

AP Physics II Syllabus

Course Overview:

AP Physics II 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

The course focuses on the interconnections between the various strands and units contained in the course syllabus and how each contributes to the “Big Ideas” that provide a core foundation for this science course. Problem solving techniques and strategies are fine tuned throughout the year, and students are continually tasked with connecting physics applications learned in different units in order to synthesize solutions to complex problems. The topics covered will be developed through discussion, lecture, derivations, labs (through the use of Guided Inquiry (GI) and Open Inquiry (OI)), computer simulations and applets, presentation of problems as well as laboratory results through whiteboard presentations. The primary method of instruction used to teach AP Physics II will be through the Modeling Method of Instruction.

AP Physics II is a college level course. That being said, it will be treated as such. Retake exams will not be counted toward your final grade. Retakes will only be used for mastery of the subject material. Quizzes, lab reports, homework, and take-home problems will not be considered for retakes. Late homework will be accepted for ½ credit for up to one week after being collected. Make-ups, and any other late work will not be accepted two weeks prior to the end of the semester.

Course Text:

Giancoli, Douglas C. 2005. *Physics: Principles with Applications*. 6th Edition. 2007. *College Physics: A Strategic Approach*. 1st Edition. Pearson Prentice Hall. NJ.

INSTRUCTIONAL STRATEGIES

The AP Physics 2 course is conducted using inquiry-based instructional strategies that focus on experimentation to develop students’ conceptual understanding of physics principles. The students begin studying a topic by making observations and discovering patterns of natural phenomena. The next steps involve developing, testing, and applying models. Throughout the course, the students construct and use multiple representations of physical processes, solve multi-step problems, design investigations, and reflect on knowledge construction through self-assessment rubrics.

In most labs, the students use probeware technology in data acquisition. In the classroom, they use graphing calculators and digital devices for interactive simulations, Physlet-based exercises, collaborative activities, and formative assessments.

Students have the opportunity to meet the learning objectives in a variety of ways and to apply their knowledge to real world experiences and societal issues. Instructional time involves a variety of student-centered activities. Students have the opportunity to work cooperatively to solve challenging problems and to present their solutions to the class. Throughout the year connections to the world are explored in discussions, group projects, and class demonstrations. Laboratory work, described below, offers frequent opportunities to work cooperatively, explore ideas, and present information. Outside of class students read the assigned text and complete homework assignments that support and reinforce each lesson as well as what has been learned in the laboratory setting. Unit exams take place at the end of each block of instruction.

Students will spend at least 25% of the instructional time engaged in laboratory work. **[CR5]** Experiments designed by the instructor are used to demonstrate procedural guidelines and to learn how to use specific

laboratory equipment. The majority of labs are inquiry-based where students are given an objective and a set of materials. They are tasked with designing a procedure and collecting data to determine specific quantities, determine the relationship between variables, and/or to derive fundamental physics equations. Laboratory design, experimentation, data gathering, data presentation, analysis, drawing conclusions, and experimental error analysis are elements in these lab activities.

Laboratory work will be recorded in a laboratory notebook, and students will have opportunities to present their laboratory findings to their peers via whiteboard presentations. All aspects of the laboratory work including any pre-lab work, question/hypothesis, experimental procedure, data, analysis, graphs, conclusion, and error analysis will be recorded. **[CR7]** Additional information as indicated in the following pages will also be included in the lab notebook. At the end of completing the lab work for the investigations that are labeled “Guided-Inquiry,” the students will present their method, data and conclusions on whiteboards. The class will then engage in peer critique of each group’s results, and discuss strategies that could be used to decrease error as well as suggestions for further investigations.

Bold questions and problems at the end of each list will be turned in for credit. Underlined problems will be shown on whiteboards in class – If you’re assigned one, be sure to have it done for the next day. You will only have time to copy your problem on to a whiteboard, not figure it out in class. The rest of the problems are for your practice and benefit and may be discussed in class depending on questions. Practice is necessary to become well versed in any activity. Do it, and you will succeed!

