Course Syllabus: AP Physics

Text: Physics, Giancoli; Sixth Edition, Pearson, PrenticeHall, 2005

Class meets for six 56 minute periods in a six day cycle (one double period lab day, one day off).
Normal planning period is the sixday cycle.
Focus is on problem solving, data gathering and analysis.

Unit 1 Measurement and data collection (6 days)
1. Units of measure
2. Measuring tools and accuracy (uncertainty)
3. Using sensors, calculators and computers to gather and analyze data (CBL and LabPro)

Unit 2 Motion in one dimension (4 days)
1. Graphical description of motion
2. Interpreting displacement/time and velocity/time graphs
3. Equations of motion with constant acceleration

Students use the corridor or the track to record motion of their peers. They attempt to model motion with constant velocity or constant acceleration.

Unit 3 Motion in two dimensions: vectors (8 days)
1. What are vectors?
2. Components of a vector
3. Sum/difference and multiples of vectors
4. Vectors on a surface
5. Projectile motion analyzed with components and equations of motion.

Students use a force board and spring balances to achieve equilibrium and confirm that the vector sum is zero.
Students are given distances and bearings to reach a specific location outside school. Students develop the range equation, and then attempt to launch projectiles that will land in the same place from different launch angles

Unit 4 Newton's Laws of Motion (15 days)
1. What is Mass?
2. Net force and motion
3. Gravitational force and weight
4. Frictional forces and their effect on motion
5. Free body diagrams: Atwood machines and inclined planes
6. Equilibrium: Balanced forces and torques
7. The centripetal force vector and circular motion

8. Orbits and Kepler's laws
9. Equilibrium and Torque
Students will use smart pulleys to determine that $\Sigma F = ma$
Students will determine coefficients of friction using a ramp or by pulling objects across a surface using a known force.
Students will determine the relationship between velocity of an object in circular motion and the centripetal force required to keep the object in circular motion

Unit 5 Work, Energy and Momentum (12 days)
1. Definition of work
2. Analyzing Force/distance diagrams for constant or nonconstant force
3. Potential and Kinetic energy: changing back and forth
4. Conservation of Energy and energy losses to friction
5. Power
6. Force and momentum and Impulse
7. Momentum is a vector! Conservation of momentum.
8. Elastic and Inelastic collisions in one and two dimensions
Students will use slotcar roller coaster to show change of energy from potential to kinetic and vice versa; also will show how energy is lost to friction.
Students will measure their own power output by lifting weights, running up stairs or riding a bike on the track.
Students will use the air track to analyze collision in one dimension: use the air table to analyze collisions in two dimensions. Some collisions will be almost elastic (pucks) or inelastic (stuck together with Velcro)

Unit 6 Rotational motion (10 days)
1. Comparison of linear and angular descriptions of motion (Units)
2. Angular momentum and rotational kinetic energy
3. F = ma and $T=I\alpha$ 4. Problem solving with velocity/time graphs.
5. Rotational inertia and the factors that affect it.
Students will show how rotational inertia is affected by shape (lazy susan and weights: we have many skaters here, and they can control their rate of spin to an amazing degree. The rest of us fall off when we spin too fast)
Students have the coffee can race where they try to achieve the highest or lowest rotational inertia with a given amount of mass. The school has ramped corridors for this purpose.

Unit 7 Fluids, Pressure and Buoyancy (12 days)
1. Comparison of pressure units
2. Density and pressure
3. Floating and sinking: Apparent weight
4. Fluids in motion: Bernoulli's equations and the relationship with KE and PE
5. Viscosity and Surface Tension
Students will use manometer to determine relative densities.
Students will use pressure apparatus and weights to find pressure in units of

newtons/m*m
Students will use Archimedes' principle to determine unknown densities (Eureka!)
Students will observe differences in pressure in moving liquid using a venturi tube

Unit 8 Simple Harmonic Motion, Waves and Sound (15 days)
1. Circular motion model of Simple Harmonic Motion
2. Velocity, period and energy of oscillator
3. Simple pendulum and Physical pendulum
4. Springs and SHM
5. Longitudinal and Transverse waves
6. Constructive and Destructive interference
7. Resonance and energy transmission
8. Sound as pressure wave
9. Representing sound as sinusoidal wave
10. Intensity of sound: decibels
11. Waves on strings and vibrating air columns: harmonics
12. Superposition and beats
13. Doppler Effect

Students will use a wheel to show how circular motion is used to model SHM
Students will use meter sticks and other common objects as physical pendulums to find center of oscillation.
Students will use combinations of springs to determine rules for SHM
Students will use sabre saw to set up standing waves on a string and determine velocity of the wave on the string.
Musical instruments (string or air) will be used to determine speed of sound in air, using CBL microphone to determine frequency.

