Topic	Associated Labs and Projects	Evidence
• AP Physics B Course Syllabus		
• Course Title		
• AP Physics B		
• School		
• Alternating 100 minute block schedule with odds/evens		
• labs occur as needed		
• On lab days please adhere to safety standards for lab dress; i.e., no open-toed shoes, baggy jackets, long hair not restrained		
• Textbook		
• College Physics, 7th edition, by Serway and Faughn. 2006. (Thompson Brooks/Cole, Belmont, CA.) ISBN 0-534-99723-6		An appropriate textbook is used.
• Recommended Supplies		
• Three-ring binder		
• Scientific or graphing calculator		
• Access to a personal computer/internet		
• Lab notebook (composition-book style, permanently bound)		
• ruler, compass, pencil, colored pencils		
• Web Sites		
• www.espaceacademy.com		
• www.astronomyteacher.com		
• homepage.mac.com—apphysics		
• Grading		
• Grades are cumulative throughout the semester. Category weights are not used, only point values. You should expect that grades in each category will work out approximately as follows.		
• Approximate category weights		
• Homework		
• Practice/Attempts - only check to see if problems are started 20%		
• Credit - work will be corrected with comments 20%		
• Labs - Requiring the collection and analysis of data by hand - 20%		
• Projects - Applying rules of physics and requiring evidence - 20%		
• Exams - 20%		
• Final - 20%		
• Point values		
• Practice/Attempts problems - 1 point per problem		
• Credit Problems - 3 points per problem		
• Projects - 30 points each		
• Labs - 30 points each		
• Exams - 70-100 points each, multiple choice and open response, AP-style exams		
• Final Exams 75 questions, 2 points each, multiple-choice only, traditional style		
• Special Assignments		
• Summer homework		Laboratory Evidence 3: Students can Analyze Data
• Students must read the web page on equation analysis at homepage.mac.com/astronomyteacher/grapheq.html. During summer break please analyze every equation on the AP Physics B equation list, and show the following:	See description of summer homework at left	
• identify the variables		
• state every possible logical relationship (i.e., the relationship between F and m in Newton's second law is direct)		

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• ignore constants and fractions		
• sketch the graph of each relationship on labeled axes without values		
• state the name of the equation and describe what it means in English		
• one page per equation		
• Course Syllabus		
• First Semester : Mechanics		
• Unit 1: GREEAT Science		
• Graphing		
• independent - x, dependent - y , scaling, labeling		
• Equations		
• analyze summer homework		
• Experiments		
• designing lab experiments from scratch	***Paper helicopters** Conduct a simple self-designed experiment on paper helicopters to find what variables affect falling time.	Lab 1: Designing experiments
• vocabulary of science		
• Format for a lab report		
• Abstract		
• Hypothesis		
• Equipment list		
• Procedure		
• Data		
• Graphs		
• Analysis		
• Conclusion		
• Assessments and Tests		
• AP-style grading		
• To guess or not to guess		
• Show your work on open response		
• state equations without values		
• use conceptual reasoning		
• drawing pictures		
• Unit 2: Kinematics		C1-A: Curriculum evidence is provided for Kinematics
• Vectors		
• Vector symbols and drawing conventions		
• Addition and subtraction of vectors		
• Multiplication of vectors by scalars		
• Graphical vs. trigonometric solution of vector problems		
• One dimensional motion		
• Graphing d vs. t motion	**Motion detector lab** Walk in front of a motion sensor to create steady speed and accelerated motion graphs and record the general shapes.	Lab 2: Observe and measure real phenomena
• Graphing v vs. t motion		
• Relating v and d in graphs		
• Definition of velocity		
• Definition of acceleration		
• vector nature of acceleration		
• Kinematics equations		
• Projectile motion		
• Vertical projectiles		
• Horizontal projectiles	***Marble in a cup** Determine the exit velocity of a marble launcher using a photogate. Predict the	Lab 2: Observe and measure real phenomena