I would encourage you to work with another AP Physics student as you attack the questions and problems. Having someone else there to bounce ideas off of is extremely helpful. However, if it becomes a distraction, it may be better to simply work alone.

Grading:

Grades will be weighted as such: Tests/Quizzes = 60% Lab Reports = 30% Homework = 10%

$A \geq 90\%$	$80\% \leq B < 90\%$	$70\% \leq C < 80\%$	$60\% \leq D < 70\%$	$F < 60\%$
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Policies:

I will enforce school policies regarding tardies, plagiarism, and any type of electronic device other than a calculator. If you have questions regarding these policies, please consult your student handbook.

This information should be shared with your parents and signed by both of you. Return the bottom portion to me by Friday and keep the rest in your Physics folder for future reference.

Unit 1: Introduction 2 Weeks Chapters: 1-4 Big Idea 3: The interactions of an object with other objects can be described by forces. Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.	
Course Sequence	Student Labs and Activities [CR6a] & Assignments
A. Review of physical quantities (chapter 1) B. Algebra and trigonometry review C. Newton's biggest hits (review of important Physics 1 topics)	<p><i>Lab 1a:</i> Design an experiment to determine the relationship between terminal velocity and mass for falling coffee filters.</p> <p><i>Lab 1b:</i> Using a pendulum, design an experiment to determine the acceleration due to gravity.</p> <p>Skim pp. 1-10 & skim pp. 11-15 HW #1 Page 16+ Questions: 6,10 Problems: <u>7,10,11,18,22,23,27,28,37,42</u></p> <p>Skim section 3-4 (adding vectors) HW #2 Page 66+ Problems: 7,11</p> <p>Skim pp. 72-96 (Dynamics: Newton's Laws of Motion) HW #3 Page 97+ Questions: <u>6,12</u> Problems: <u>29,33,47,64,70,81</u></p> <p>Quiz on Linear Motion & Dynamics</p>

Unit 2: Fluid Mechanics 3 Weeks[CR2b] Chapter: 10 Big Idea 1: Objects and systems have properties such as mass and charge. Systems may have internal structure. Big Idea 3: The interactions of an object with other objects can be described by forces. Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.	
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	<p><i>Lab 2</i> 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.</p> <p>Read pp. 255-262 HW #4a Page 280+ Questions: 2,4,6 Problems: 4,8,11,3,7,9,16</p> <p>HW #4b Page 280+ Problems: <u>12,17,20,14,18</u></p> <p>Read pp. 263-267 Buoyancy HW #5 Page 280+ Questions: <u>7,10,11,12</u> 8,15,16 Problems: <u>25,31,32</u>, 22,23,33</p>

