independence of horizontal and vertical velocity.
5. Rocket Launch: Students collect data to indirectly calculate launch velocity and maximum height

Unit 2: Newton's Laws of Motion

6. Atwood's Machine: **Guided Inquiry** in which students determine the relationship between acceleration and total mass as well as acceleration and mass difference.
7. Yo-Yo Analysis: Students analyze the forces acting on a yo-yo to determine variables of its motion.
8. Terminal Velocity Coffee Filter Lab: Students collect data to determine the terminal velocity of a coffee filter as well as the drag coefficient.
9. PhET Friction Simulation: Through guided inquiry students explore the effects of friction and motion.
10. Mu of Shoe: **Guided Inquiry** in which students devise a method to determine the coefficient of friction of their shoe on multiple surfaces .
11. Engineering Design Project: **Guided Inquiry** Drone Parachute Challenge—Students are tasked with designing a parachute that will accurately and safely deliver a package from a predetermined drop height.
12. Flying Pig Lab: **Guided Inquiry** in which students explore circular motion and must devise a method for making accurate measurements.

Unit 3: Work Energy Power

13. Power Lab: Students collect data to determine the amount of power generated in walking stairs and doing pushups.
14. Conservation of Energy of a Popper: **Guided Inquiry** in which students must find the popping velocity of a toy popper.
15. Conservation of Energy Lab: **Guided Inquiry** in which students design a lab to show the conservation of energy.
16. Hot Wheels Launch Challenge: **Guided Inquiry** utilizing knowledge of kinematics, forces and energy; students predict where a hot wheels car will land.
17. Hooke's Law exploration: **Guided Inquiry** in which students discover the differences of springs in series and parallel and conduct calculation for determining their spring constants.
18. Bungee Design Challenge: **Guided Inquiry** in which students are tasked with developing a formula that will predict the number of rubber bands needed for a diver to successfully jump from an unknown height.

Unit 4: Systems of Particles, Linear Momentum

19. Ballistic Pendulum Lab: **Guided Inquiry** in which students develop a method for determining the launch velocity of the sphere.
20. Smart Cart Conservation of Momentum Lab: Students will explore the three main types of collisions.
21. Smart Cart Impulse Exploration: Students will explore the idea of impulse and its importance when it comes to car crashes.
22. Online Cart Crash Simulation Activity: **Guided Inquiry** in which students will discover that momentum is conserved in all collisions while kinetic energy is not.

Unit 5: Rotation

23. PhET Ladybug Revolution Lab: In this inquiry-based activity, students will explore rotational dynamics
24. Twirly Lab: Students will explore the relationships between rotation variables.
25. Toilet Paper Challenge: **Guided Inquiry** in which students must predict where to drop an unrolling roll of toilet paper so it hits the ground at the same time as a roll of toilet paper dropped from 2 m. CR11
26. Moment of Inertia Challenge: **Guided Inquiry** in which students must predict the internal structure of three disks based on their behavior as they roll.

Unit 6: Oscillations

27. PhET Pendulum and Mass Spring Oscillation Lab: Students will discover the properties of pendulums and springs in simple harmonic motion and the variable that affect their period and frequency.
28. Engineering Design Project … Earthquake Retrofit 2.0: Students will design a retrofit system to alter the natural frequency, period, and resonance of an existing toy block model building.

Unit 7: Gravitation

29. Elliptical Orbit Simulation Lab: Students will prove Kepler's Law is equivalent to the law of conservation of momentum.
30. My Solar System PHET Lab: Students will explore the variable related to orbiting objects and prove that angular momentum is conserved in orbiting objects, regardless of the shape of its path (F_g, U_g, L, orbits, etc.).

In this AP Physics C Mechanics course, all formal lab investigations will conclude with students completing a lab report. The lab report will contain the required components that are included in the lab notebook (Claim/question, Hypothesis, Experimental Procedure, Experimental Data, Data Analysis, Conclusions, Error Analysis, etc.). These lab reports will be retained in their lab report portfolio. CR12

CR12

The syllabus must include the components of the written reports required of students for all laboratory investigations.

