AP Physics 2 Syllabus

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

AP Physics 2 is an algebra-based college-level second year physics course. General physics topics presented during the course closely follow those outlined by the College Board and are based on seven big ideas:

Big Idea 1 – Objects and systems have properties such as mass and charge. Systems may have internal structure.

Big Idea 2 – Fields existing in space can be used to explain interactions.

Big Idea 3 – The interactions of an object with other objects can be described by forces.

Big Idea 4 – Interactions between systems can result in changes in those systems.

Big Idea 5 – Changes that occur as a result of interactions are constrained by conservation laws.

Big Idea 6 – Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.

Big Idea 7 – The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems

The structure of the course is designed to allow students to discover and master these big ideas on their own as much as possible. To facilitate this more than 25% of the course is devoted to laboratory experiments and other student centered activities. In these activities students are typically expected to design a procedure and collect data to determine the relationship between variables and/or to derive a physics equation. Students will be expected to carefully collect and organize data, to use the collected data to reach a scientific conclusion and to perform an experimental error analysis during the lab experiments. Students are required to keep laboratory notes for each experiment and will have to write formal lab reports for some experiments and present their findings to their peers for review.

Besides the laboratory work the course will consistently include other types of activities. A normal week in the course consists of one or two teacher-centered instructional periods, two or three student-centered instructional periods and the extended lab period. The teacher-centered instructional periods typically begin with a demonstration or video clip that students are asked to interpret through guided inquiry. This is followed by a presentation of new material pertaining to the demonstration or video clip and the period finishes with a problem solving session based on any new equations related to the material. The student-centered periods typically consist of either a collaborative problem solving session using a released AP exam question that students will work on in small groups or a short experiment/ simulation based activity that students will use to explore fundamental concepts.

Each unit in the AP Physics 2 course will follow the same outline. It will begin with the presentation of a pre-test problem that will be used to initiate discussion of the topics included in the unit and to check for prior knowledge and misconceptions students may have. The pre-test problem will not be collected until the end of the unit and students will be encouraged to work on it over the course of the unit as they learn new material. Each unit will also have an associated problem set that will be available on-line while the unit is being covered. These problems will stress basic equation manipulation and are set up so that students can retry the problem set as many times as they wish as the software will generate new numbers for each attempt. This is meant to develop mastery of the math skills required for the unit. About halfway through the unit a multiple choice quiz will be administered to check student understanding of concepts and equations covered to that point. At the end of each unit there will be a two part exam. The first part will be an in-class collaborative free response question that students will have one period to complete. The question will be based on a released AP question and will serve as both part of the exam grade for the unit and as a final review before the individual assessment, which will be given on the following day. The individual section of the exam will consist of two or three free response topics that stress the main concepts of the unit.

Grading System:

AP Physics 2 students are evaluated using a hybrid grading system. Fifty points of the marking period grade will be standards based. Students are expected to demonstrate mastery of ten identified standards over the course of the marking period through a variety of assessments. The standards reflect fundamental physics principles (for example "Apply Ohm's Law to situations involving electricity") and sound scientific practices (for example "Perform data analysis and evaluation of evidence"). Students will have multiple opportunities to show mastery of each standard and must have demonstrated continued mastery of every standard to receive the fifty points.

The other fifty points of the marking period grade will be based on traditional assessments according to the following distribution:

25 points – Unit exams and lab presentations
15 points – Laboratory work (Including reports and notebooks)
10 points – Quizzes, problem sets and pre-tests

Primary Text:

Urone, Paul Peter., Roger Hinrichs, Kim Dirks, and Manjula Sharma. College Physics. Houston, TX: OpenStax College, Rice University, 2013.

Secondary Text (Classroom set):

Serway, Raymond A., Robert J. Beichner, and John W. Jewett. Physics for Scientists and Engineers. 5th ed.

Pacific Grove, CA: Brooks/Cole, 2000.

Additional Resources:

Lewin, Walter. 8.01 Physics I: Classical Mechanics, Fall 1999. MIT OpenCourseWare: Massachusetts Institute of Technology. < http://ocw.mit.edu>

Lewin, Walter, John Belcher, and Peter Dourmashkin. 8.02SC Physics II: Electricity and Magnetism, Fall 2010. MIT OpenCourseWare: Massachusetts Institute of Technology. < http://ocw.mit.edu>

Mavalvala, Nergis, Walter Lewin, and Wolfgang Ketterle. 8.03 Physics III: Vibrations and Waves, Fall 2004. MIT OpenCourseWare: Massachusetts Institute of Technology. < http://ocw.mit.edu>

MIT Department of Physics Technical Services Group. RES.8-003 Physics Demonstration Videos, Spring 2012 MIT OpenCourseWare: Massachusetts Institute of Technology. < http://ocw.mit.edu>

"PhET: Free Online Physics, Chemistry, Biology, Earth Science and Math Simulations." PhET Project: University of Colorado. <http://phet.colorado.edu/>.