	<p>Lab Practicum: Archimedes Puzzle</p> <p>Read pp. 268-272 Bernoulli's Principle HW #6 Page 280+ Questions: <u>18,19,20,22,17,21,23</u> Problems: <u>35,36,38,43,40,41,46,63c,68,77,86</u></p> <p>Mini-Group-Lab: Venturi Tube Puzzle</p> <p>Exam including Bernoulli Take-Home problem.</p>
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Unit 3: Thermal Physics 5 Weeks [CR2a] Chapter: 13,14,15	
<p>Big Idea 1: Objects and systems have properties such as mass and charge. Systems have internal structure. 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 7: The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems.</p>	
<p>A. Temperature and Heat</p> <ol style="list-style-type: none"> 1. Mechanical equivalent of heat 2. Heat transfer and thermal expansion <p>B. Kinetic Theory</p> <ol style="list-style-type: none"> 1. Ideal gases & the Ideal Gas Law 2. Gas laws <p>C. Thermodynamics</p> <ol style="list-style-type: none"> 1. Thermodynamic processes <ol style="list-style-type: none"> a. Adiabatic b. Isothermal c. Isobaric d. Isochoric e. Cyclic 2. pV diagrams <ol style="list-style-type: none"> a. Determining work done b. Interpreting graphs 3. Zeroth Law of Thermodynamics 4. First Law of Thermodynamics <ol style="list-style-type: none"> a. Internal energy b. Energy conservation 5. Second Law of Thermodynamics <ol style="list-style-type: none"> a. Entropy b. Heat engines c. Carnot cycle 	<p>Chapter 13 <i>Lab 3</i> Relationship between pressure and temperature for a contained gas (Guided-Inquiry).</p> <p>Read pp. 352-359 HW #7 page 379+ Questions: <u>1,7,9,11,3,6,14</u> Problems: <u>10,16,1,3,7,13,18</u></p> <p>Read pp 376-371* HW #8 Page 379+ Questions: <u>20,21,22,22</u> Problems: <u>25a,41,48,49,80, 30,33,44,55</u> *To really understand the kinetic theory and the mathematical model behind it, you should work your way through section 13-10, which is the derivation behind the connections between momentum and temperature and pressure*</p> <p>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.</p> <p>Quiz: Chapter 13 Linear & Volumetric Expansion & Gas Law</p> <p>Chapter 14 <i>Lab 4</i> Connecting electric power (energy) with heat (measuring temp. change).</p> <p>Read pp. 384-395 HW #9 Page 403+ Questions: <u>2,5,8,9</u></p>

Problems: 10,16, **1,3,7,13,18**

Read pp. 395-397

HW# 10 Page 403+ Questions: 6,7,12,17

Problems: 21,22,25*, 33,37,39, **14,41,42**

Read pp. 397-402

HW# 11 Page 403+ Questions: 26,27,28

Problems: 35,38, **49,58**

Lab 5 Solar Shed heat loss and solar gain. (a lot of internet research for avg. monthly temp and monthly solar insolation. A stretch would be to use the heat storage and predict the temp).

Chapter 15

Read pp. 408-413 and study guide ch:15 4 thermodynamic processes

HW# 12 Page 433+ Questions: 2,4,5,3

Problems: **1-11**

Quiz: 4 Thermodynamic Processes

Read pp. 415-421 Heat engines including Carnot Efficiencies

HW# 13 Page 433+ Questions: 6,10,11,**9**

Problems: 18,20,23,**17,19,25**

AP Take-Home Problem: Heat Engine

Read pp. 419-425 Entropy

HW# 14 Page 433+ Questions: 13,17

Problems: 35,51,64, **37,43,52**

Exam: Thermal Physics & Take-Home Problem

Unit 4: Electricity 5 Weeks [CR2c] [CR2d]

Chapters: 16,17,18,19

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.