AND

The syllabus must include an explicit statement that students are required to maintain a lab notebook or portfolio (hard copy or electronic) that includes all their lab reports.

CollegeBoard AP

SAMPLE SYLLABUS #1

AP® Physics C: Electricity and Magnetism

Curricular Requirements

CR1	Students and teachers have access to college-level resources including a college-level textbook and reference materials in print or electronic format.	*See page:* 3
CR2	The course provides opportunities to develop student understanding of the required content outlined in each of the Unit Guides of the AP Course and Exam Description.	*See pages:* 4, 5
CR3	The course provides opportunities for students to develop the skills related to Science Practice 1: Visual Interpretation.	*See page:* 7
CR4	The course provides opportunities for students to develop the skills related to Science Practice 2: Question and Method.	*See page:* 7
CR5	The course provides opportunities for students to develop the skills related to Science Practice 3: Representing Data and Phenomena.	*See page:* 7
CR6	The course provides opportunities for students to develop the skills related to Science Practice 4: Data Analysis.	*See page:* 7
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CR8	The course provides opportunities for students to develop the skills related to Science Practice 6: Mathematical Routines.	*See page:* 7
CR9	The course provides opportunities for students to develop the skills related to Science Practice 7: Argumentation.	*See page:* 7
CR10	The course provides students with opportunities to apply their knowledge of AP Physics concepts to real-world questions or scenarios to help them become scientifically literate citizens.	*See page:* 8

CR11	Students spend a minimum of 25 percent of instructional time engaged in a wide range of hands-on laboratory investigations with an emphasis on inquiry-based labs to support the learning of required content and development of science practice skills throughout the course.	*See pages:* 3, 4, 8, 9
CR12	The course provides opportunities for students to record evidence of their scientific investigations in a portfolio of lab reports or a lab notebook (print or digital format).	*See page:* 4

Advanced Placement Physics C: Electricity and Magnetism Sample Syllabus #1

Course Description

AP® Physics C: Electricity and Magnetism is a calculus-based, college-level physics course, especially appropriate for students planning to specialize or major in the physical sciences or engineering. Introductory differential and integral calculus are used throughout the course. The laboratory portion of the course focuses on students asking questions, making observations and predictions, designing experiments, analyzing data, and constructing arguments in a collaborative setting where they direct and monitor their progress. Each student completes a lab notebook or portfolio of lab reports. Students who take this course are required to take the AP Physics C: Electricity and Magnetism Exam.

Text

Serway, Raymond A., and John W. Jewett, *Physics for Scientists and Engineers* 8th ed. 2012. Brooks/Cole Cengage Learning. **CR1**

Schedule

AP Physics C: Electricity and Magnetism is a yearlong course that meets for 270 minutes per week. The modified block scheduling allows for the course to meet 3 times a week for 90 minutes, one 90-minute period per week is dedicated to laboratory practice. **CR11**

Student Practice

Throughout each unit, **Topic Questions** will be provided to help students check their understanding. The Topic Questions are especially useful for confirming understanding of difficult or foundational topics before moving on to new content or skills that build upon prior topics. Topic Questions can be assigned before, during, or after a lesson, and as in-class work or homework. Students will get rationales for each **Topic Question** that will help them understand why an answer is correct or incorrect, and their results will reveal misunderstandings to help them target the content and skills needed for additional practice.

At the end of each unit, **Personal Progress Checks** will be provided in class or as homework assignments in AP Classroom. Students will get a personal report with feedback on every topic, skill, and question that they can use to chart their progress, and their results will come with rationales that explain every question's answer. One to two class periods are set aside to re-teach skills based on the results of the Personal Progress Checks.

CR1
The syllabus must cite the title, author, and publication date of a calculus-based, college-level textbook.