Course Outline and Correlation to Big Ideas

Unit	BI 1	BI 2	BI 3	BI 4	BI 5	BI 6	BI 7
AP Physics 1 Review and Lab Techniques	✓		✓	✓	✓		
• Significant Digits • Absolute and Relative Error • Sources of Uncertainty vs. Avoidable Errors • Graphing Data • Newton' Laws • Conservation Laws							
Fluid Mechanics	✓		✓	✓	✓		
• Pressure and Density • Pressure with Depth • Pascal's and Archimedes' Principles • Buoyant Force • Flow Rate and Continuity • Bernoulli's Equation							
Thermal Physics	✓			✓	✓		✓
• Thermal Definitions • Internal Energy vs. Heat • Heat Transfer • Thermal Expansion • Ideal Gas Laws • Kinetic Theory of Gases • First Law of Thermodynamics • PV Diagrams and Gas Cycles • Second Law of Thermodynamics							
Electrostatics	✓	✓	✓	✓	✓		
• Conservation of Charge • Coulomb's Law • Electric Field • Electrostatic Equilibrium • Electric Potential Difference and Electric Potential Energy • Equipotential Lines and Surfaces • Work and Energy in Electric Fields							
Circuits and Capacitance	✓	✓		✓	✓		
• Current • Ohm's Law and Resistance • Series and Parallel Resistors • Kirchhoff's Rules • Capacitance and Parallel Plate Capacitors • Dielectrics • Series and Parallel Capacitors • RC Circuits							

Unit	BI 1	BI 2	BI 3	BI 4	BI 5	BI 6	BI 7
Magnetism	✓	✓	✓	✓			
• Properties of Magnets • Magnetic Fields • Ferromagnetism • Force on a Moving Charge • Force on a Current Carrying Wire • Magnetic Flux • Faraday's and Lenz's Laws • Mutual Inductance and Transformers							
Optics						✓	
• Diffraction, Refraction and Reflection • Superposition and Interference • Single and Double Slit Diffraction • Diffraction Gratings • Snell's Law and Total Internal Reflection • Spherical Mirrors • Thin Lenses							
Atomic, Nuclear and Quantum Physics	✓		✓	✓	✓	✓	✓
• Photoelectric Effect • Wave-Particle Duality • Compton Effect and Davison-Germer Experiment • Mass-Energy Equivalence • Quantum Model of the Atom • Photon Emission and Absorption • Radioactive Decay and Half-life							
Capstone Projects	✓	✓	✓	✓	✓	✓	✓
• Research Project: Groups of students will be assigned a device or system that could be found in their houses that uses both electricity and magnetism. For example a group may be assigned circuit breakers or a "fenceless" pet containment system. Students will be required to research the science behind how their device works. Each Group will then be required to teach the class about their selected device and how it works and to answer questions from their peers. • Experiment: Groups of students will be responsible for designing and conducting an experiment that investigates a topic not covered in the labs already completed this year. They will then present their conclusions to their peers and be prepared to defend them							

Lab Experiments and Activities

Experiments and activities are classified according to the following categories:

- Teacher Directed (**TD**): Short activities in which students follow given instructions to collect data and reach a conclusion
- Guided Inquiry (**GI**): An experiment in which students are given a problem statement or objective and are required to create a procedure to reach a conclusion
- Computer-based Inquiry (**CBI**): Activity in which students use a computer simulation to collect data and reach a conclusion
- Open Inquiry (**OI**): Experiment in which students are responsible for the entire process of creating a hypothesis and testing it with the teacher only acting as a consultant

Experiment/Activity	**Type**			
	TD	**GI**	**CBI**	**OI**
Graphing Newton's 2nd Law – Students will collect data in an attempt to graphically verify Newton's 2nd Law		✓		
Non-ohmic Resistance – Students examine the relationship between current, resistance and voltage for a non-ohmic resistor		✓		
Conservation of Momentum – Student will use video analysis software to examine the momentum of an elastic collision		✓		
Density and Buoyancy – Students will use a computer simulation to investigate the effect density has on the buoyant force			✓	
Buoyant Force – Students will determine the density of an unknown metal by using the apparent weight of the metal				✓
Torricelli's Law – Students will derive Torricelli's Law using projectile motion and conservation of energy		✓		
Ideal Gas Laws – Students will determine the relationships between pressure, temperature and volume for ideal gases			✓	
Heat Transfer – Students will examine the factors that affect the rate of heat transfer			✓	
Thermal Expansion – Students will derive the formula for linear thermal expansion			✓	
First Law – Students will use a computer simulation to verify the First Law of Thermodynamics			✓	
Gas Cycle – Students will use a computer simulation to examine the net work done on a gas			✓	
Electric Fields and Equipotentials – Students will use a potential demonstrator to examine electric fields and determine the relationship between electric field lines and equipotential lines	✓			
Coulomb's Law – Students will verify Coulomb's Law using a computer simulation			✓	
Coulomb's Law Video Analysis – Students will use video analysis software and vector math to examine Coulomb's Law				✓
Potential Energy – Students will use a computer simulation to examine the potential energy of a system of point charges			✓	
Millikan Experiment – Student will determine the fundamental charge on an electron			✓	
Parallel Plate Capacitor – Students will examine the effect of area and plate separation on the capacitance of a parallel plate capacitor			✓	

