AP Physics C Mechanics Syllabus

Prerequisites: Successful completion physics 1 and AP Physics B with a grade of A- or better. Successful completion or currently enrolled in Calculus.

Text: Physics, Halliday and Resnick

Course Overview: The course follows the college board syllabus for AP physics C and is equivalent to a full year of university calculus based physics. The course covers mechanics and electricity and magnetism in full detail, has a strong laboratory component, and emphasizes student problem solving strategies.

Classes consist of lecture, discussions, cooperative learning, and critical thinking exercises. There is a strong emphasis on problem solving techniques, including inquiry-based learning, student centered problem solving, graphical approaches to problem solving and calculus problem solving techniques. Students are required to detail all their steps in a calculation and to be able to explain in words what they are doing. Students keep a notebook for both notes and problem solving technique (both homework and in class problems are kept here)

Each unit consists of at least one major lab. All of the labs are hands on. Some of the labs are 'design experiment' labs, where the students design and conduct their own experiment. Most of the labs are typical of university labs in that they follow certain directions to conduct an experiment. For all of the labs, students write a 4 to 5 page lab report detailing the objective, procedure, calculations and data tables, results, error analysis, and conclusion. Students keep a lab book, which is checked and graded after each unit.

Exams are conducted at the end of each unit. The exams are modeled after the AP exam with both multiple choice and free response. There is also one question concerning the lab work they did for this unit.

Student Assessment is roughly as follows:

Tests	50%
Labs	20%
Quizzes	15%
Homework	15%

1st Semester Course Outline

Weeks 1-2: Kinematics
Scalars and Vectors
Kinematics
Motion in -D
Motion in 2-D
Projectiles
Uniform Circular Motion
Relative Motion
Intro to Special Relativity
Lab: Falling Coffee Filters. A short stack of coffee filters is dropped onto a motion detector in order to introduce 1-D motion with air resistance and spreadsheet modeling.
Lab: Air drop (Students use motion detectors and frictionless carts to calculate where to place a package. The students design the experiment to test the accuracy of their drop and then test it to their theoretical calculations)

Weeks 3-4: Newton's Laws of Motion
Mass
Force
Tension and Normal Force
Friction
Circular Motion
Difficult Newton's Law Problems
Lab: Pulley Incline lab (Students
Lab: Brake pad lab (Students use a force probe to calculate the coefficient of static and kinetic friction for various materials on a disc brake and write an engineering report recommending one of the materials as the companies next brake pad)
Lab: Circular Motion Lab (Students analyze a bunch of movie clips using video point and do various calculations)

Weeks 5-6: Linear Momentum
Centre-of-Mass Discrete and Continuous (Including full integration techniques)
Impulse and Linear Momentum
Law of Conservation of Linear Momentum
Two-Body and Three-Body Collisions in 1-D
Two-Body Collisions 2-D
Lab: Momentum Conservation in Collisions (Students use air tracks, photo gates and excel spread sheet and calculate predictions to compare with their results)
Lab: Momentum Conservation in Particle Collisions (Students use real particle physics data and their knowledge of momentum conservation in 2-D to calculate momentum of neutrinos)
Lab: Falling Chain Lab (Students let a heavy rope/cable drop into a cup on a force plate sensor. Students investigate impulse and change in momentum.)

Week 7-10: Rotational Dynamics
Constant Angular Speed
Constant Angular Acceleration
Angular motion kinematics equations Rigid Bodies
Moment of Inertia Discrete and Continuous (Including full integration techniques)
Torque
Newton's 2^{nd} Law for Torque
Rotational Equilibrium
Mechanical Equilibrium
Angular Momentum
Conservation of Angular Momentum
Rolling Motion
Lab: Angular Motion of CD's and Records (Students use a record player and photogate detector to calculate angular acceleration and the relationship between linear velocity and angular velocity)
Lab: Moment of Inertia Lab (Students design experiments to find the moment of inertia of a large pulley, a yo-yo, and a long block of wood)
Lab: Rolling objects lab

Week: 11-12: Work, Energy, and Power
Energy
Conservation of Energy
Energy Transfer (i.e. Work)
Closed System and Conservative and Non-conservative Forces
Kinetic and Potential Energies
Conservation of Mechanical Energy
Relationship Between Potential Energy and Force
Energy Problems with Both Linear and Rotational Motion
Power
Lab: Ballistic Pendulum (Students design an experiment to predict the initial velocity of a BB gun, using only string, clay, ruler and any of the available detector equipment)
Lab: Rotating Object (Students use conservation of energy and photo-gates to compare theory to experimental angular speeds)
Lab: Energy Conservation in Particle Physics (Students use real particle physics data and their knowledge of Energy Conservation to predict missing energies and combined with the momentum information from previous lab can calculate the mass of the missing particle)

