AP Physics C Combined Syllabus

AP Physics C Mechanics Syllabus

Prerequisites: Physics I (AP Physics 1 highly recommended), completed or currently enrolled in Calculus (enrolled in BC is highly recommended or completed Calculus)

Textbook: *Physics: For Scientists and Engineers, A Strategic Approach*. 5th Edition. Randal D. Knight

Required materials: Graphing calculator approved for use on the AP Physics examine, Dry Erase Markers, 1 Composition Books (prefer with graph paper), access to computer spread sheet program (Microsoft Excel, LibreOffice Calc, Google Docs), committed student.

Course Overview: This course is based on "Learning Objectives for AP® Physics" and covers "C" course objectives. The curriculum is equivalent to a full year of university-level calculus-based physics. The class is split into two main subject areas: Newtonian mechanics (Semester 1) and electricity and magnetism (Semester 2). The class also includes a 2-hour hands-on laboratory component that occurs outside normal school hours. Students are required to attend 1 lab session every week. Lab sessions will be determined by the class during the first 3 days of school.

Classroom time will include 15-25 minute college-style lectures with a heavy emphasis on participation. The lectures are primarily to introduce concepts. While learning about concepts in physics is important, the main objective is to learn the process of problem solving using calculus-based physics as both a framework and a more realistic model of what occurs in the real world. Students will be challenged to use high-order critical thinking skills in order to analyze a problem, evaluate different ways to solve the problem, and to produce a result using various tools (mathematical and physical) together. **Working in small groups is encouraged as collaboration and learning effective critiquing skills are essential skills that need to be learned and practiced.**

Students will be called upon to present their work to the class. Students work will be mainly critiqued by other students. This provides constructive feedback, keeps the other students engaged, and allows me to provoke higher-ordered thinking such as "next step" and alternative methods to solving problems. Students will be continually asked to justify their answers by referring back to first principles as a way of strengthening a student's foundation in physics.

Hands-on laboratories are essential parts of this class. Some labs will be guided, while others will require students to develop their own protocol in order to reach a "discovery." All students are required to keep a laboratory journal in which the student will document in detail the objective, procedure, data analysis, calculations, and analysis. Objectives and primary data must be placed into the notebook as it is collected. Other sections may be typed up, printed, and affixed into the notebook. The notebook will be submitted for grading. **As some universities have asked students for their lab notebooks, I suggest that the notebook be well kept.** During some laboratory periods, more than one lab may be assigned. For these labs, a brief summation and analysis that includes the relevant calculations will be required.

Term and semester grades for the class will be based on the following approximate percentages:

50%	Tests
30%	Lab
20%	Quizzes/Homework

Grading will emphasize understanding and communicating "how to solve" rather than the "correct answer." In other words, students are required to show their work in detail. Weekly quizzes will include multiple-choice, short answer, and free response question. Late work will not be accepted without prior approval by the instructor. Students will be given enough time to complete assignments.

There will be a test at the end of each unit. Free response questions will be graded in a similar manner as a real AP exam.

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Laboratory Notebook

Use a bound notebook. The marbled “Composition” books are perfect.

⇒Page one – title page: name, subject, class period

⇒Page two – Table of Contents: titles of labs and initial page number of the labs

⇒Number remaining pages in lower left (for left page) and lower right (for right page).

⇒**Primary data** – must be entered as lab progresses. This data can be unorganized, but should not be overyly messy. These serve as your notes for how the experiment was conducted and should include one-off measurements.

⇒**Pencil is okay**. However, no erasures are to be made and no “white-out” may be used. Draw a single line through any errors.

⇒Do not remove pages from the lab book. To “delete” a page, draw a single large “X” over the page.

⇒Each lab report entered in the notebook should include all data and observations recorded during the experiment. Students should not record data on other paper for later transfer to the notebook.

⇒Recommend method - Final lab report can be typed, printed, then attached into the lab notebook. Overall, the report still must follow the Lab Report Format.