Experiment/Activity	Type			
	TD	**GI**	**CBI**	**OI**
Dielectrics – Students will examine the effect of a dielectric on capacitance			✓	
Series and Parallel Capacitors – Students will derive the formulas for series and parallel arrangements of capacitors				✓
Circuit Design – Students will design and construct a circuit containing both resistors and capacitors to meet given criteria. The circuit will then be analyzed using Kirchhoff's Laws and steady state RC conditions. Final designs will be presented to the class for peer review and critique.		✓		
Mapping Magnetic Fields – Students will map magnetic fields around a bar magnet, solenoid and straight wire in order to draw conclusions about the direction of magnetic field lines	✓			
Magnetic Field Around a Wire – Students will conduct an experiment to determine the relationship between distance from a wire and magnetic field strength		✓		
Magnetic Force on a Particle – Students will collect data to determine the equation relating force, velocity and charge			✓	
Magnetic Field of a Solenoid – Students will examine the relationships between magnetic field strength, current and number of loops		✓		
Induction – Students will examine the emf induced by a magnet dropping through a coil of wire and determine the relationship between the rate of change of flux and induced emf		✓		
Transformers – Students will investigate a real-world transformer to identify if energy is conserved		✓		
Ripple Tank – Students will use identify refraction, reflection and diffraction in patterns viewed in a ripple tank	✓			
Double Slit – Students will determine the relationship between slit separation and the angle at which the first maxima are observed			✓	
Diffraction Grating – Students will use a diffraction grating to determine the wavelength of a He-Ne laser				✓
Reflection – Students will collect data to establish the Law of Reflection		✓		
Mirror Lab – Students will examine the relationship between the radius of curvature and the focal length for a spherical mirror			✓	
Snell's Law – Students will examine the refraction of light in order to verify Snell's Law of Refraction		✓		
Converging Lenses – Student will use optics benches to examine the relationship between object distance, image distance and focal length		✓		
Photoelectric Effect: Cutoff Frequency – Students will use a computer simulation to examine the effect frequency has on the photoelectric effect			✓	
Photoelectric Effect: Work Function – Students will use a computer simulation to determine the work function of several materials			✓	
Hydrogen Emission Spectrum – Students will examine the hydrogen emission spectrum to determine the wavelengths and energies of the emitted photons			✓	

Readings and Suggested Problems

Solutions to all the suggested problems are found in the student solution manual.

AP Physics 1 Review and Lab Techniques	
Readings	Suggested Problems
Chapter 1	Ch 1: 10, 15
Fluid Mechanics	
Readings	Suggested Problems
Chapter 11 Chapter 12	Ch 11: 12, 23, 27, 40 Ch 12: 21, 27
Thermal Physics	
Readings	Suggested Problems
Chapter 13 Chapter 14 Chapter 15	Ch 13: 21, 38 Ch 14: none Ch 15: 11
Electrostatics	
Readings	Suggested Problems
Chapter 18 Chapter 19 sections 1-4	Ch 18: 20, 32, 44, 50 Ch 19: 17, 23, 29
Circuits and Capacitance	
Readings	Suggested Problems
Chapter 19 sections 5 - 7 Chapter 20 Chapter 21	Ch 19: 46, 59, 66 Ch 20: 1, 19, 31, 65 Ch 21: 1, 31, 37, 63, 74
Magnetism	
Readings	Suggested Problems
Chapter 22 Chapter 23	Ch 22: 1, 7, 13, 36, 42, 50 Ch 23: 14, 46
Optics	
Readings	Suggested Problems
Chapter 24 Chapter 25 Chapter 26 Chapter 27	Ch 24: 8, 17 Ch 25: 1, 7, 22, 49, 57 Ch 26: none Ch 27: 7, 25, 48
Atomic, Nuclear and Quantum Physics	
Readings	Suggested Problems
Chapter 29 Chapter 30 Chapter 31	Ch 29: 7, 13, 33, 40, 54 Ch 30: 12, 18, 33 Ch 31: 22, 34, 40