<p>A. Electrostatics</p> <ol style="list-style-type: none">1. Coulomb's Law2. Electric Field<ol style="list-style-type: none">a. Force on a test chargeb. Field diagramsc. Motion of particle in an E field3. Electric Potential<ol style="list-style-type: none">a. Due to a group of chargesb. Potential differencec. Work on a charged. Between parallel plates4. Electrostatics with Conductors<ol style="list-style-type: none">a. Absence of E field in conductorb. Equipotentialc. Charging by induction <p>B. Capacitors</p> <ol style="list-style-type: none">1. Capacitance2. Energy and charge stored3. Parallel plates <p>C. Electric Current</p> <ol style="list-style-type: none">1. Definition of direction of current2. Ohm's Law3. Resistance and Resistivity4. Power <p>D. DC Circuits</p> <ol style="list-style-type: none">1. Schematic diagrams/Kirchhoff's Laws2. Resistors<ol style="list-style-type: none">a. In seriesb. In parallel3. Capacitors<ol style="list-style-type: none">a. In seriesb. In parallel	<p>Skim pp. 439-463 HW# 15 Page 464+ Questions: 10,16 Problems: <u>11,21,32,40,41,54,61</u></p> <p><i>Lab 6 Investigating Equipotential Lines and Electric Fields (Guided-Inquiry) [CR6b] • Objective: Students will draw lines of equal electrostatic potential and electric field lines for various charge configurations and determine the dependence of the electrostatic potential on the distance from a point charge.</i></p> <p>Read pp. 470-475 HW# 16 Page 488+ Questions: <u>2,3,4</u> Problems: <u>1,11, 3,5,14</u></p> <p>Read pp. 476-479 HW# 17 Page 488+ Questions: <u>5,7,12</u> Problems: <u>16,19,20,22</u></p> <p>Read pp. 480-485 Capacitors HW# 18 Page 488+ Questions: <u>14,15</u> Problems: <u>31,47,51,33,35,43</u></p> <p>Review Problems pp. 488+ Problems: <u>55,59,65,66</u></p> <p>Quiz on Chapter 16 &17</p> <p>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.</p> <p>Skim pp. 493-510 top HW# 19 Page 514+ Questions: <u>6,9</u> Problems: <u>7,9,17,22,36,38</u></p> <p>Read pp. 520-545 Comb/Kirchoff's HW# 20 Page 545+ Questions: 7,8,13 Problems: <u>4,11,15,19,24, 29,30, 33</u></p>
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<p>4. Terminal voltage and internal resistance</p> <p>5. Steady-state RC circuits</p>	<p>RC Circuit Lab</p> <p>Read pp. 520-545 RC Circuits</p> <p>HW# 21 Page 545+ Questions: 19</p> <p>Problems: <u>36,37,39,46, 47,49, 50,51,82</u></p> <p>Test Chapter 18 & 19</p>
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<p>Unit 5: Magnetism 4 Weeks [CR2e]</p> <p>Chapter: 20,21</p> <p>Big Idea 2: Fields existing in space can be used to explain interactions.</p> <p>Big Idea 3: The interactions of an object with other objects can be described by forces.</p> <p>Big Idea 4: Interactions between systems can result in changes in those systems.</p>	
<p>A. Magnetostatics</p> <ol style="list-style-type: none"> 1. Magnetic field 2. Forces on moving charges 3. Forces on a current-carrying wire 4. Magnetic field of current-carrying wires <p>B. Electromagnetism</p> <ol style="list-style-type: none"> 1. Magnetic flux 2. Faraday's Law and Lenz's Law 3. Induced emf and induced current 	<p>7) Investigating Magnetic Fields (Guided-Inquiry) [CR6b] • Objective: Students will determine the magnetic field around magnets and represent this information as magnetic field lines.</p> <p>Read pp. 554-566</p> <p>HW# 21 Page 576+ Questions: <u>3,4,6,9,13,10,18</u></p> <p>Problems: <u>2,3,8,11,16,5,7,9,10</u></p> <p>Quiz</p> <p><i>Lab 8: Measurement of the Earth's Magnetic Field (Guided-Inquiry) [CR6b] • Objective: Students will apply Ampere's Law to measure the strength of the horizontal component of the earth's magnetic field in the lab room.</i></p> <p>Read pp. 567-569</p> <p>HW# 22 Page 576+ Problems: <u>29,32,48,27</u></p> <p>Take-Home Problem</p> <p><i>Lab 9: Measuring Magnetic Fields & e/m</i></p> <p>Read pp. 570-573 top</p> <p>HW# 23 Page 576+ Questions: <u>17,21</u></p> <p>Problems: <u>41,67,71</u></p> <p>Quiz & Take-Home problem</p> <p><i>Lab 10: Electromagnetic Induction (Guided-Inquiry) [CR6b]</i></p> <p>• Objective: Students will qualitatively observe the transfer of energy between two coils. Determine how the ratio of number of coils affects the voltage and current in each coil.</p>