Lab Report Format

Heading and Title

Name, date and lab partners, written in upper right hand corner

Introduction

Write simple statements giving the reason for performing the experiment and an introduction to the general topic investigated in the experiment. Include any important equations or principles that will be used.

Procedure

Begin with a subsection listing necessary materials and equipment. A step-by-step protocol that includes enough information for some other student to be able to repeat the experiment. A person who understands physics should be able to read this section and know what is being done and be able to repeat it. A subsection regarding lab safety issues and necessary precautions is required.

Data Table (if needed)

Transfer your primary data into data tables. Observational/One-off data may be listed on separate lines. Units are required when applicable. The data presented here is for clarity and should be the same as recorded during the lab. For labs with extensive data logging, only small snippets of the data is required.

Calculations

Show how calculations are carried out. Give equations when appropriate and show how your values are substituted into it. If there are many repeated calculations, a representative sample is shown. Results of calculations may be part of data tables

Graphs (if needed)

Data plots should be neatly constructed using Graph Paper or through a spreadsheet or data analysis program. Proper titles and axis labels are required. If a scatter plot is used, a trend line (best fit line) is required with the equation and an appropriate correlation factors on or under the plot. Data type and graph type should match.

Questions and Problems

Paraphrase questions posed by the lab and answer in complete sentences. Some questions are extremely opened ended, however Claim, Reasoning, and Evidence answer format will be very helpful to structure your answers.

Analysis/Conclusion

This section should be a thorough discussion of the results of the experiment. It is to reflect thinking and understanding. Be sure to include the following:

- Discussion of Concept: What do the calculations/observations/graphs reveal? Why does (or doesn’t) the experiment work? What physical concept was demonstrated in this experiment?
- Experimental Sources of Error: What are some specific sources of error and how do they influence the data? (Instrumental error and human error exist in all experiments, and should not be mentioned as a source of error unless they cause a significant fault.)
- Propagation of Error: Which error produced the largest effect on the result? And what is the amount of variability caused by this error? What are some minor sources of errors and their estimated effects on variability? Estimate the variability of the answer caused by the accumulation of ALL errors in MEASUMENTS.

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Course Outline

Semester I – Mechanics

Term 1
Week 1: Introductions, including the course, the AP exam, limits, derivatives, and integrals; Chapter 2
Concepts: Motion in 1D, Calculus

Week 2-3: Chapters 2-3
Concepts: Motion in 1D and 2D, including projectile motion
Lab: Linear Motion – Students will analyze the motion of a cart to discover its initial velocity. Students will use calculus to support/demonstrate their results
Lab: Bullseye – Students will create a consistent simple machine and predict the exact landing spot of a steel bearing. Students are only allowed one chance.

Weeks 4-6: Chapters 4-5
Concepts: Newton's three laws of motion
Lab: Atwood machine and Newton's second law – Students will analyze the dynamics and kinematics of the moving weights in an Atwood machine.
Lab: Hooke's Law lab – Student will determine the spring constant of springs in different orientations..
Lab: Drag Coefficients – Students will design a protocol to determine the drag coefficient of an object and analyze the results by applying kinematic equations and Newton's laws of motion. **This is a guided inquiry lab.**

Weeks 7-8: Chapters 6-7
Concepts: Work-energy theorem, potential energies, kinetic energy, instantaneous **power,** Conservation of Energy
Lab: Friction – Students will determine initial energy, energy lost to friction, and the coefficient of friction of different sets of materials.
Labs: Energy in a collision – Students will design an experiment using a pendulum to determine energy lost in a real world collision with a steel marble. Students will need to explain where and how energy is transferred within the system. **This is a guided inquiry lab.**
Labs: Efficiency (video analysis) – Students will design a protocol and then determine the efficiency of engines in automobiles by video analysis of car reviews

Term 2
Weeks 9-10: Chapter 8
Concepts: Center of mass, impulse, momentum, conservation of momentum in systems of particles
Lab: Impulse and Momentum – Students will investigate the conservation of momentum using Pasco carts, tracks, motion detectors, force detectors and integration of force with respect to time. **This is a guided inquiry lab.**

Weeks 11-13: Chapters 9-10
Concepts: Uniform circular motion, torque, rotational statics/kinematics/dynamics, conservation of angular momentum
Lab: Orbits – Students will explore Kepler's law through integration and analysis of orbital motion.
Lab: Circular and Rotational Motion – Students will study the relationships between angular acceleration, angular velocity, and force using Pasco turn-tables.

