Physics C: Mechanics Syllabus

Overview of Course

Class Meeting Time: Four 45 minutes periods and one 90 minute period per week.

Physics C: Mechanics is taught as the first half of a second year physics course. Students in the class have previously completed a year of algebra-based physics with a comprehensive hands-on laboratory component. Students are required to have completed or be concurrently taking a calculus course. The extended period is normally used for a laboratory experiment which consists of a mathematical challenge that requires the derivation of a function for a given variable followed by a student-designed experiment to evaluate the variable or function. Students complete a lab report for each experiment that stresses scientific conclusions and validity of results. Exams in the course are designed along the lines of the free response section of the AP exam. Quiz grades are based on in class multiple choice quizzes based on the AP exam (no calculators or equation sheets allowed). Quizzes are given during weeks in which there is no exam. Students are additionally expected to complete an assigned set of homework problems for each quiz or exam. Selected students will present their solutions for assigned problems to the class each week, with extra credit being awarded based on the presentations.

Text

Serway, Raymond A., and John W. Jewett. Physics for Scientists and Engineers. 8th ed. Belmont, CA. Brooks/Cole, 2010.

Grading

Exams	60%
Labs	20%
Quizzes	20%

Course Structure

The Physics C: Mechanics course is taught with the understanding that many students are just beginning the study of calculus as the year starts. For that reason the more calculus intensive mechanics topics are reserved for the end of the course. This also allows the students to firmly establish a basic understanding of major concepts before revisiting them at the end of the course and allows them to develop appropriate math skills before tackling these topics. Additionally as the Physics C: Mechanics course shares laboratory space with a Physics B course and a first year physics course this course structure allows for the lab experiments in the courses that use the same equipment to be conducted at the same time.

Instructional Approach

The instructional approach of the Physics C: Mechanics course is to provide students with many opportunities to discover basic concepts on their own. Typically when a new topic is to be introduced the students are first allowed to explore the topic through a “Quick Lab” or computer simulation that will allow the students to determine the relationships between the variables involved in the concept. The students then discuss their findings as a group before the teacher begins a presentation on the topic. Connections between the students’ findings and the accepted physics of the topic will be made during the presentation and an analysis of the equations governing the topic will be made to see if the students’ findings follow the presented equations. Additionally, many of the labs are timed to occur before the main concept of the experiment is covered in the class. This forces students to apply knowledge of similar situations to the new concept and create their own approach to the problem, rather than simply doing it the way it is presented in the textbook.

Course Outline

Exam 1: Linear Motion and Newton's Laws (12 instructional periods)

Assigned Readings:
- Ch 2 Sections 1 – 8
- Ch 4 Section 6
- Ch 5 Sections 1 – 8

Three equations of linear motion
Frames of reference
Relative motion
Graphs of linear motion
Derivative and integral for polynomials
Newton's Three Laws of Motion
Free body diagrams
Friction

Exam 2: Projectiles, Circular Motion and Energy (12 instructional periods)

Assigned Readings:
- Ch 3 Sections 1 – 4
- Ch 4 Sections 1 – 5
- Ch 6 Sections 1 – 3
- Ch 7 Sections 1 – 9
- Ch 8 Sections 1 – 3, 5

Vectors
Vector math
Motion in two dimensions: Projectiles
Rotational kinematics
Work, energy and power
Conservation of energy
Conservative forces
Work – Energy Theorem
Energy diagrams

Exam 3: Momentum and Rotational Dynamics (15 instructional periods)

Assigned Readings:
- Ch 9 Sections 1 – 6
- Ch 10 Sections 1 – 4, 6, 8 – 9
- Ch 11 Sections 1 – 5

Momentum and collisions
Center of Mass
Rotational energy
Torque
Non-uniform circular motion
Moments of Inertia
Rolling motion
Angular momentum

Exam 4: Statics, SHM, and Gravitation (15 instructional periods)

Assigned Readings:
- Ch 12 Sections 1 – 4
- Ch 15 Sections 1 – 7
- Ch 13 Sections 1 – 5

Rotational equilibrium
Pendulum motion
Mass and spring motion
Simple harmonic motion and energy
Equations of simple harmonic motion
Law of Gravitation
Kepler's Laws
Gravitational field and potential energy

Exam 5: Extended Topics (15 instructional periods)

Assigned Readings:
- Ch 6 Section 4
- Ch 8 Section 4
- Ch 9 Section 7 – 9
- Ch 10 Sections 5, 7
- Ch 13 Section 6

Projectiles with Calculus
Differential Equations and F=ma
Drag
Work and Energy with Calculus
Center of mass through integration
Center of Gravity
Moment of Inertia through integration
Parallel Axis Theorem
Rolling with slipping
SHM and differential equations
Gravitation with extended bodies
Kepler’s Laws and energy

Review and Final Exam (5 instructional periods)

Labs

Labs are categorized as follows:
Hands-on − Students perform an experiment using physical apparatus. All hands-on experiments are open ended where students are provided with an objective and equipment but are left to devise an appropriate experimental procedure.
Numerical − Students are provided data and equations and are asked to reach a conclusion based on a numerical analysis
Demo − Students use data from an experiment performed by the teacher

Laboratory Experiment	Exam	Type	Time Required
Experiment 1 – Numerical Analysis Introduction to graphing and curve fitting	1	Numerical	45 minutes
Experiment 2 – Relative Motion Using relative motion to find a solution that allows two cars to arrive at the same spot simultaneously	1	Hands-on	90 minutes
Experiment 3 – Inclined Motion The motion of a block sliding down a ramp is used to find the coefficient of kinetic friction	1	Hands-on	90 minutes
Experiment 4 – Projectile Motion Video analysis of projectiles is used to verify the range and maximum height equations students derive	2	Hands-on	90 minutes
Experiment 5 – Rolling Motion The energy of a ball rolling down a ramp is investigated	2	Hands-on	90 minutes
Experiment 6 – Ballistic Pendulum Calculating the speed of a “bullet” using momentum and energy	3	Demo	90 minutes
Experiment 7 – Moment of Inertia The moment of inertia of an object is calculated using rotational dynamics	3	Hands-on	90 minutes
Experiment 8 – Atwood Machine The effect of mass ratio and mass differential on the motion of an Atwood Machine	3	Hands-on	90 minutes
Experiment 9 – Statics The rotational equilibrium of a “bridge” is analyzed	4	Hands-on	90 minutes
Experiment 10 – Kepler's Laws Astronomical information is used to confirm Kepler’s Third Law using a linear graph	4	Numerical	45 minutes
Experiment 11 – Force Constant The force constant of a spring is measured using Hooke’s Law and SHM The restoring force of an elastic band is measured and graphed	4	Hands-on	90 minutes
Experiment 12 – Drag Falling coffee filters are used to examine the effect of drag on a falling object	5	Hands-on	90 minutes
Experiment 13 – SHM with differentials The motion of a physical pendulum is analyzed	5	Hands-on	90 minutes