AP Physics C: Mechanics
Syllabus

Text

Serway, R. A. & Jewett, J. W. *Physics for Scientists and Engineers*, 6th ed., Vol. 1. Belmont, CA: Brooks/Cole—Thompson Learning, 2004.

Course Description

This second-year physics course is equivalent in content to a first-year/first semester calculus-based college physics class. The content and pace indicated in this syllabus have been designed to prepare students for the AP® Physics C: Mechanics Exam given in May. All enrolled students are required to take the Mechanics portion of the exam. Concurrent enrollment in Calculus is required.

Website

Be sure to check in on the class website at Blackboard.com (Bb). Here, you will be able to check for announcements, assignments, and other important information. I will update the site several times a week—check for announcements about as often (especially over weekends and snow days).

Class Materials and Preparation (Daily Expectations)

- Textbook
- Pencil (preferred) or pen (black or blue)
- Notebook/paper for note-taking (I will supply "work paper" for assignments to be turned in.)
- Two Quad-ruled (graph paper) composition books (These may be stored in my classroom.):
  - One for recording classwork and problem sets
  - One to document your laboratory experiences
- Scientific calculator (*A graphing calculator, although nice, is not mandatory.*)

Course Evaluation (per Quarter)

Grades will be calculated on a percentage basis. Grades will be weighted as follows:

- Tests 50%
- Quizzes 20%
- Labs 20%
- Problem Sets 10%

Each quarter will comprise 22% of your final grade—the final exam will count for 12%.
For exempted seniors, final grades will be the average of equally weighted (25%) quarter grades.

Tests

Tests will be modeled after the AP® Physics C: Mechanics Exam, which consists of two sections, each lasting 45 minutes—multiple choice (35 questions, 45 pts), and free response (3 questions, 45 pts). Calculators and equation sheets will be permitted for the free response section only.

Tests will be cumulative, and will typically be given twice per quarter, although circumstances may dictate slight variations in frequency.

Quizzes

Quizzes will be given no more often than once per week and will be announced at least one class meeting prior to their administration. Quizzes may vary in their grade weights, but the typical quiz will be worth about 25 points. *Equations sheets are not permitted on quizzes,* but physical constants will be provided as needed. At the end of a quarter, individual quiz averages may be adjusted upward if test scores show significant improvement over quiz scores.

Labs

Labs will be conducted approximately 4-5 times per quarter and will comprise 20% of your coursework. These hands-on investigations may be formal data collection and evaluation activities with lab reports or student-centered inquiry-based investigations. Activities will typically be team-based, and will emphasize the co-operative collection and analysis of physical data. Lab data and related evaluations will be recorded in individual composition books and retained as evidence of your experiences. Laboratory write-ups will be maintained in a portfolio.

Experiments, especially later in the course, will incorporate multiple physics concepts (i.e. kinematics, energy conservation) to emphasize their interconnected nature, and to dispel any perception that physics ideas occur in isolation. Team-based investigations will encourage you to consider the physical situation from various perspectives and to consider multiple avenues to solving the focus problem

Formal labs will be teacher-guided, but will typically be student-centered in design and implementation. These labs will require:

- The formation of a viable hypothesis as suggested and supported by initial observations, class discussion of the focus problem, and through independent research
- The design of an experiment according to sound scientific practice (i.e. isolation of variables, controls, constants) to test your hypothesis
- The collection of data and observations
- Calculations using the collected data
- Conclusions about how well the experimental data support the hypothesis
- A class discussion of data variance, divergent conclusions, and error analysis
- A formal written report (formatting details will be provided under separate cover)

Inquiry labs will incorporate demonstrations and/or the collection of class data followed by an assigned set of problems related to the demonstration. Guided class/group discussions will be implemented to assist you in developing rational and logical solutions to the focus problem. Solutions and their justification(s) will be recorded in your lab journals.

