AP Physics C - Mechanics Curriculum and Syllabus

AP Physics C is a national calculus-based course in physics. The learning objectivesfor this course are developed by the College Board. This course is equivalent to the pre-engineering introductory physics course for college and university students. The course emphasizes understanding concepts and skills and using those concepts and formulae to solve problems. Laboratory work is an integral part of this course. Students engage in inquiry-based activities to develop their understanding of the material of the course. Students work together in small groups to solve problems. Students present solutions to the class.

This course is conducted in a small group or independent study. This course is equivalent to a first-year college physics class and is designed to prepare for the AP Physics C: Mechanics Exam given in May. Typically, students will have completed AP Physics 1 prior to taking this course. Students enrolled in Physics C courses will have taken or are currently taking Calculus. This course requires and employs a basic understanding of calculus (differentiation and integration). Mechanics will be covered in the fall semester and Electricity and Magnetism in the spring semester. Concepts and problem solving techniques will be introduced through lectures, problem solving sessions, question and answers as well as lab activities.

Pre-Requisite: Students should have taken or be taking Calculus.

Schedule: This class will meet the equivalent of 5 periods per week. The classroom will be open for students to work during any period they wish. Lectures will be recorded and posted. Class time will be used for problem solving and lab activities. We will schedule meetings during study halls and after school as needed. As the test approaches, we will hold review sessions as well.

Textbook: University Physics, Young & Freedman, 13th edition. Homework will be available via WebAssign. We will also make use of online resources for review:
https://archive.org/details/ap_physics_c
https://archive.org/details/Calculus-Based_Physics_I_textbook
http://aplusphysics.com/community/index.php/videos/

Curriculum: The AP Physics C – Mechanics curriculum covers the following areas: kinematics, Newton's laws of motion, work and energy, linear momentum, circular and rotational motion, and oscillations and gravitation.

Lab Investigations More than twenty-five percent of instructional time in this course is devoted to hands-on laboratory work with an emphasis on inquiry-based investigations. Students will work in small groups to perform lab investigations as a part of each unit. These activities will be built upon the Science Practices from AP Physics 1 and AP Physics 2. Investigations will require students to ask questions, make observations and predictions, design experiments, analyze data, and construct arguments in a collaborative setting, where they direct and monitor their progress. All students will maintain an electronic logbook using Evernote. Each of the lab investigations listed below will be recorded in the logbook. Most of these labs will also require a summary component completed in some other form.

Students will work in lab groups, but each student is responsible for maintaining their own logbook. Each lab should contain an Introduction (purpose, procedure, and problem statement), Data and Observations, Analysis (calculations and graphical analysis), and Conclusion including error analysis. Some labs will also include peer review or the final product.

Self-Pacing: It is the student's responsibility to adhere to the schedule (shown in the table below) for completing homework assignments, quizzes, and tests. The suggested approach for each assignment is as follows:

- Do the reading assignment in the textbook.
- Complete the accompanying online modules.
- Do all assigned *WebAssign* problems. You may need to review parts of the reading assignment in order to do this.
- Meet with Mr. Smith to discuss issues involving conceptual understanding and/or problem-solving strategies for problems, as needed. This needs to be done before school, after school, or during one of Mr. Smith's planning periods.
- Schedule quiz or test, if applicable (see schedule).

Course Outline

Unit 1 – Kinematics in 1 and 2 Dimensions

Content

• Kinematics in 1D
• Constant Acceleration
• Time Varying Acceleration
• Projectile Motion – Kinematics in 2D

Lab Investigations

1. Scientific Method: To duplicate Galileo's proof of acceleration of falling bodies.
2. Video Analysis of Motion: To use video analysis tools (Capstone) to determine the motion of objects and observe how camera position affects the values found.
3. Determining g: To use different experimental models to determine the acceleration due to gravity.
4. Projectile Motion: To determine the relationship between θ and range.

Unit 2 – Newton's Laws of Motion

Content

• Force and Mass
• Friction and Drag Force

Lab Investigations

5. Freefall and Air Resistance: To determine the effect of air resistance on coffee filters falling.
6. Atwood's Machine: to verify the acceleration of masses suspended over a pulley.
7. Friction: to determine the coefficient of friction between materials on an incline.

Unit 3 – Work and Energy

Content

• Work
• Energy
• Nonconservative and Conservative Forces
• Conservation of Mechanical Energy
• Power

Lab Investigations

8. Work – Energy: To determine the work via the integral of a force-distance graph.

9. Rolling Away: To determine the landing position of a rolling object down a ramp and off a table.

Unit 4 – Linear Momentum

Content

- Impulse and Momentum
- Conservation of Momentum
- Two Body Collisions in 1D and 2D
- Systems of Particles

Lab Investigations

10. Collisions Lab: To verify conservation of momentum in two dimensions for a collision of objects.

Unit 5 – Circular and Rotational Motion

Content

- Uniform Circular Motion
- Rotational Kinematics
- Relationship between Linear and Angular Quantities
- Rigid Bodies

Lab Investigations

11. Conical pendulum: To determine the relationship between period, radius and tension for an object moving in a conical pendulum.

Unit 6 – Rotational Dynamics

Content

- Rigid Bodies
- Moment of Inertia and Torque
- Angular Momentum
- Rotational Equilibrium
- Rolling Motion

Lab Investigations

12. Newton's 2nd Lab for Rotational Motion: To determine the rotational inertia of an object which is spinning under a known torque by measuring angular acceleration.

Unit 7 – Gravitation

Content

- Newton's Law of Gravitation
- Gravitational Potential Energy
- Kepler's Laws
- Critical and Escape Velocities

Lab Investigations

13. Orbital Simulations: To determine the law of gravitation and Kepler's Laws through an online simulation.

Unit 8 – Oscillations

Content
• Simple Harmonic Oscillators
• Simple Pendulum
• Spring – Mass System
• Physical Pendulum

Lab Investigations

14. Physical Pendulum: To determine the relationship between the period and length of a meter stick.