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.