Weeks: 13-15: Gravitation and Oscillations
Kepler's Laws
Newton's Universal Law of Gravitation
Gravitational Potential Energy (including full integration techniques involving spheres)
Motion of Planets and Satellites

Escape Velocities
Superposition Principle
Simple Harmonic Oscillations
Differential Equation of Harmonic Oscillations
Simple Pendulum
Spring Mass System
Physical Pendulum
Resonance and damping
Taylor Series Expansion of Simple Pendulum
Lab: Planetary motion (Students investigate orbits periods, etc. using Interactive Physics to compare to their calculations using circles and ellipses)
Lab: Pendulum Lab (Students investigate the simple pendulum at small and large angles using the Taylor series expansion to investigate larger angles)

Week 16: Review For Final Exam

2nd Semester Course Outline

Weeks 1-3: Electrostatics
Charge and Coulomb's Law
Electric Field and Electric Potential
Gauss's Law (including non-trivial integration problems)
Fields and Potential's of other charge distributions
Lab: Coulomb's Law (Students investigate electrostatics conceptually and analytically in a lab with 4 stations)
Lab: Electric Potential Lab (Students charge up plates and measure the electric potential with an electroscope at various distances and in the process draw equipotential and electric field lines as well as doing various calculations)

Weeks 3-5: Conductors, Capacitors, Dielectrics
Electrostatics with Conductors
Capacitors (parallel plate, cylindrical, and spherical geometries)
Dielectrics
Lab: Mapping Electric Field and Equipotential Lines (Students map out field lines for various geometries and distances)
Lab: Capacitor Project (Students design and build a simple capacitor, explain how it works and report on everyday uses of capacitors, for example RAM in your computer)

Weeks 6-8: Electric Circuits
Voltage and Equipotential
Current and Resistance
Resistivity
Power
Capacitors and Resistors in Circuits

RC Circuits (including analysis of first order differential equations)
Lab: Resistors in Series and Parallel (Students investigate the properties of resistors in series and parallel)
Lab: Internal Resistance of a Battery (Students design an experiment to measure the internal resistance of a battery. They then conduct the experiment on various batteries (some brand new, some 'dead') and report their findings along with an error analysis)
Lab: Power Lab (Students investigate the Power output, dissipation in various circuits across various devices)
Lab: RC circuits (Students investigate and graph transients in RC circuits. Using a light bulb and stopwatch they estimate the RC time constant. Then using a current meter they repeat, but more accurately. They also use standard resistors and capacitors and plot out graphs for each and match the printed values with the experimental findings)

Week 8-11: Magnetic Fields
Forces on Moving Charges in a Magnetic Field
Forces on Current-Carrying Wires in Magnetic Field
Charge Density
Integral Form of Force on Current-Carrying Wire
Fields of Long Current Carrying Wires
Ampere's Law (including integrating non-trivial current distributions)
Biot-Savart Law (including 1-D vector calculus integrals)
Lab: Ampere's Law (Students investigate Ampere's Law using straight wire and circular wire loops. They also use a current transducer to see the meaning of 'I enclosed)
Lab: Solenoids and Toroids (Students use a hall probe, slinky type coils, and a toroid transformer to investigate magnetic fields in and out)
Lab: MRI magnet (Students take a tour of a GE 3T magnet and study the field using a Hall probe and field transducer)

Week: 12-14: Electromagnetism
Electromagnetic Induction
Inductance
Maxwell's equations
LR circuits
LC circuits
LCR resonant circuits (including solving the 2^{nd} order differential equation)
Lab: Lenz's Law lab (Students investigate, take data and calculate magnetic field of variously shaped rare earth magnets falling between two aluminum plates)
Lab: High pass and low pass filters (Students design LR and LC circuits to attenuate certain frequencies of sound. They use an oscilloscope to check themselves along the way)
Lab: LCR resonant circuits (Students design and then use LCR resonant circuits with a

variable capacitor so that it resonates at different frequencies. They then graph and analyze their results)

Weeks: 15-17: Review of Mechanics and EM and AP Exam Prep

Review Mechanics
Review Electricity and Magnetism
AP Exam Prep
AP Exam

Week 18: Modern Physics

Intro to Quantum Mechanics and Particle Physics
Lab: Double slit experiment and quantum eraser (Investigate wave nature of light, and show observer effect in quantum mechanics using polarized light)
Lab/Acitivity: Build a cloud chamber to observe cosmic ray particles