CR11
The syllabus must include an explicit statement that at least 25 percent of instructional time is spent engaged in hands-on laboratory investigations, with an emphasis on inquiry-based labs.

AND

Laboratory investigations must be listed with a title and brief description. Guided- and open-inquiry labs must be labeled.

Evaluation

Students will be graded on problem sets, quizzes, laboratory work, projects, and exams. Exams are typically worth 100 points and will consist of questions similar to those on the AP Exam. Homework assignments and quizzes will consist of problems from the textbook, supplements, and old AP Exams. Projects include challenge labs and current events essays. Laboratory work is student-centered and primarily composed of guided-inquiry or open-inquiry investigations. Grades will be determined by taking the number of points a student has earned and dividing it by the total number of points that the student could have achieved. This decimal is multiplied by 100, and that will be the student's grade.

Laboratory Practical

One 90-minute class period per week is dedicated to laboratory work, accounting for approximately 30% of the course. The majority of labs are either guided- or open-inquiry based activities in which students engage in hands-on, inquiry-based laboratory experiences across a variety of course topics. **CR11**

Each student is required to maintain an electronic portfolio of laboratory work for every laboratory experience throughout the course. Each lab report must contain a claim/question/hypothesis, experimental procedure and lab equipment used, a visual representation of the experimental setup, experimental data, data analysis, error analysis, and conclusion(s). **CR12**

CR12
The syllabus must include the components of the written reports required of students for all laboratory investigations.

AND

The syllabus must include an explicit statement that students are required to maintain a lab notebook or portfolio (hard copy or electronic) that includes all their lab reports.

Outline of Course Content **CR2**

CR2
The syllabus must include an outline of the course content using any organizational approach that demonstrates the inclusion of all required course topics and big ideas listed in the AP Course and Exam Description (CED).

AP Physics C: Electricity and Magnetism Course and Exam Description (CED) Units

- Unit 1: Electrostatics
- Unit 2: Conductors, Capacitors, and Dielectrics
- Unit 3: Electric Circuits
- Unit 4: Magnetic Fields
- Unit 5: Electromagnetism

Unit	Topic	Science Practices	Big Ideas
1: Electrostatics	1.1 Electrostatics: Charge and Coulomb's Law	1.A, 6.B, 6.C	2, 3, and 4
	1.2 Electrostatics: Electric Field and Electric Potential	1.A, 3.A, 3.D, 4.A, 4.B, 6.B, 6.C	
	1.3 Electrostatics: Electric Potential Due to Point Charges and Uniform Fields	1.B, 5.A, 5.B, 5.C, 6.B, 6.C	
	1.4 Electrostatics: Gauss's Law	1.A, 5.A	
	1.5 Electrostatics: Fields and Potentials of other charge distributions	6.B, 7.A, 7.C, 7.D	
	Assign Unit 1 Progress Check: MCQ		
	Assign Unit 1 Progress Check: FRQ		

