

TUNKHANNOCK AREA SCHOOL DISTRICT

AP Physics 2 Syllabus

Derived From Sample Syllabus 4: 1066438v1

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This is the proposed syllabus for AP Physics 2 at Tunkhannock Area High School. This syllabus includes a rationale, breakdown of content (including time spent), and laboratory exercises.

Curricular Requirements	Page(s)
CR1 Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.	1
CR2a The course design provides opportunities for students to develop understanding of the foundational principles of kinematics in the context of the big ideas that organize the curriculum framework.	2
CR2b The course design provides opportunities for students to develop understanding of the foundational principles of dynamics in the context of the big ideas that organize the curriculum framework.	2
CR2c The course design provides opportunities for students to develop understanding of the foundational principles of gravitation and circular motion in the context of the big ideas that organize the curriculum framework.	2
CR2d The course design provides opportunities for students to develop understanding of the foundational principles of simple harmonic motion in the context of the big ideas that organize the curriculum framework.	2
CR2e The course design provides opportunities for students to develop understanding of the foundational principles of linear momentum in the context of the big ideas that organize the curriculum framework.	2
CR2f The course design provides opportunities for students to develop understanding of the foundational principle of energy in the context of the big ideas that organize the curriculum framework.	2
CR2g The course design provides opportunities for students to develop understanding of the foundational principles of rotational motion in the context of the big ideas that organize the curriculum framework.	2
CR2h The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.	2
CR2i The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.	2
CR2j The course design provides opportunities for students to develop understanding of the foundational principles of mechanical waves in the context of the big ideas that organize the curriculum framework.	2

CR3 Students have opportunities to apply AP Physics 1 learning objectives connecting across enduring understandings as described in the curriculum framework. These opportunities must occur in addition to those within laboratory investigations.	6
CR4 The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.	6
CR5 Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.	5
CR6a The laboratory work used throughout the course includes investigations that support the foundational AP Physics 1 principles.	3,4,5
CR6b The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.	3,4,5
CR7 The course provides opportunities for students to develop their communication skills by recording evidence of their research of literature or scientific investigations through verbal, written, and graphic presentations.	5,6
CR8 The course provides opportunities for students to develop written and oral scientific argumentation skills	5

Course Description

AP Physics 2 is equivalent to most college-level introductory physics courses with a focus on the following topics: fluid statics and dynamics, thermodynamics, PV diagrams and probability, electrostatics, electrical circuits with capacitors, magnetic fields, electromagnetism, physical and geometric optics, and other topics in modern physics. *AP Physics 1 should be taken before this course, which covers traditional mechanics and other important introductory topics.*

Emphasis will be placed on understanding physical science literacy and applying physics concepts to think critically and solve problems. Algebra and trigonometry are the primary mathematical tools for problem solving. Science literacy is the process of both knowing physics and doing physics. Hands-on laboratory and the scientific notebook will be emphasized. This course will prepare the student for the AP exam in May. This class is scheduled for 40 minutes per day, and will meet 5 days per week.

Resources

Text

Serway, Raymond and Vuille, Chris. *College Physics*. 10th edition. Stamford, CT: Cengage Learning, 2015. [CR1]

Teaching Strategies

The course consists of the units listed in the course outline (see below), with a test at the completion of each unit. Most units begin with an overview of the content with leading questions or a “quick-discovery” student “hands-on” session, which are designed to help students discover and explore physical relationships.

Homework is assigned regularly and recorded in a student notebook which is peer reviewed regularly. Labs are provided with each unit at a time that will best reinforce the concepts of the unit. Informal, formative, and summative evaluation will be used to provide timely feedback to students regarding their progress and level of understanding of the content. Student “clickers” (Classroom Response System) will be used with the Promethean Board to provide ‘live’ feedback to students and the teacher to maximize course effectiveness.

Students will gain experience using the TI-84 family of calculators and Calculator Based Lab (CBL) collection materials as the course progresses.