	<p>Read pp. 584-591 HW#24 Page 609+ Questions: <u>1,4,2,3,5</u> Problems: <u>2,4,5,11,13,17,6,15</u></p> <p>Read pp. 592-597 HW#25 Page 609+ Questions: <u>18,10,11,15</u> Problems: <u>31,34,72,77,36</u></p> <p>Test Chapter 20 & 21 including Take-Home Problem</p>
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<p>Unit 6: Optics 6 Weeks [CR2f] Chapters: 22,23,24,25</p> <p>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.</p>	
<p>A. Physical Optics</p> <ol style="list-style-type: none"> 1. The electromagnetic spectrum 2. Interference a. Two-source interference 3. Diffraction <ol style="list-style-type: none"> a. Diffraction grating 4. Thin films <p>B. Geometric Optics</p> <ol style="list-style-type: none"> 1. Reflection and refraction <ol style="list-style-type: none"> a. Snell's Law b. Total internal reflection 2. Images formed by mirrors <ol style="list-style-type: none"> a. Ray diagrams b. Thin lens/mirror equation 3. Images formed by lenses <ol style="list-style-type: none"> a. Ray diagrams b. Thin lens/mirror equation 	<p>Read pp. 615-623 – To truly understand Maxwell's equations you need to use differential equations, so this is just a brief look...</p> <p>HW# 26 Page 629+ Questions: <u>2,3, 7</u> Problems: <u>5,11,13</u></p> <p><i>Lab 11 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.</i></p> <p>Read pp. 632-641 HW# 27 Page 657+ Questions: <u>7,9</u> Problems: <u>1,4,9,10,12, 7</u></p> <p>Read pp. 642-646 HW# 28 Page 657+ Questions: <u>11,14,13</u> Problems: <u>29,24,27,31</u></p> <p><i>Lab 12 Focal Length of a Lens (Guided-Inquiry) [CR6b] • Objective: Students will design an experiment to measure the length of a converging lens and a diverging lens.</i></p> <p>Read pp. 647-654 HW#29 Page 657+ Questions: <u>18,20,24,25</u> Problems: <u>43,53,81</u></p>

	<p><i>Lab 13: Simple Telescope. Students will design and create a simple telescope.</i></p> <p>Read pp. 646-666 top & 668-677 Diffraction & interference HW# 30 Page 691+ Questions: 6,7,19 Problems: 3,4,27</p> <p><i>Lab 14: Diffraction Grating to measure λ and grooves on a CD</i></p> <p>Read pp. 679-683 Thin film interference & polarization HW# 31 Page 691+ Questions: 14 Problems: 41,16,17,39</p> <p>Quiz Chapter 23 & 24 including Take-Home Problem</p> <p>11) 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.</p> <p>13) 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.</p>
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<p>Unit 7: Atomic & Nuclear Physics 4 Weeks [CR2g] Chapters: 26,27,28,30,31</p> <p>Big Idea 1: Objects and systems have properties such as mass and charge. Systems may have internal structure.</p> <p>Big Idea 3: The interactions of an object with other objects can be described by forces.</p> <p>Big Idea 4: Interactions between systems can result in changes in those systems.</p> <p>Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.</p> <p>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.</p> <p>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.</p>	
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Course Sequence	Student Labs and Activities
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<p>A. Atomic Physics and Quantum Effects</p> <ol style="list-style-type: none"> 1. Discovery of the Electron and Atomic Nucleus <ol style="list-style-type: none"> a. Cathode ray tube b. Millikin's Oil Drop Experiment c. Rutherford scattering 2. Photons and the Photoelectric Effect <ol style="list-style-type: none"> a. Energy of a photon b. Intensity and number of photons c. Stopping potential 3. Bohr Model <ol style="list-style-type: none"> a. Energy levels b. Emission and absorption spectra c. Transition between energy levels 4. DeBroglie Wavelength <ol style="list-style-type: none"> a. Wavelength of Particles 5. Production of X-rays 6. Compton Scattering 	<p>Chapter 26</p> <p>Chapter 27</p> <p>Read pp. 754-761 History & <i>Photoelectric Effect</i> HW#32 Page 782+ Questions: 5,7,27 Problems: 1,11,17,21</p> <p><i>Lab 15: Anti-Photo Electric Effect</i></p> <p>Read pp. 762-764 & 765-768 Momentum, Compton Scattering, deBroglie HW# 33 Problems: 38</p> <p><i>Lab 16 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.</i></p>
<p>B. Nuclear Physics</p> <ol style="list-style-type: none"> 1. Atomic number, mass number, and atomic mass 2. Nuclear processes <ol style="list-style-type: none"> a. Radioactive decay (alpha, beta, and gamma) b. Fusion c. Fission 3. Mass-Energy equivalence 	<p>Read pp. 769-778 & 780-781 Bohr Model w/ deBroglie λ of electron HW# 34 Page 782+ Problems: 49,54</p> <p>Take-Home Problem</p> <p>Chapter 30</p> <p>Read pp. 835-841 Nucleus basics & binding energy HW# 35 Page 859+ Questions: 1,4,6 Problems: 9,12</p> <p>Read pp. 841-852 Nuclear decay & $\frac{1}{2}$ life HW#36 Page 859+ Questions: 21 Problems: 18,20,37,40,43</p> <p><i>Lab 17: Measuring Radiation: Background, Distance and determining $\frac{1}{2}$ life.</i></p> <p>Quiz Chapter 27 & 30</p>