Unit	Topic	Science Practices	Big Ideas
2: Conductors, Capacitors, Dielectrics	2.1: Conductors, Capacitors, Dielectrics: Electrostatics with Conductors	1.A, 1.E, 5.A, 7.C, 7.D	2, 3, and 4
	2.2: Conductors, Capacitors, Dielectrics: Capacitors	1.A, 2.A, 2.B, 2.E, 5.B, 7.A, 7.D	
	2.3: Conductors, Capacitors, Dielectrics: Dielectrics	2.B, 3.C, 3.D, 5.B, 6.C, 7.A, 7.B	
	Assign Unit 2 Progress Check: MCQ		
	Assign Unit 2 Progress Check: FRQ		
3. Electric Circuits	3.1. Electric Circuits: Current and Resistance	3.A, 6.A, 6.B, 7.D	3 and 4
	3.2. Electric Circuits: Current, Resistance, and Power	1.A, 1.C, 1.D, 2.C, 2.D, 3.A	
	3.3. Electric Circuits: Steady-State Direct-Current Circuits with Batteries and Resistors Only	1.B, 2.F, 3.B, 4.A, 4.B, 4.C, 4.D, 7.F	
	3.4 Capacitors in Circuits	1.A, 1.D, 2.D, 3.C, 3.D, 6.C, 7.B	
	Assign Unit 3 Progress Check: MCQ		
	Assign Unit 3 Progress Check: FRQ		
4. Magnetic Fields	4.1. Magnetic Fields: Forces on Moving Charges in Magnetic Fields	2.B, 3.D, 6.C, 7.A, 7.C, 7.D	1, 3, and 4
	4.2. Magnetic Fields: Forces on Current Carrying Wires in Magnetic Fields	2.C, 2.D, 2.F, 3.A, 6.B, 7.D, 7.E, 7.F	
	4.3. Magnetic Fields: Fields of Long Current-Carrying Wires	3.B, 3.C, 5.E, 7.C	
	4.4 Magnetic Fields: Biot-Savart Law and Ampere's Law	5.D, 5.E, 7.A	
	Assign Unit 4 Progress Check: MCQ		
	Assign Unit 4 Progress Check: FRQ		
5. Electromagnetism	5. Electromagnetism: Electromagnetic Induction (Including Faraday's Law and Lenz's Law)	1.D, 1.E, 6.D, 7.A, 7.E	2, 3, and 4
	5. Electromagnetism: Inductance (Including LR Circuits)	5.A, 6.B, 6.C, 7.D	
	5. Electromagnetism: Maxwell's Equations	1.E, 4.C, 4.E, 5.E, 7.D	
	Assign Unit 5 Progress Check: MCQ		
	Assign Unit 5 Progress Check: FRQ		

The Big Ideas of the Course CR2

- Big Idea 1: Interactions produce changes in motion
- Big Idea 2: Forces characterize interactions between objects or systems
- Big Idea 3: Fields predict and describe interactions
- Big Idea 4: Conservation Laws constrain interactions

SAMPLE ACTIVITIES

Big Idea	Activities	CED Units
1	In Units 4 and 5, Big Idea 1 is developed through problem solving involving the presence of a magnetic field around a moving charged particle, such as in a mass spectrometer problem that causes a change in motion of the charged particle. Problems in Unit 5 address Big Idea 1, for instance, students are required to describe qualitatively how electromagnetic braking can cause changes in motion.	4, 5
2	In Units 1 and 2, Big Idea 2 is developed through application of Coulomb's Law governing the force that characterizes interactions between charged conductors and induced charge on insulators. For instance, students will experiment qualitatively with sticky tape that is statically charged, neutral paper, and neutral aluminum foil to investigate the claim that like charges repel and opposite charges attract. Students will also apply this in the study of capacitors and dielectrics in their ability to store electrical potential and increase capacitance respectively.	1, 2
3	In Units 1, 2, and 4, Big Idea 3 is developed. For instance, in studying electrostatics, students will work in small groups to determine the electric field strength at the center of a conducting spherical shell using symmetry arguments; in Unit 2, students will create sketches of a simple, parallel-plate capacitor and the field between the plates and then a sketch of the same capacitor once a dielectric is inserted in order to explain how the capacitance of the capacitor changes upon insertion of the dielectric; in Unit 4, students will predict and experimentally determine the forces acting on two current-carrying wires and use their understanding of fields to predict what direction the wires will accelerate depending on the direction of current flow in each wire.	1, 2, 4
4	In Units 1, 2, and 3, Big Idea 4 is developed. Students will engage in activities and labs relevant to conservation of charge in Units 1 and 2; in Unit 3 students will analyze DC circuits using Kirchhoff's Rules and relate them to Conservation of Charge and Conservation of Energy.	1, 2, 3