Physics Outline of Units with Timelines * *Notations are the links to the AP Physics 2 Enduring Understandings.*

I. Introduction - weeks 1-2

Big Ideas: 3 and 5

* 3.A, 3.B, and 5.D

- A. Review of physical quantities (chapter 1)
- B. Algebra and trigonometry review
- C. Newton’s biggest hits (review of important Physics 1 topics)

II. Fluid Mechanics (chapter 9) - weeks 3-4

Big Ideas: 1, 3, and 5 **[CR2b]**

*1.E, 3.C, 5.B, and 5.F

- A. Density and Pressure
 1. Density and specific gravity
 2. Pressure as a function of depth
 3. Pascal's principle
- B. Buoyancy
 1. Buoyant force
 2. Archimedes' principle
- C. Fluid flow continuity
- D. Bernoulli's Equation

III. Thermal Physics (chapters 10, 11, and 12) - weeks 5-9

Big Ideas: 1, 4, 5, and 7 **[CR2a]**

*1.E, 4.D, 4.E, 5.B, 7.A, and 7.B

A. Temperature and Heat

1. Mechanical equivalent of heat
2. Heat transfer and thermal expansion

B. Kinetic Theory

1. Ideal gases
2. Gas laws

C. Thermodynamics

1. Thermodynamic processes
 - a. Adiabatic
 - b. Isothermal
 - c. Isobaric
 - d. Isochoric
 - e. Cyclic
2. pV diagrams
 - a. Determining work done
 - b. Interpreting graphs
3. First Law of Thermodynamics
 - a. Internal energy
 - b. Energy conservation
4. Second Law of Thermodynamics
 - a. Entropy
 - b. Heat engines
 - c. Carnot cycle

IV. Electricity (chapters 15, 16, 17, and 18) - weeks 10-14

Big Ideas: 1, 2, 3, 4, and 5 **[CR2c]** **[CR2d]**

*1.E, 2.A, 2.C, 2.D, 2.E, 3.A, 3.C, 3.G, 4.E, 5.B, and 5.C

A. Electrostatics

1. Coulomb's Law
2. Electric Field
 - a. Force on a test charge
 - b. Field diagrams
 - c. Motion of particle in an E field
3. Electric Potential
 - a. Due to a group of charges
 - b. Potential difference
 - c. Work on a charge
 - d. Between parallel plates
4. Electrostatics with Conductors
 - a. Absence of E field in conductor
 - b. Equipotential
 - c. Charging by induction

B.

Capacitors

1. Capacitance
2. Energy and charge stored
3. Parallel plates

C. Electric Current

1. Definition of direction of current
2. Ohm's Law
3. Resistance and Resistivity
4. Power

D. DC Circuits

1. Schematic diagrams/Kirchhoff's Laws
2. Resistors
 - a. In series
 - b. In parallel
3. Capacitors
 - a. In series
 - b. In parallel
4. Terminal voltage and internal resistance
5. Steady-state RC circuits

V. Magnetism (chapters 19 and 20) - weeks 15-16

Big Ideas: 2, 3, and 4 **[CR2e]**

*1.E, 2.A, 2.B, 2.E, 3.G, 4.E, and 5.B

A. Magnetostatics

1. Magnetic field
2. Forces on moving charges
3. Forces on a current-carrying wire
4. Magnetic field of current-carrying wires

B. Electromagnetism

1. Magnetic flux
2. Faraday's Law and Lenz's Law
3. Induced emf and induced current

VI. Optics (chapters 22, 23, 24, and 25) - weeks 17- 22

Big Idea 6 **[CR2f]**

*1.D, 5.D, 6.A, 6.B, 6.C, 6.D, 6.E, 6.F, and 6.G

A. Physical Optics

1. The electromagnetic spectrum
2. Interference
 - a. Two-source interference
3. Diffraction
 - a. Diffraction grating
4. Thin films