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	landing site of the marble when shot horizontally off a table.	
• Projectiles at angles		
• Unit 3: Dynamics - Newton's Laws		C1-B: curriculum evidence is provided for Newtonian mechanics-dynamics
• First Law		
• Second Law		
• Equilibrium		
• Non-Equilibrium	***Atwood's Machine Lab Design** Set up Atwood's machines using smart pulleys to determine the acceleration when net force is changed and when total mass is changed; derive F= ma from results. Formal Lab report.	Lab 1: Designing experiments Lab 5: Communicate results.
• Third Law		
• The normal force	***Normal or Abnormal** *Measure the normal force on a ramp using an electronic balance and compare to a mathematical model of the normal force.	Lab 3: Analyze data
• Ramp problems		
• Paper airplanes	**Paper airplane contest** Design a paper airplane to fly in class contest. Observe characteristics of winners to generalize how to improve the design; use the 3rd law to make control surfaces work.	Lab 2: Observe and measure real phenomena
• Friction		
• Static		
• Sliding		
• Unit 4: Energy		C1-C: Curriculum evidence is provided for Work, Energy and Power
• Work		
• Power		
• Energy		
• Kinetic		
• Potential		
• gravitational	***Dropping Things** Determine the exchange of potential to kinetic energy for an object that is falling, using photographic motion capture software.	Lab 2: Observe and measure real phenomena
• spring		
• chemical		
• electric		
• Work-Energy Theorem	***Atwood revisited** Carefully compare the kinetic energy in an Atwood's machine to the potential energy to see if any fraction is lost due to friction, and if so, how much.	Lab 3: Analyze data
• Unit 5: Momentum		C1-D: Curriculum evidence is provided for Momentum
• Definition of momentum		
• Impulse and momentum	**Egg Drop** Design a container that will protect an egg from a 5 meter fall given specific constraints resembling those of a passenger car.	Lab 1: Designing experiments
• Conservation of momentum		
• Vector nature of momentum		
• Collisions		

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• Elastic one-dimensional	***Air Track** Determine an unknown mass given all other quantities in a one-dimensional elastic air-track cart collision. Uses photogates.	Lab 3: Analyze data
• Inelastic one-dimensional	**Air Track II** Determine an unknown mass given all other quantities in a one-dimensional Inelastic air-track cart collision. Uses photogates.	Lab 3: Analyze data
• Inelastic two-dimensional		
• Unit 6: Rotation		C1-E: Curriculum evidence is provided for Circular Motion and Rotation
• Torque	**K'nex me** Using K'nex, build a seesaw in rotational equilibrium and determine an unknown mass. Build several simple machines and find the mechanical advantage and report to the class.	Lab 4: Analyze errors Lab 5: Communicate results
• Centripetal Force		
• centripetal vs. centrifugal		
•		
• Unit 7: Gravity and oscillations		
• Gravity		
• Newton's Law of Gravity		
• Acceleration of gravity		
• Gravity on other planets		
• Nature of orbital motion		
• Kepler's laws	***Kepler's Models** Construct a mathematical model matching observed planetary semi-major axes and orbital periods from data in a book.	Lab 3: Analyze data
• Oscillations		
• Rotating objects		
• angular velocity		
• frequency		
• centripetal acceleration		
• Springs		
• Hooke's Law	***Hooke's Law Lab** Determine the spring constant for a variety of springs and relate the constant to the springs' period of oscillation.	Lab 2: Observe and measure real phenomena
• Period of oscillation of a spring		
• Potential energy in a spring		
• Pendulums		
• Conservation of energy in a pendulum		
• Period of oscillation of a pendulum		
• Waves introduction		
• Second Semester: E&M		
• Unit 8: Static Electricity		C3-A: Curriculum evidence is provided for Electrostatics
• Coulomb's law		
• Polarization		
• Charging	**Static Demonstrations Lab** Students work through a series of demonstrations of electrostatic events such as the magic soda can, flying fur, determining the charge on various cloth and rod combinations, and so on. Written explanations required.	Lab 2: Observe and measure real phenomena
• contact		
• induction		
• opposites attract...		

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• Electroscopes		
• Van deGraaf generators		
• Electrophorus		
• lightning rods		
• electric field		
• electric potential energy		
• electric potential		
• charge in a conductor		
• Electric field		
• Definition of electric field		
• Conceptual treatment		
• Capacitors		C3-B: Curriculum evidence is provided for Conductors and capacitors
• definition of capacitance		
• Shape dependence		
• combinations of capacitors		
• series		
• parallel		
• both		
• energy in a capacitor		
• Unit 9: Electric Circuits		C3-C: Curriculum evidence is provided for Electric Circuits
• Volts and voltage		
• Ohm's law	***Ohm's Law Lab** Use a variable power supply to measure the linear relationship between V and I. Verify Ohm's Law. Student-designed procedure. Formal lab report.	Lab 1: Designing experiments Lab 5: Communicating results
• Series circuits	***Circuit Lab** Verify the series and parallel rules by constructing a series of circuits and testing with a multimeter	Lab 2: Observe and measure real phenomena
• current constant		
• voltage adds up		
• resistance adds up		
• parallel circuits		
• voltage constant		
• current adds up		
• resistance follows inverse rule		
• combination circuits		
• capacitor circuits		
• Unit 10: Magnetism		C3-D and E: Curriculum evidence is provided for Magnetic fields and Electromagnetism
• Origin of magnetism		
• Definition of magnetic field	**Trace the magnetic field lines** Students trace magnetic field lines around a permanent magnet using compasses.	Lab 2: Observe real-world phenomena
• Forces on particles moving in magnetic fields		
• Right hand rule		
• Force on a current carrying wire		
• Forces on loops		
• Magnetic field around a current carrying wire		
• Faraday's Law	**Build a Speaker Project** Build a primitive speaker and demonstrate for	Lab 1: Designing experiments