Problem Sets

Problem Sets will be completed in a composition book, and will be due on an approximately bi-weekly basis. Some co-operative class time will be provided to complete problem sets, but expect to spend at least as much time outside of class completing them as “homework.” Group work is encouraged, but copying will only hurt you in the long run. It is important not only to do the homework, but to understand it as well. *Diligent completion of your problem sets is essential to your success in AP physics*.

Late homework will be accepted for credit that decays with a half-life of one week:

Grade = $100\% \times e^{-0.099x(\text{days late})}$

Extra Help

An extra afternoon “recitation” session will be held on a regularly scheduled day each week. These sessions can be used for questions and/or for quiet or group study. I will monitor the sessions and be available to answer questions, but, primarily, you will be encouraged to help each other.

Participation in recitation sessions will be encouraged but will not be mandatory.

Course Content

I. Critical Thinking Skills Outcomes and Performance Indicators
   A. Applying the Science of Physics to Life.
      1. Use knowledge of basic physics concepts to develop
         a. Scientific and mathematical proficiency
         b. Higher order thinking skills — analyze, solve, infer, evaluate, classify, develop, create, predict, estimate, generalize
         c. Communication skills — present, persuade, demonstrate, explain, defend, consider, deduce, recommend, share
         d. Goal setting and attainment skills — research, brainstorm, envision, plan, organize, conduct, revise, persist
         e. Social and ethical considerations of science
      2. Use sound methodology to evaluate problems both within and outside the realm of science
      3. Use physics experiments as a bridge to connect theory and application.
      4. Use technology to assist in experimentation and problem-solving
   B. Becoming Familiar with the Scientific Process in Physics.
      1. Know that there may be several approaches in solving the same problem.
      2. Use the scientific method to solve problems and carry out experiments.
         a. Determine and apply appropriate controls, measured parameters, and variables in an experiment
         b. Perform independent research (maintain experimental standards, make accurate computations, conduct experiments)
         c. Gather and represent data (data tables and graphs)
         d. Interpret data and graphs to draw conclusions
         e. Report experimental results in a manner consistent with scientific practice
   C. Understanding the Relationship among Quantities, their Symbols, and their Dimensions
      1. Identify and understand the magnitude of SI (“metric”) units
      2. Demonstrate the appropriate use of scientific notation and significant figures
      3. Incorporate order of magnitude and dimensional analysis in evaluating problems
      4. Be familiar with the physics nomenclature
      5. Demonstrate the appropriate use of simple differential and integral calculus, the dot product, and the cross product.
      6. Be able to write, derive, and use equations in problem solving situations.

II. Know, interpret, understand, and apply major concepts of Newtonian Mechanics:
   A. Vectors and vector methods in problem solving.
   B. Velocity and acceleration in one and two-dimensional motion
   C. Basic differential and integral calculus to derive and apply equations of Newtonian Mechanics
   D. Newton’s Three Laws of Motion and the Universal Law of Gravitation
   E. Systems in static, translational, and rotational equilibrium.
   F. Relate and differentiate between of mass and weight.
   G. The Work-Energy Theorem and the Law of Conservation of Mechanical Energy (for both conservative and non-conservative systems)
   H. Momentum, impulse, and center of mass, and the Law of Conservation of Momentum in physical systems.
   I. Systems in circular motion and rotational motion
   J. Kepler’s Laws of Planetary Motion.
   K. Cite and create models that explain systems in both linear and rotational motion
   L. Systems in oscillatory motion.