Unit 9 Temperature, Heat and Thermodynamics (18 days)
1. Temperature scales
2. Gas laws
3. Temperature as KE of molecules: Avogadro's number
4. Changes of phase at specific temp and pressure
5. Gain and loss of energy (heat)
6. Specific heat and heat exchange
7. Calorimetry including changes of phase
8. First Law of Thermodynamics
9. Second Law of Thermodynamics
10. Heat engines (refrigerators, etc)
11. Entropy

Students will keep track of heat loss/gain with calorimetry
Students will use calorimetry to find specific heat of metal objects
Students will determine PV now = PV later, if temp is constant, using balloons and the CBL pressure sensor

Unit 10 Electrostatics (8 days)
1. Conservation of Charge
2. Sources of charge in the atom
3. Induced charges
4. Coulomb's Law: forces and vectors
5. Electric Fields
6. Potential Difference
7. Equipotential lines in a field
8. Potential from a point charge
9. Electrons volts as energy
10. Capacitance, dielectrics and energy storage

Students will follow induced charges using electroscopes
Students will map electric fields using small compasses
Students will make capacitors and show the effects of different dielectrics

Unit 11 Currents and Circuits (12 days)
1. Ohm's Law
2. Power and currents
3. DC and AC and generators: batteries
4. Resistors in series and parallel
5. Kirchoff's Rules and circuits
6. Capacitors in series and parallel
7. Simple RC circuits

Students will set up simple circuits and use voltmeters and ammeters to track Ohm's law around series and parallel sections of a circuit
Students will see change in voltage in the charge discharge cycle of circuit using Oscilloscope

Unit 12: Magnetism and Induction (6 days)
1. Magnetic fields and electric currents
2. Forces and directions in magnetic fields: right hand rules
3. Force on a current and force on a moving charge
4. Faraday's Law and Lenz's Law
5. Magnetic flux

Students will note the change in orientation of magnetic field when current is reversed in a wire.
Students will observe the application of Lenz's Law when dropping a neodymium magnet through a copper pipe

Unit 13 Electromagnetic waves: Light (15 days)
1. Propagation of Electromagnetic waves
2. Speed of Light
3. Straight line model of light movement (ray model)
4. Ray tracing with flat mirrors
5. Ray tracing with circular or spherical mirrors
6. Electromagnetic Spectrum

7. Refraction and Snell's Law: Internal reflection
8. Refraction and lenses
9. Wave nature of light
10. Single slit diffraction
11. Diffraction grating
12. Thin film interference: soap bubbles, oil slicks and coatings of lenses
13. Polarization of light: Brewster's angle
14. Lenses and mirrors in optical instruments and eyes

Students will trace rays (laser) to find image formed with flat and curved mirrors.
Students will find focus of a curved mirror.
Students will trace rays to find index of refraction and critical angle for water/air boundary, water/glass boundary and glass/air boundary
Students will use diffraction gratings with known distance between openings to determine wavelength of light emitted by gas tubes or filaments.
Students will then use those wavelengths to determine the spacing of openings on an unknown grating
Students will observe the affect of polarizers and use them to determine Brewster's angle

Unit 14 Relativity and Quantum Theory (12 days)

1. Galileo's and Newton's versions of Relativity
2. Einstein's Special Theory
3. Consequences of the special theory (time, length and mass)
4. $E = mc^2$
5. Quantized energy
6. Light as wave/particle
7. Photoelectric effect
8. Diffraction and Bright line spectra

Lab activities and reports:

Some labs are cookbook variety designed to increase student's knowledge of equipmentor experimental techniques (especially error). Others are problem based and solutions are open ended.
A few activities are repeated, used once as cookbook, and repeated at a later time when the theory has been presented and the activity has greater meaning.
4 lab reports per quarter are turned in and evaluated.

All students are required to have a project that involves construction and measurement. Students borrow equipment for measurements and as parts for their constructions. Two progress reports are required as projects evolve.

1. Period of Simple Harmonic Oscillator (timing and using CBL or LabPro)
2. Using inclined plane to determine g (using motion detector)
3. Using smart pulley to determine acceleration (and thereby g)

4. Determine coefficient of friction on an inclined plane (static and kinetic)
5. Match motion to displacement time and velocity time graphs
6. Verify that F = ma
7. Using accelerometer to measure straightline and centripetal acceleration
8. Conservation of momentum on the air track
9. Conservation of momentum in two dimension (air table or ball bearing pucks)
10. Balancing torques (find weight of the mystery fish!)
11. Conserving angular momentum with changing rotational inertia
12. Using buoyancy to determine density
13. Using manometers to determine differences in pressure in pipes of different diameters (assuming constant flow)
14. Using strings and pipes to determine speed of sound
15. Determine the coefficient of linear expansion
16. Determine rotational inertia of a physical pendulum
17. Mapping an electric field
18. Setting up simple circuits, using voltmeter, ammeter as needed
19. Using laser to measure spacing on diffraction grating.
20. Using calibrated grating to determine wavelengths of visible light (sources could be gas tubes or incandescent bulbs with clear glass and long filaments)
21. Forming images with mirrors and lenses
22. Using laser to find focal points of mirrors and lenses