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	the class. Generalize any observations you can make about which speaker performs the best.	
• Lenz's Law		
• Unit 11: Wave motion and Sound		C4-A: Curriculum evidence is provided for Wave motion (including sound)
• Waves (general)		
• Definition of waves		
• amplitude		
• wavelength		
• longitudinal waves		
• compressional waves		
• speed of waves		
• in air	***Speed of sound lab** Measure the speed of sound by measuring the time for a snapped finger and echo using a recording, graphing microphone.	Lab 2: Observe and measure real phenomena
• in water		
• dependencies		
• Sound waves		
• Superposition principle		
• Resonance	**Resonance tube apparatus** Measure the speed of sound in a tube with one end closed and a tuning fork of known frequency.	Lab 4: Analyze errors
• Tubes with one end closed	**Design a musical instrument Project** Design a musical instrument using resonance principles and play a song for the class.	Lab 1: Designing experiments Lab 5: Communicate results
• Strings		
• Tubes with both ends open		
• Doppler effect-qualitative demonstration		
• Unit 12: Optics		C4-B: Curriculum evidence is provided for Physical Optics and C4-C: Geometric Optics
• Law of Reflection	**Image formation in flat mirrors** Locate the image in a flat mirror by ray tracing.	Lab 2: Observe and measure real phenomena
• Law of Refraction		
• Image formation	***Optical Bench** Perform the standard optical bench measurements using candles, screens, lenses, mirrors. Establish the 5 domains for real images and verify the thin-lens equation.	Lab 2: Observe and measure real phenomena
• in convex lenses		
• In concave mirrors		
• ray trace diagrams	**Optics Project** Build a functioning projector, copier, camera, or spotlight or solar cooker. Provide ray-trace diagrams and thin-lens equation analysis to back up your design.	Lab 1: Designing experiments
• thin-lens equation		
• magnification		
• Diffraction		
• two slit interference		
• diffraction gratings		
• Thin film interference		
• Unit 13: Fluid mechanics and Thermodynamics		

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• Fluid Dynamics		C2-A: Curriculum evidence is provided for Fluid Mechanics
• Pressure		
• Bernoulli's Principle		
• Equation of Continuity		
• Archimede's Principle		
• Buoyancy		
• Temperature and heat		C2-B: Curriculum evidence is provided for Fluid Temperature and Heat
• Thermal expansion	***Thermal expansion lab** Measure the coefficient of thermal expansion in a heated rod.	Lab 2: Observe and measure real phenomena
• Heat transfer		
• conduction		
• convection		
• radiation		
• Ideal Gas Law		C2-C: Curriculum evidence is provided for Kinetic Theory and Thermodynamics
• Equation analysis		
• Application of ideal gas law	**Vacuum chamber** Compare pressure and volume in a closed vacuum chamber.	Lab 2: Observe and measure real phenomena
• Laws of Thermodynamics		
• Work done by a gas		
• Work done on a gas		
• Heat absorbed by a gas		
• Heat Engine cycles		
• Carnot Engine		
• PV cycles		
• Efficiency		
• Unit 14: Atomic and Nuclear physics		C5-A: Curriculum evidence is provided for Atomic and Quantum Effects
• Photoelectric Effect		
• Photonic collisions		
• De Broglie waves		
• mass-energy equivalence		
• Balancing atomic equations		C5-B: Curriculum evidence is provided for Atomic and Nuclear Effects
• nucleons		
• atomic mass		
• atomic number		
• beta decay		
• Atomic spectra		
• Bohr model		
• types of spectra	***Observing spectra** Match spectra observed through spectroscopes to un-identified spectrograms.	Lab 2: Observe and measure real phenomena
• emission		
• absorption		
• continuous		

