ADVANCED PLACEMENT PHYSICS B   2007-2008

OVERVIEW

All students in this class are seniors who have had a previous physics course emphasizing classical mechanics and additional topics based on instructor preference. This class meets every day on an alternating schedule, 85 minutes one day, 40 minutes the next. Labs are reserved for long periods, and may carry over into the next period. Other than labs, class time is typically spent in interactive lecture-discussions, homework presentations, tests, and quizzes. All students are required to take the AP Physics B exam.

The method of instruction is guided inquiry, influenced by the Modeling Method of High School Physics Instruction (Arizona State University). Students are led to see concepts as models with multiple representations: graphical, mathematical, and verbal.

Homework problems are assigned from the text, the University of Texas Homework Service, and past AP papers. The course is designed to encourage students to apply concepts to the problems, rather than algorithms. Daily homework directly addresses concepts discussed in class. Example problems are not worked in class in advance of the homework assignment. All students are expected to attempt all problems and a few students are chosen to present their solutions to the class on whiteboards. The class discusses whether the approach is reasonable, whether the correct model has been applied, and if the calculations are correct. The goal is to make all students think analytically about the nature of the problem, including the content and the solution process. The due dates on the online University of Texas Homework are set for the day after the class discussion of the homework. This allows students the chance to benefit from the class discussion and rework problems they had trouble with initially.

There are frequent quizzes, many designed to assess whether students understand the concepts in the homework from the night before. This provides a reason to not procrastinate in completing the online homework, and encourages students to be concerned with understanding the problems, rather than just completing the assignment.

There are fourteen units based on the AP Physics B course description. Units average 12 class days to complete. A test constructed from past AP papers concludes every unit. Students work the multiple-choice section without calculator or equation sheet. In due time, students are provided solutions to all quiz and test problems.

Text: *Physics: Principles with Applications* (5th Revised Edition) by Douglas C. Giancoli, 1997

COURSE OUTLINE

First Semester	Second Semester
Unit 1, Tools Review of vectors, experimental methods, data analysis, and uncertainty **Unit 2, Kinematics** 1 dimensional kinematics with constant acceleration, and projectile motion, graphical, verbal, mathematical representations **Unit 3, Force** Systems, Newton's laws, friction and drag, torque and rotational statics, uniform circular motion, universal gravitation, and orbits **Unit 4, Energy** Conservation of energy, work, power, oscillating systems (dynamics and energy relationships) **Unit 5, Momentum** Impulse, conservation of linear momentum, collisions (1-d, 2-d) **Unit 6, Mechanical waves and Sound** Wave pulses, traveling waves, standing waves on a string and in an open or closed pipe, reflection, refraction, interference, and diffraction **Unit 7, Fluids** Pressure, buoyancy, continuity, Pascal's principle, Bernoulli's principle	**Unit 8, Electrostatics** Charge, field, potential, Coulomb's law, capacitors, conductors **Unit 9, Current Electricity** Conductors, current, resistance, power, Ohm's law, circuits, Kirchhoff's rules, RC circuits with capacitors, terminal voltage **Unit 10, Magnetism** Magnetic fields, forces on charges in magnetic fields, forces on wires in magnetic fields, fields of long wires, induction, Faraday's and Lenz's laws **Unit 11, Thermodynamics** Kinetic model of matter, temperature and Zeroth law, heat transfer and mechanical equivalent, thermal expansion, ideal gases, First Law, P-V diagrams and thermodynamic processes, Second Law and engines, efficiency **Unit 12, Physical Optics** Wave model of light, interference, diffraction, and dispersion of light. **Unit 13, Geometric Optics** Ray approximation, refraction, Snell's law, reflection, plane and curved mirrors, thin lenses **Unit 14, Atomic and Nuclear Physics** Planck's hypothesis and early quantum theory, photons & photoelectric effect, Compton effect, Davisson-Germer experiment, de Broglie wavelength, atomic energy levels, wave-particle duality, nuclear reactions

LABS

Many units begin with a laboratory investigation preceding any other instruction. The subject of the lab is designed to introduce one or more concepts important in the unit. These labs begin with a demonstration for the students to discuss. In the discussion they are prompted to brainstorm variables that might be reasonably presumed to govern the behavior of the apparatus. They then design and conduct an investigation to find relationships between the variables. A class discussion follows in which the class describes a model for the behavior observed. Afterwards the model becomes explanatory, and can be invoked in explaining concepts and solving problems.