Weeks 14-16: Chapters 11 & 14
Concepts: Simple harmonic motion, pendulums and other oscillators, universal gravitation, orbits
Lab: Simple Harmonic Motion – Students will analyze the motion of springs using Pasco motion sensors in order to determine spring constants. The students will also need to calculate and describe kinetic, gravitational potential, and elastic potential energies of the system at specific instants during the spring's motion.

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AP Physics C E&M Syllabus

Course Outline

Semester II – Electricity and Magnetism

Term 3
Weeks 1-3: Chapters 22-23
Concepts: Coulomb's law, electric fields and potentials, Gauss's law, **electrostatics**
Lab: Coulomb's Law – students will be tasked with mapping electrical charges on two **metal conductive** spheres. Students will relate electric charge and force fields **through application of Gauss's Law**.
Lab: Capacitance – students will study the affect of space and area on capacitance
Lab: Map electric field: force and potential – students will design and execute a protocol to determine the spatial relationship between electric force and electric potential. This is a guided inquiry lab.

Weeks 4-6: Chapters 24-25
Concepts: Electric potential of point charges and surfaces, **capacitors, dielectrics**
Lab: Map electric potential in a fluid – students will be tasked to use what they have learned in "Map electric field: force and potential" to a 3D system with a slightly conductive fluid and electrodes. This is a guided inquiry lab.

Weeks 6-9: Chapter 26
Concepts: Current, resistance, power, DC (RC) circuits, Kirchhoff's law, Ohm's law
Lab: RC Circuits – students will determine the effect of measuring has on a circuit and analyze how batteries lose energy
Lab: Advanced Capacitance – students will analyze how capacitor configurations **with different dielectrics** affect charge storage. This will be a guided inquiry lab.
Lab: Proving Kirchhoff's and Ohm's laws – students will measure voltages across different RC circuits that include current, voltage and resistance to prove Kirchhoff's and Ohm's laws. Students will also relate their data to power consumption and energy efficiency.

Week 10: Spring Break

Weeks 11 (Term 3), 12-13 (Term 4): Chapters 28-29
Concepts: Magnetic fields, Biot-Savart law, Ampere's law
Lab: Magnetic Currents lab – Students will tasked to develop a protocol to determine the magnetic and force field surrounding a straight wire carrying DC current. This is a guided inquiry lab.
Lab: Magnetic Currents lab 2 – students will extend what they learned in the first lab to coils of wires with different number of coils.

Weeks 14-16: Chapters30-32
Concepts: Magnetic induction using Faraday's and Lenz's laws, Maxwell's equations, LR and LC circuits
Lab: EMF lab using alternating currents – students will determine the induced emf in a coil by measuring the magnetic field and apply the concept to transformers.
Lab: Induction – students will develop a protocol to induce a potential difference, show that induction is occurring, and calculate the speed of electron displacement. This is a guided inquiry lab.

Weeks 17-18: Review

May 11, 2015: AP Physics Exam: mechanics in the afternoon session and EM in the late afternoon session

Week 19-21: Project Design, Build, Test
Lab: Students will have a choice in how they will proceed with their capstone project. The students will be required to fully explain to the same level of thoroughness as the previous labs at least one aspect of the project and how it relates to a concept we have learned, including graphs and calculus calculations. Suggested projects include creating and using an Arduino controller, creation of a complex machine with multiple functions, or a student proposal that is approved by the instructor. Students will be allowed approximately 1 week to submit a proposal that will be critiqued by the class using a rubric. Students will then have 1.5 weeks to implement or build their projects. In the last 2 days, the students will have to present their project to the class, including the detailed analysis of a physics concept. Project must include a mechanical and an electronic component. This is a guided inquiry project.