Topic	Associated Labs and Projects	Evidence
• Lab Reports		
• **Requirements**		
• All students will complete lab reports and put them in lab binder.		
• Lab Reports will be typed with integrated graphs, illustrations, and tables.		
• Lab Reports will consist of the following components:		
• Abstract:	This is a summary of the entire lab including the hypothesis, procedures, results. Do not include data tables and graphs. The abstract should be one paragraph long. You write it LAST but put it FIRST.	
• Materials	Provide a list of all the equipment used	
• Variables	List the independent, dependent, and interfering variables	
• Purpose/Hypothesis	Write the variables in a hypothesis that makes a testable, educated guess.	
• Job accountability	List what each group member did, and be specific. No "helping."	
• Procedure	Write narrative prose about how you selected the independent variable values, measured the dependent variable, and verified that the interfering variables didn't. Write past-tense, include problems solved and describe the equipment setup. Include illustrations or photographs as needed for clarity.	
• Data	Record all data in tables including units. Use an appropriate number of significant figures.	
• Graphs	Plot dependent vs. independent and include units on all graphs.	
• Results/Conclusion	Interpret the meaning of the graphs you generated, draw a conclusion based on your observations and compare to your hypothesis.	
• Error Analysis	If you have a result that is already known, compare your result to the accepted value using a relative error calculation. if not, provide information on the spread of your data using standard deviation of multiple measures. Qualitative labs may skip this step.	
• **Lab Descriptions**		
• Labs marked with an asterisk* in the course syllabus will require a written lab report. Additional labs may be assigned as time permits.		
• Group size will range from 1 to 4 people depending on the amount of equipment available.		
• Please save an electronic copy of your report in the AP Physics folder on the server.		
• We will do at least 12 of these labs, although report length will vary with the complexity of the lab		
• **Lab Titles:**	**Details**	
• ***Paper helicopters** Conduct a simple self-designed experiment on paper helicopters to find what variables affect falling time.	Students create the experimental procedure by brainstorming possible variables to investigate and carrying out a simple experiment.	
• ***Marble in a cup** Determine the exit velocity of a marble launcher using a photogate. Predict the landing site of the marble when shot horizontally off a table.	Students find the relationship between launcher height and landing site plus the value of careful control of interfering variables. Passing the assignment requires hitting the cup on the first try. Rulers, marbles, photogates, ramps, and cups are used.	
• ***Atwood's Machine Lab Design** Set up Atwood's machines using smart pulleys to determine the acceleration when net force is changed and when total mass is changed; derive F= ma from results. Formal Lab report.	This lab requires the student to simultaneously change the independent variable (mass or force) while holding the other (force or mass) constant. This lab will allow the students to create the experimental method rather than following prewritten directions. Pulleys, standard masses, photogates and associated software is used.	

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• ***Normal or Abnormal** *Measure the normal force on a ramp using an electronic balance and compare to a mathematical model of the normal force.	This lab uses modeling to determine the connection between theory and reality. Students will need to hypothesize on reasons why the model does not match reality (it usually doesn't due to the balance's internal design.) Masses, protractors, balances are used.	
• ***Dropping Things** Determine the exchange of potential to kinetic energy for an object that is falling, using photographic motion capture software.	This is a simple lab that uses time as the independent variable. Video cameras and motion capture software is used.	
• ***Air Track** Determine an unknown mass given all other quantities in a one-dimensional elastic air-track cart collision. Uses photogates.	This lab requires a theoretical analysis prior to conducting the lab so students know what to measure. Air track, photogates, and software to determine velocities from photogates are used.	
• ***Kepler's Models** Construct a mathematical model matching observed planetary semi-major axes and orbital periods from data in a book.	Students will use modeling techniques to find the relationship between orbit radius and orbit period. The hypothesis is that the relationship is a power rule. The conclusion states a value for the power that allows the model to match the data.	
• ***Hooke's Law Lab** Determine the spring constant for a variety of springs and relate the constant to the springs' period of oscillation.	This is a straightforward lab that students will use to infer the relationship between the spring constant and the period of an oscillating spring. Standard masses and stopwatches are used.	
• ***Ohm's Law Lab** Use a variable power supply to measure the linear relationship between V and I. Verify Ohm's Law. Student-designed procedure. Formal lab report.	Students design the procedure to find the relationships in $V = IR$ using a variable power supply and volt and ammeters. Resistors, power supplies, and a variety of meters are used.	
• ***Circuit Lab** Verify the series and parallel rules by constructing a series of circuits and testing with a multimeter	Students are given instruction on how to build series and parallel circuit parts with diagrams. Resistors, power supplies, and a variety of meters are used.	
• ***Speed of sound lab** Measure the speed of sound by measuring the time for a snapped finger and echo using a recording, graphing microphone.	Students measure the distance between a sound and its echo on a pressure vs. time diagram generated by a microphone connected to a computer.	
• ***Optical Bench** Perform the standard optical bench measurements using candles, screens, lenses, mirrors. Establish the 5 domains for real images and verify the thin-lens equation.	Students make observations of the five general domains of images formed by convex lenses. Observations are used to verify the thin-lens equation and establish qualitative patterns of image formation. lenses, optical benches, screens, candles, rulers are used.	
• ***Thermal expansion lab** Measure the coefficient of thermal expansion in a heated rod.	Students measure the linear expansion of metal rods from an oven or a water bath. Rulers, calipers, hot plates, and metal rods are used.	
• ***Observing spectra** Match spectra observed through spectroscopes to un-identified spectrograms.	Spectrum tubes are observed with spectroscopes and photographed to make spectrograms using image-analysis software. Students calibrate the photographs and identify the Ballmer series of lines as well as identifying other elements from the spectra.	