B. Geometric Optics

1. Reflection and refraction
 - a. Snell's Law
 - b. Total internal reflection
2. Images formed by mirrors
 - a. Ray diagrams
 - b. Thin lens/mirror equation
3. Images formed by lenses
 - a. Ray diagrams
 - b. Thin lens/mirror equation

VII. Atomic and Nuclear Physics (chapters 27, 28, and 29) - weeks 25 - 28

Big Ideas: 1, 3, 4, 5, 6, and 7 **[CR2g]**

* 1.A, 1.B, 1.C, 1.D, 3.G, 4.C, 5.B, 5.D, 5.G, and 7.C

A. Atomic Physics and Quantum Effects

1. Discovery of the Electron and Atomic Nucleus
 - a. Cathode ray tube
 - b. Millikin's Oil Drop Experiment
 - c. Rutherford scattering
2. Photons and the Photoelectric Effect
 - a. Energy of a photon
 - b. Intensity and number of photons
 - c. Stopping potential
3. Bohr Model
 - a. Energy levels
 - b. Emission and absorption spectra
 - c. Transition between energy levels
4. DeBroglie Wavelength
 - a. Wavelength of Particles
5. Production of X-rays
6. Compton Scattering

B. Nuclear Physics

1. Atomic number, mass number, and atomic mass
2. Nuclear processes
 - a. Radioactive decay (alpha, beta, and gamma)
 - b. Fusion
 - c. Fission

3. Mass-Energy
equivalence

VIII. Modern Physics and Review for AP Exams - weeks 29-32

Laboratory

Labs are done throughout the school year when they best fit in the curriculum. One class period out of four (25% of the scheduled instructional time) will be devoted to the laboratory experience. **[CR5]**

Students are required to keep a portfolio (in the form of a scientific notebook) of their work. The labs incorporate a variety of skills and learning experiences for the students. During the lab, students work in pairs or small groups, but they are required to turn in individual work. **[CR7]**

Generally, labs follow the following format:

- 1) Objective: An objective is presented at the beginning of the laboratory period to communicate the goal of the lab to the students. For some labs, students are given equipment and asked to design an experiment to test a particular physical concept. For other labs, students collect data from a specified set of equipment.
- 2) Pre-Lab Open-Ended Questions: Students are required to demonstrate a basic understanding of the skills and physical concepts of the lab before engaging in any lab work.
- 3) Procedure: For student-designed labs, students are required to submit their procedure to the teacher for approval before doing the procedure. For pre-designed labs, students follow a given procedure.
- 4) Data: Each student is required to record their data set. Students are required to analyze their data qualitatively, graphically, statistically, or mathematically, depending on what the lab necessitates. Graphs may be done by hand on graph paper, or on a graphing program such as Excel. Statistical analysis may be done using a calculator or Excel. All work will be recorded in the student write-up.
- 5) Extension Questions: These are open-ended questions that require the student to think critically about the lab and to reflect on their real-world experiences.

Laboratory List **[CR6a]**

These laboratory experiences have two versions: one is a guided-inquiry, formative student exploration of the topic; the other is a traditional approach, which is summative in nature. For all the guided-inquiry labs, students will be required to present their data and calculations to the class and be prepared to defend their analysis and conclusions.

Labs may need to be redesigned and re-run. **[CR8]**

1) Measurement and Propagation of Uncertainty

- Objective: Students will use a pendulum to take scientific measurements and estimate and calculate the amount of uncertainty of those measurements.
- Science Practices 2 and 5

2) Fluids: Archimedes' Principle (Guided-Inquiry)

- Objective: Students will determine the density of an unknown fluid and an unknown solid using a fluid of known density and other standard equipment.
- Extension: Students will apply this exercise to building a cardboard boat and calculating buoyant force. Cardboard boat will compete in obstacle course races in the school's pool.
- Science Practices 1, 2, 4, 5 and 6

3) Latent Heat of Fusion and Specific Heat (Guided-Inquiry)

