PHYSICS AP C MECHANICS COURSE OUTLINE

Textbook: Tipler, Physics for Scientists and Engineers 4th edition

Course description

Our Physics C course is a two semester course covering mechanics in the first semester and electricity and magnetism in the second semester. The course is designed to be equivalent to a two semester physics sequence for college students majoring in engineering and physical science.

The prerequisites for the course are Physics I and concurrent enrollment in Calculus I.

Grades are determined according to the following:
Exams: 60%
Homework 10%
Labs 30%

The course includes a laboratory component comparable to a semester long, college level physics laboratory. Each student is required to write up lab reports and maintain a lab notebook. All the labs are hands on, open ended and student designed. The primary goal of these labs is to develop independent thinking and problem solving skills. Students spend 30% of class time doing labs. In all of our physics labs students will:

• design experiments;
• observe and measure real phenomena;
• organize, display, and critically analyze data;
• analyze sources of error and determine uncertainties in measurement;
• draw inferences from observations and data; and
• communicate results, including suggested ways to improve experiments and proposed questions for further study.

Graphical Analysis programs are used extensively for data analysis such as linear regression (including correlation coefficients), curve fitting and equation modeling.

In addition, students are taught how to estimate errors during labs, how to report errors, how to do calculations with errors and the difference between systematic and random errors.

This course utilizes a wide variety of instructional methods including guided inquiry and student centered learning to foster the development of critical thinking skills. We promote cooperative learning, authentic instruction and active learning, not only for their instructional benefits, but also for their ability to put students at the center of their own learning.

Some examples include:

- Socratic dialog
- Peer tutoring
- Interactive online java applets
- Extensive student use of the Interactive Physics computer program
- Student construction projects (water powered rockets, catapults, mousetrap powered cars, harmonographs, toothpick bridges, rube goldberg machines)

Semester 1: Mechanics

week	topic	reading	Labs
1	1 d motion Constant acceleration Equations of motion	Chapter 2 Sections 1,2,3	Measuring acceleration of cart on inclined plane Measuring acceleration of a cart/pulley/mass system using a smart pulley
2	Free fall Motion graphs Derivatives and integrals	Chapter 2 Sections 3,4	Determining the value of "g" Using a motion detector to graph motion Graph matching using a motion detector
3	vectors Notation Addition, subtraction Polar to rectangular conversion	Chapter 3 Sections 1,2	Force table lab
4	2 d motion, projectiles Position, velocity vectors Relative velocity	Sections 3,4	Determining the initial velocity of a projectile Projectile motion using an air table

5	Newton's laws Free body diagrams Inertia F=ma Action reaction pairs Mass and weight	Chapter 4	Hooke's law lab Determine unknown mass using dynamics carts, pulley and motion detector
6	Newton's laws Statics Friction Circular motion Banked curves Resistive forces	Chapter 5	Using force sensors to determine mu Forces on booms and cranes Ball and string to investigate centripetal force
7	work and energy, dot products Work energy theorem	Chapter 6 Sections 1,2,3,4	Determine work done by gravity using force sensors and motion detectors. power Forceposition graphs Integrals and areas Area under a force vs. position graph using a graphical analysis program
8	potential energy, conservative force fields, Springs	Section 5	Conservation of energy using inclined plane and dynamics carts
9	conservation of energy Mechanical and potential energy Nonconservative forces	Chapter 7 sections 1,2,3	Determining drag forces using falling coffee filters and motion detectors

10	momentum, particle systems, center of mass Impulse Force – time graphs	Chapter 8 Sections 1,2,3	
11	conservation of momentum Collisions Elastic inelastic	Chapter 8 Section 4	Conservation of momentum using dynamic carts 2d conservation of momentum using pucks on an air table with spark timer
12	rotation, angular quantities, cross products rotational kinematics Rotational dynamics Torque moment of inertia	Chapter 9 Section 1,2,3	
13	Calculation moment of inertia Parallel axis theorem Energy Rolling motion	Sections 4,5,6,7,8	Moment of inertial of different objects rolling down inclined planes
14	Angular representation using vectors Angular momentum Conservation of angular momentum	Chapter 10	Conservation of angular momentum using a turntable
15	gravitation, Kepler's laws	Chapter 11 Sections 1,2	Investigating Kepler's 3rd law using Interactive Physics
16	gravitational fields,	Sections 3,4	

	potential energy		
17	simple harmonic motion Mass spring systems Simple pendulums Compared to uniform circular motion	Chapter 14 Sections 1,2,3	Motion graphs of oscillating massspring using a motion detector Determining the value of "g" using a simple pendulum
18	finals		