The Science Practices of the Course

- Science Practice 1: Visual Representations
- Science Practice 2: Question and Method
- Science Practice 3: Representing Data and Phenomena
- Science Practice 4: Data Analysis
- Science Practice 5: Theoretical Relationships
- Science Practice 6: Mathematical Routines
- Science Practice 7: Argumentation

SAMPLE ACTIVITIES

Science Practice	Activities
SP1	Field-Lines, Equipotentials, and Free-Body Diagrams: Throughout the course students will be required to graphically represent electric field lines around groups of charges and conductors, such as through the Mapping the E-Field Lab, magnetic field lines around differently shaped magnets in the Mapping the B-Field Lab, and visually representing the forces acting on current carrying wires or charged objects using Free-Body Diagrams. **[SP1.A, 1.B, 1.C, 1.D]** **CR3**
SP2	DC Circuit Lab: In this guided-inquiry lab, students are provided with a number of different types of unlabeled resistors, and students must design an investigation to determine whether each resistor is ohmic or non-ohmic. **[SP2.A, 2.B, 2.C, 2.D, 2.F]** **CR4**
SP3	RC Circuits Lab: Students will be required to sketch graphs of potential difference vs. time and current vs. time across charging and discharging capacitors and across resistors in the circuit. **[SP3.A, 3.C]** **CR5**
SP4	Slinky Solenoid Lab: In this guided-inquiry lab, students will use a conducting slinky and voltage source to graphically determine a value for μ_0. **[SP4.C, 4.D, 4.E]** **CR6**
SP5	Problem-Solving: Students will be required to apply Gauss's Law to determine electric field strength at some radial distance from the source using appropriate Gaussian surfaces, such as using cylindrical gaussian surfaces for finding E-Field strength at some height above a uniformly charged large, thin sheet conductor. **[SP5.A, 5.E]** **CR7**
SP6	Time-Varying Current Analysis in RC Circuits: Students will work in groups to derive an expression for current as a function of time while a capacitor in an RC circuit is charging or discharging by solving a differential equation. Students will assess and discuss the reasonableness of their resulting expressions by examining the output of the derived equation given certain extreme inputs, e.g., $t = 0$. **[SP6.A, 6.B, 6.D]** **CR8**
SP7	TIPER Activity: Students will individually complete ranking tasks throughout the course; for instance, students may be asked to rank the relative magnitude and direction of an induced current due to changing magnetic flux. After individually completing the task, students will share their answers in groups and collaborate to form a consensus ranking to share with the class. **[SP7.A, 7.C, 7.D]** **CR9**

CR3
The syllabus must include one activity or lab describing how students analyze and/or use nonnarrative/nonmathematical representations of physical situations, excluding graphs. The activity or lab must be labeled with the relevant skill(s) (e.g., "1.B") associated with Science Practice 1.

CR4
The syllabus must include one activity or lab describing how students determine scientific questions and methods. The activity or lab must be labeled with the relevant skill(s) associated with Science Practice 2.

CR5
The syllabus must include one activity or lab describing how students create visual representations or models of physical situations. The activity or lab must be labeled with the relevant skill(s) associated with Science Practice 3.

CR6
The syllabus must include one assignment, activity, or lab describing how students analyze quantitative data represented in graphs. The assignment, activity, or lab must be labeled with the relevant skill(s) associated with Science Practice 4.

CR7
The syllabus must include one assignment, activity, or lab describing how students determine the effects on a quantity when another quantity or the physical situation changes. The assignment, activity, or lab must be labeled with the relevant skill(s) associated with Science Practice 5.

CR8
The syllabus must include one assignment, activity, or lab describing how students solve problems of physical situations using mathematical relationships. The assignment, activity, or lab must be labeled with the relevant skill(s) associated with Science Practice 6.

CR9
The syllabus must include one assignment, activity, or lab describing how students develop an explanation or a scientific argument. The assignment, activity, or lab must be labeled with the relevant skill(s) related to Science Practice 7.

As long as one skill under Science Practice 7 is represented, evidence is sufficient.