For example, the Fluids unit begins with an inquiry lab in which students measure the force on an object as it is lowered into a container of water and becomes submerged. This leads them to Archimedes' principle and becomes a basis for hydrostatics. Later, students complete a lab in which they cause a plastic hose to move in circles at various constant speeds while monitoring the pressure inside the hose. This provides a basis for the introduction of Bernoulli's principle.

Some labs are presented as open-ended lab problems. For example, in the Kinematics unit, students are given graphs or descriptions of motion and must manipulate a set of materials to reproduce the graph or description with a motion detector or video analysis.

All labs require written work. Students are required to keep a binder or notebook with all of their completed, graded labs in it. Some labs consist of a challenging lab problem and don't lend themselves to a traditional lab report. For these, students submit a narrative (with sketches and calculations, where appropriate) of their attempts to solve the problem, and an analysis of their success.

Class time for labs is allotted only for pre-lab discussion, data collection, and class discussion of results. Students who fail to complete data collection during class must make arrangements to complete it during lunch, a free block, or break. Students must complete data analysis, answers to questions, and report writing outside of class. Labs account for 25% of the grade in the class.

All students are required to have a laptop computer. The school has a large number of Vernier LabPro computer interfaces and a good selection of probes. Virtual labs use simulations by the University of Colorado's Physics Education Technology (PhET) project (http://phet.colorado.edu).

LABS BY UNIT

First Semester	Second Semester
Unit 1, Tools 1. Coupled oscillators - Students use computer or video data collection to find models for the behavior of coupled oscillators. **Unit 2, Kinematics** 2. Describing motion - Students use motion detectors or video analysis to collect graphs mimicking given graphs. 3. Galileo's experiment – Students find the value of *g* on an incline. **Unit 3, Force** 4. Atwood machine – Students derive Newton's second law using an Atwood machine. 5. Friction and drag – Students come up with original ways to determine the coefficient of friction of a toy car and investigate drag on falling coffee filters using computer data collection. **Unit 4, Energy** 6. Elastic energy lab – Students compare the energy stored in an elastic band to the kinetic energy of the cart it accelerates. 7. Energy in the simple harmonic oscillator – Students examine conservation of energy in an oscillating mass on a spring. **Unit 5, Momentum** 8. Bungee jumper lab – Students devise a method to minimize the maximum force experienced by a "bungee-jumping" doll. 9. Momentum – Students determine the value of an unknown mass by colliding carts and measuring changes in their velocity. **Unit 6, Mechanical waves and Sound** 10. Wave observations – Students observe the behavior of wave pulses in stretched slinky springs, and measure the characteristics of standing waves. 11. Virtual Ripple Tank - Students measure wave diffraction and interference in the PhET ripple tank simulation. **Unit 7, Fluids** 12. Archimedes' Principle - Students plot force versus depth using a force sensor as an object is submerged. 13. Bernoulli's Principle – Students plot speed versus internal pressure as a plastic hose is slung in a horizontal circle.	**Unit 8, Electrostatics** 14. Coulomb's Law – Students estimate the number of excess electrons on a piece of tape repelled by an electric charge. 15. Capacitor Challenge – Students are challenged to design and build a capacitor that will store the greatest amount of charge using household materials. 16. Surfing an E-field - Students measure and plot the voltage field around charged objects in a pan of water. They relate the potential to E-field and energy. **Unit 9, Current Electricity** 17. RC circuits – Students collect charging and discharging curves for an RC circuit. 18. DC Circuits – Students are challenged to produce circuits with the given characteristics. **Unit 10, Magnetism** 19. Motor, generator, speaker - Students are challenged to build a motor, a generator, and a speaker out of household materials. **Unit 11, Thermodynamics** 20. Virtual Gas Laws – Students use the PhET Gas Properties simulation to model thermodynamic processes. **Unit 12, Physical Optics** 21. Diffraction grating – Students attempt to determine the wavelength of a pen laser using a diffraction grating. **Unit 13, Geometric Optics** 22. Geometric Optics – Students observe refraction and reflection with mirrors, slabs, and thin lenses and draw ray diagrams to explain their observations. **Unit 14, Atomic and Nuclear Physics** 23. Virtual Photoelectric effect – Students derive the equation for the photoelectric effect from the PhET Photoelectric effect simulation.