- Objective: Use Pasco Temp Probes to plot Temp vs Time graph for melting ice and calculate Heat of Fusion and Specific Heat.
- Science Practices 1, 2, 4 and 5

- 4) Gas Properties PhET Simulation
 - Objective: The students will explore the relationships between pressure volume, temperature and number of moles for an ideal gas using the "Gas Properties" simulation.
 - Science Practices 1, 2, 3, 4, 5, and 6
- 5) Investigating Electric Charge: Conduction/Induction/Polarization (Guided-Inquiry) **[CR6b]**
 - Objective: Students will use electroscopes, pith balls, glass and rubber rods, animal fur and silk to create different charges. Qualitative studies of how charges interact will ensue.
 - Science Practices 1, 2, 3, 4, and 5
- 6) Understanding Ohm's Law (Guided-Inquiry) **[CR6b]**
 - Objective: Students will analyze the relationship among current, voltage, and resistance by designing circuits with different resistors and resistor combinations. Different voltages will be available by using multiple batteries and/or variable voltage supplies.
 - Science Practices 1, 2, 3, 4, and 7
- 7) Investigating Magnetic Fields (Guided-Inquiry) **[CR6b]**
 - Objective: Students will determine the magnetic field around bar, horseshoe, and disc magnets and represent this information as magnetic field lines. Magnetic compasses will be used.
 - Science Practices 1, 2, and 4
- 8) Electromagnetic Induction (Guided-Inquiry) **[CR6b]**
 - Objective: Students will design a procedure to calculate the number of turns in a solenoid by dropping a magnet through a coil of wire.
 - Science Practices 1, 2, 4, and 5
- 9) Using Snell's Law (Guided-Inquiry) **[CR6b]**
 - Objective: Students will use Snell's Law to design an experiment to determine the index of refraction of an unknown substance.
 - Science Practices 1, 2, 3, and 4
- 10) Understanding Geometric Optics (Guided-Inquiry) **[CR6b]**
 - Objective: Students will design a lab to gain understanding of the types of images formed by various mirrors and lenses.
 - Science Practices 1, 2, and 5
- 11) Focal Length of a Lens (Guided-Inquiry) **[CR6b]**
 - Objective: Students will design an experiment to measure the focal length of a converging lens and a diverging lens.
 - Science Practices 1, 2, and 4
- 12) Double Slit Interference (Guided-Inquiry) **[CR6b]**
 - Objective: Students will design an experiment to determine the spacing between two narrow slits based upon an analysis of the interference pattern from monochromatic light. Multiple colors of lasers will be provided.
 - Science Practices 1, 2, and 4
- 13) Analyzing Emission Spectra
 - Objective: Students will compare and contrast the emission spectra of various gases, and investigate quantitatively the emission spectrum of hydrogen and relate it to Bohr's theory of atomic structure.
 - Science Practices 1, 2, and 3
- 14) Modeling Radioactive Decay
 - Objective: Students will simulate radioactive decay using various types of dice.
 - Science Practices 1 and 2

Real World Activity

The students are presented with the following scenario: the local power company wants to build a nuclear reactor in the district. The town council is hearing arguments to decide on whether to pass an ordinance allowing or forbidding the construction of nuclear power plants in city limits. Students will engage in a classroom debate on the merits and drawbacks of nuclear fission reactors. The students will be divided into three groups: one group will argue in favor of the nuclear power plant, one group will argue against the nuclear power plant and one group will serve as the town council and hear arguments. Both groups must use scientific-based evidence to construct their arguments [Essential Knowledge 4.C.4] **[CR4] [CR8]**

Activity to Cross Enduring Understandings [CR3]

Students will design a cardboard boat that will safely allow two passengers to cross a pool and come back. Students must include boat design features and calculations to show how their boat design should float. [LO 1.E.11, 1.E.1.2, 3.A.4.1, 3.A.4.2, 3.A.4.3, 3.B.1.4]