Real-World Applications in the Course

Students will be exposed to multiple real-world applications of calculus-based physics throughout the course. Within each unit there will be opportunities for students to explore direct application of concepts.

Sample Activities CR10

Electric Motor Challenge: Students are challenged to apply their understanding of electricity and magnetism to construct electric motors from basic construction materials, magnets, and batteries. Students are required to create a short presentation of physical laws relevant to the construction of a working motor and to demonstrate the efficacy of their motor by having it lift a small mass from the ground to the top of the lab table using a simple pulley attachment.

Building an Electromagnet: Students are challenged to create a solenoid wrapping around a ferrite core and connect the ends of their magnet wire to a voltage source. Students test their electromagnets by seeing how many paperclips can be suspended from their magnet when it is turned on. Students then use compasses and a Hall-effect sensor to detect the magnetic field strength and magnetic field lines around their electromagnet and compare their findings to other permanent magnets they have encountered earlier in the course.

CR10
The syllabus must label and provide a description of at least one assignment or activity requiring students to apply their knowledge of AP Physics concepts to understand real-world questions or scenarios.

LIST OF LABORATORY PRACTICAL

CED Unit	Topics	Lab Activities CR11
1	Electrostatics	**Sticky Tape Lab –** Students use scotch tape, aluminum foil, and paper to investigate like and opposite charge interactions as well as charging by induction. **Electroscope Investigation –** Students use electroscopes and charging rods to investigate charging by conduction, induction, and grounding. **Coulomb's Law Lab (Guided-Inquiry) –** Students are challenged to devise a method to determine Coulomb's Constant using charged pith balls hanging from insulated threads. **Mapping Electric Field and Equipotential Lab –** Students use multimeters to identify equipotential lines around charged objects and trace the electric field lines.
2	Conductors, Capacitors, and Dielectrics	**Construct a Capacitor Lab** – Students use transparency sheets, paper, tape, paperclips, and aluminum foil to construct and test a capacitor.
3	Electric Circuits	**Ohm's Law Lab (Guided-Inquiry) –** Students are provided with different ohmic resistors and develop a procedure by which they can determine Ohm's Law with a simple circuit. **Ohmic Resistors Investigation (Guided-Inquiry) –** Students are provided with different types of resistors and develop a procedure by which they can determine whether each resistor is ohmic or non-ohmic. **Resistivity Lab (Guided-Inquiry) –** Students are provided with carbon graphite and are challenged to determine the resistivity of the material. **Simple Circuits Lab (Open-Inquiry) –** Students investigate equivalent resistance and Kirchhoff's Rules using simple circuits. **RC Circuits Lab –** Students predict and experimentally verify the time constant for an RC circuit charging and discharging.

CR11
The syllabus must include an explicit statement that at least 25 percent of instructional time is spent engaged in hands-on laboratory investigations, with an emphasis on inquiry-based labs.

AND

Laboratory investigations must be listed with a title and brief description. Guided- and open-inquiry labs must be labeled.

CED Unit	Topics	Lab Activities CR11
4	Magnetic Fields	**Mapping Magnetic Fields Lab (Open-Inquiry) –** Students investigate and map magnetic fields generated by various sources using a wide range of measurement techniques.
5	Electromagnetism	**Construct an Electromagnet Lab –** Students use magnet wire and a ferrite core to construct and test an electromagnet. **Slinky Solenoid Lab (Guided-Inquiry) –** Students are challenged to find a value for μ_0 using a metal slinky as a solenoid. **Electromagnetic Induction Lab (Guided-Inquiry) –** Students are challenged to design an experiment to determine the variables that affect the EMF that can be induced in a coil by a permanent magnet. **LR/LC Circuits Lab –** Students predict and experimentally verify the time constant for LR circuits and the behavior of LC circuits. **Electric Motor Challenge (Guided-Inquiry) –** Students are challenged to design and construct a working electric motor that can lift a known mass from the ground to the top of a lab table.