AP PHYSICS C: MECHANICS

Syllabus for:

Ryan Neenan

Wallenpaupack Area High School

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 2
CR2	The course provides opportunities to develop student understanding of the required content outlined in each of the units described in the AP Physics C: Mechanics Course and Exam Description.	See Page 2
CR3	The course provides opportunities for students to develop the skills related to Science Practice 1: Creating Representations.	See Page 3
CR4	The course provides opportunities for students to develop the skills related to Science Practice 2: Mathematical Routines.	See Page 3
CR5	The course provides opportunities for students to develop the skills related to Science Practice 3: Scientific Questioning & Argumentation.	See Page 3
CR6	Students spend a minimum of 25% of instructional time engaged in hands-on laboratory investigations	See Page 3
CR7	Students engage in hands-on laboratory investigations representative of the topics outlined in the AP Physics C: Mechanics Course and Exam Description.	See Page 4
CR8	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 3

CR1 CR2 Textbook and Course Content Outline

- The textbook for this course will be **Physics for Scientists and Engineers** by Serway/Jewett. Currently using the 9th Edition, Copyright 2014.

- Course Content: All the content in the current AP Physics C: Mechanics Course and Exam Description will be covered in this course. We will cover this content in the following chapters in our calculus-based, university-level textbook:
  - Unit 1: Kinematics
    - Chapter 2: Motion in One Dimension
    - Chapter 3: Vectors
    - Chapter 4: Motion in Two Dimensions
  - Unit 2: Force and Translational Dynamics
    - Chapter 5: The Laws of Motion
    - Chapter 6: Circular Motion and other Applications of Newton's Laws
    - Chapter 13: Universal Gravitation
  - Unit 3: Work, Energy, and Power
    - Chapter 7: Energy of a System
    - Chapter 8: Conservation of Energy
  - Unit 4: Linear Momentum
    - Chapter 9: Linear Momentum and Collisions
  - Unit 5: Torque and Rotational Dynamics
    - Chapter 10: Rotation of a Rigid Object About a Fixed Axis
    - Chapter 12: Static Equilibrium and Elasticity
  - Unit 6: Energy and Momentum of Rotating Systems
    - Chapter 10: Rotation of a Rigid Object About a Fixed Axis
    - Chapter 11: Angular Momentum
  - Unit 7: Oscillations
    - Chapter 15: Oscillatory Motion

CR3 CR4 CR5 Science Practices

- This course will incorporate Science Practices 1, 2, and 3 into the curriculum within each unit. Here are some examples of how that is happening:

- **Science Practice 1**: During the Kinematics Unit, students will be asked to sketch and plot position vs. time, velocity vs. time, and acceleration vs. time for a variety of different situations. During the Force Unit, students will draw free-body diagrams for individual objects and systems

- **Science Practice 2**: Atwood's Machine: students will determine the relationship between acceleration and total mass as well as acceleration and mass difference. Students will measure the time the masses take to fall and will use kinematic equations to calculate the acceleration.

  During the forces unit, students will be asked to calculate the accelerations for a variety of situations, including objects on flat surfaces, objects on inclines, and connected systems.

- **Science Practice 3**: During the force unit, students will predict the resistance force relationship between a falling coffee filter and air. They will justify this result by designing a data taking experiment to measure the resistive force on a failing coffee filter.

CR6 CR8 Hands on Laboratory Investigations

- At least 25% of instructional time is spent engaged in hands-on laboratory investigations, with an emphasis on inquiry-based labs. All students are required to keep a lab notebook for all lab work. This notebook is provided by the instructor.

CR7

- Labs will be selected from the following:
  1. Graphical Analysis of Motion: Students will model and predict the motion of various objects under zero and constant acceleration using probe ware.
  2. Horizontal Constant Acceleration: Students design a lab to show an object moves with constant acceleration.
  3. Vertical Constant Acceleration: Students determine the value of the acceleration due to gravity using various falling objects and probe ware.
  4. Predict the Projectile Lab: Students design an experiment to predict the path of a projectile and attempt to hit a falling object.
  5. Atwood's Machine Lab: Students determine the relationship between total mass and acceleration and the mass difference and acceleration.
  6. Static and Kinetic Friction: Students determine the coefficient of static and kinetic friction for different surfaces.
  7. Friction and Acceleration: Students design a lab to calculate the coefficient of friction between two surfaces by measuring the acceleration of the system.
  8. Flying Cow: Students design a lab to measure the period of an object in circular motion using theory and then compare it to a stopwatch measurement.
  9. Resistive Force of Air: Students prove the model relationship between the resistive force of air and the square of the speed of an object.
  10. Work-Energy Theorem Lab: Students will design a lab to prove the relationship between work and change of energy.
  11. Mechanical Energy: Students determine the relationship between the total mechanical energy of a bouncing ball and compare different bouncing balls while measuring their coefficient of restitutions.
  12. Conservation of Energy: Students measure the spring constant of a spring and then predict the distance a mass will fall when attached by a string to that spring.
  13. Impulse-Momentum: Students will experimentally verify the impulse momentum theorem with a collision of a smart cart and a force sensor.
  14. Conservation of Momentum (1D): Students verify that momentum is conserved in elastic and inelastic collisions using smart carts and a ballistic pendulum.
  15. Conservation of Momentum (2D): Students will verify that momentum is conserved in a two-dimensional collision of steel balls.
  16. Net Torque: Students will determine the time it takes for an unrolling spool of string (or toilet paper roll) to fall a distance, comparing their prediction to a

measure value. They will then predict where to drop the unrolling spool so it hits the ground at the same time another spool is dropped from a given height.

17. Torque and Acceleration: Students will design an experiment to solve for the linear acceleration of the end of a meterstick which has its other end fixed at a pivot.
18. Static Equilibrium: Students will measure the coefficient of friction between a stationary “ladder” and the surface it rests on using the idea of static equilibrium.
19. Rotational Inertia: Students will derive an equation and design an experiment to determine the rotational inertia of different standard shapes that are rolling down a hill.
20. Angular Momentum: Students will test the concept that angular impulse is equal to the change of angular momentum using a spinning wheel and rod set-up.
21. Conservation of Angular Momentum: Students design a lab to determine if angular momentum is conserved when an object is dropped on a spinning disc.
22. Beats Lab: Students will design a lab to make a simple pendulum and a mass on a spring oscillate to match the beat of a song.
23. Simple Harmonic Motion: Students will determine the oscillatory period of a physical pendulum and pendulum/spring setup and then compare the results with a measured result.