Details On Labs

Measuring acceleration of cart on inclined plane Students are given a meter stick, and a stopwatch and asked to determine the acceleration of a ball rolling down a ramp made from an 8 foot long 4 x 6 board.
Determining the value of "g" Students use a pasco ball drop thingy and science workshop program to measure drop times for balls falling from different heights. Then they use distance and time data to determine "g".
Using a motion detector to graph motion Students use a pasco motion detector and science workshop to collect data from a glider moving on an air track. Then they are asked to play around with the program to generate x, v and a vs. t graphs.
Force table lab Students are given a pasco force table with 2 known masses suspended from the table. Students must calculate where to place a 3rd mass and how big it should be to balance the 1st 2 masses. Then they are given the mass they calculated to see if it actually works.
Determining the initial velocity of a projectile Students are given a spring loaded dart gun and a meter stick and asked to determine the initial velocity of the dart by any means.
Projectile motion using an air table

Students use the trace of dots produced by a puck launched on an inclined air table to determine the acceleration of the puck. A spark generator and carbon paper are used to generate the trace.
Hooke's law lab Students are given a spring, ruler and mass set and asked to determine the spring constant.
Determine unknown mass using dynamics carts, pulley and motion detector Students use a string running from a cart of unknown mass, over a pulley and finally attached to a known mass. Students use a pasco motion detector and science workshop to determine the acceleration of the cart. Then they write a couple of equations (net force = ma) in 2 unknowns to solve for the mass of the cart.
Using force sensors to determine mu Students use a pasco force sensor and science workshop. By measuring the force required to drag a block across a level surface, students can determine mu for the block and surface. Different surfaces and block materials are used to compare mu for different pairs of materials.
Ball and string to investigate centripetal force Students use a whirligig to confirm f = mv^2/r for a stopper swinging around on the end of a string.
Determine work done by gravity using force sensors and motion detectors. Students lift a mass at constant speed and record force required to lift and position using a pasco force sensor and motion detector. Then they can generate a force vs. position graph to confirm that area under the graph is the work done lifting the mass.
Conservation of energy using inclined plane and dynamics carts Students use a pasco motion detector and science workshop to confirm mgh=1/2mv^2.
Determining drag forces using falling coffee filters and motion detectors Students use a motion detector to generate a velocity vs. time graph for a falling coffee filter. The graphing program can then generate an equation model to confirm V = mg/k(1e^ bt/m)
Conservation of momentum using air track gliders

Students use pasco photogates and science workshop to measure initial and final velocities of carts of varying mass undergoing elastic and perfectly inelastic collisions. Total final and initial momentums are compared.
Moment of inertia of different objects rolling down inclined planes Students roll cylinders, rings and balls (solid and hollow) of various size and mass to confirm only shape is related to the accelerations of the rolling objects.
Conservation of angular momentum using a turntable Students use Pasco Angular Momentum Apparatus to investigate angular momentum.
Investigating Kepler's 3rd law using Interactive Physics Students use interactive physics to create a solar system and investigate relationships between period and orbit. By plotting T^2 vs. R^3 they come up with a constant that is valid for every "planet" in the system.
Motion graphs of oscillating mass spring system using a motion detector Students use a pasco motion detector to plot x, v and a for a vertical mass/spring system. Then they can use the program to generate equations of the graphs. Then they can confirm that v and a equations are derivatives of the first equation.
Determining the value of "g" using a simple pendulum Students use a ruler, and stopwatch to measure the length and period of a mass on the end of a string. The they use T = 2(pi)(l/g)^1/2 to solve for g.