Course Schedule

Term	Unit	Duration	Topic
Q1	Introduction and Pre-Assessment	5 Blocks	Math Review and Expected Outcomes (Calculus)
			Review of Concepts from Physics 1 (Major Concepts per Unit)
			Force Concept Inventory as Pre-Assessment/Review FCI
	Kinematics in One Dimension	9 Blocks	Frame of Reference, Position, and Displacement
			Position, Displacement, Speed, & Velocity (Calculus)
			"Galileo's Inclines:" Inquiry Lab
			Uniformly Accelerated Motion (UAM) with Applictaions
			Freely Falling Bodies: "Freefall Baseball" Lab
			Velocity and Acceleration Data (Bowling Ball Lab) : Graphical Analysis using Microsoft Excel®—Slope and Area Under a Curve (Calculus)
			TEST 1 and Review
	Kinematics in Two Dimensions: Vectors and Projectiles	7 Blocks	Scalars and Vectors
			Vector Addition and Subtraction: Graphical and by Components
			Displacement, Velocity, and Acceleration in 2-D
			Equations of Kinematics for UAM in 2-D
			Projectile Motion
			Projectile Motion ("Target Placement" Inquiry Lab)
			TEST 2 and Review
Q2	Newton's Laws of Motion	12 Blocks	Newton's Laws of Motion
			The Vector Nature of Newton's Second Law: Free Body Diagrams
			Vector Representation of Equilibrium Conditions: Inquiry Lab
			Atwood's Machine: Lab
			Normal Force and Tension
			Normal Force and Tension in an Accelerating Elevator: Lab
			Static and Kinetic Frictional Forces
			Equilibrium and Non-equilibrium Applications of Newton's Laws
			Determining Coefficients of Static and Kinetic Friction: Inquiry Lab
			TEST 3 and Review
	Uniform Circular Motion	9 Blocks	Uniform Circular Motion: Centripital Acceleration/Centripetal Force
			Banked Curves and Conical Pendulums
			Conical Pendulum Lab
			Vertical Circular Motion
	Gravitation		Kepler's Laws
			Newton's Law of Universal Gravitation
			Satellites & Circular Orbits
			Determining the Mass of Jupiter: Analysis of Astronomical Data (Inquiry Activity)
			TEST 4 and Review

Term	Unit	Duration	Topic
Q3	Rotation	9 Blocks	Rotational Kinematics: Comparing Angular vs. Tangential/Translational Variables
			Determining Moment of Inertia for an Unknown Object: Inquiry Lab
			Forces and Torques on Rigid Bodies: Newton's Laws Revisited
			Evaluating Equilibrium Conditions for Pulleys with Varying Radii: Lab
			Angular Momentum
			TEST 5 and Review
	Work, Energy, and Power	12 Blocks	Work Done by a Constant Force
			The Work–Energy Theorem and Kinetic Energy
			Work Done by a non-Parallel Force: Lab
			Gravitational Potential Energy
			Conservation of Mechanical Energy: Conservative vs. Nonconservative Forces
			Nonconservative Forces and the Work–Energy Theorem
			Work Done by Air Resistance: Coffee Filter Lab
			Power (Calculus)
			"Snacks on the Steps:" Food, Energy, & Power Inquiry Lab
			Hooke's Law, Elastic Potential Energy, Work Done By a Variable Force (Calculus)
			TEST 6 and Review
Q4	Systems of Particles: Center of Mass, Impulse, and Momentum	6 Blocks	Systems of Particles and Center of Mass
			Finding Center of Gravity for an Irregularly Shaped Object: Inquiry Lab
			The Impulse–Momentum Theorem
			Conservation of Linear Momentum
			Collisions in One and Two Dimensions
			Combining Conservation of Energy and Conservation of Momentum: Ballistic Pendulum Lab
			TEST 7 and Review
	Oscillations	6 Blocks	Simple Harmonic Motion (SHM) & the Reference Circle
			Energy & SHM
			What Variables Affect the Period of a Pendulum?: Inquiry Lab
			The Pendulum
			Inquiry Lab Extension: Finding Local Values of "g" Using the Period of a Pendulum
			TEST 8 and Review
	Practice Tests & Review	4 Blocks	Practice Test 1 and Review
			Practice Test 2 and Review
	AP Physics C Exam		
	Post-Exam	5 Blocks	Post Exam Lab Design Projects
			Post Exam Problem-Based Unit
			Course Evaluation