INSTRUCTIONAL ACTIVITIES

Throughout the course, the students engage in a variety of activities designed to build the students' reasoning skills and deepen their conceptual understanding of physics principles. Students conduct activities and projects that enable them to connect the concepts learned in class to real world applications. Examples of activities are described below.

1. SIMULATION ACTIVITY

Students engage in activities outside of the laboratory experience that support the connection to more than one Learning Objective.

ACTIVITY: Quantum Wave Interference [CR3]

DESCRIPTION:

The PhET Quantum Wave Interference simulation (<http://phet.colorado.edu/en/simulation/wave-interference>) helps students to visualize the behavior of photons, electrons, and atoms as particles and as waves through a double-slit. The students work in small groups through a series of ‘experiments’ that confront students with the basic conflict between the wave model and particle model. The groups have to gather evidence that will allow them to justify how the double slit interference pattern is consistent with both the classical wave view and the photon view. After the class discussion, the students should be able to articulate how the wave view is related to the photon view. This activity is designed to allow students to apply the following Learning Objectives:

Learning Objective 1.D.1.1 The student is able to explain why classical mechanics cannot describe all properties of objects by articulating the reasons that classical mechanics must be refined and an alternative explanation developed when classical particles display wave properties.

Learning Objective 6.G.1.1 The student is able to make predictions about using the scale of the problem to determine at what regimes a particle or wave model is more appropriate.

2. REAL WORLD APPLICATIONS [CR4]

DESCRIPTION:

Students will theoretically design the most efficient heat exchange using copper refrigeration tubing. Students will be presented with three different inner-diameter tubing and asked to design an efficient heat exchanger. They will use tap water forced through the copper tubing in order to create the heat exchanger. Students will boil 1000 ml of water and test their design to see how long it takes the temperature of the water to drop to 25°C. Students will have 3 class days in order to complete the research, design and construction of their heat exchanger.

Learning Objective 4.C.3: Energy is transferred spontaneously from higher temperature system to a lower temperature system. This process of transferring energy is called heating. The amount of energy transferred is called heat.

Learning Objective 5.B.6: Energy can be transferred by thermal processes involving differences in temperature; the amount of energy transferred in this process of transfer is called heat.

Learning Objective 5.B.10: Bernoulli’s equation as well as the continuity equation describes the conservation of energy in fluid flow.

3. ACTIVITY: Nuclear Energy: Friend or Foe

DESCRIPTION: In addition to the physics concepts, this project requires the evaluation of ethical concerns in order to arrive at a decision regarding nuclear energy. This project is meaningful and engaging to students as it requires the use of evidence-based reasoning through dialogue and provides a context for understanding scientific information.

Students work in teams of two to investigate the socio-scientific issue about the pros and cons of the use of nuclear energy. The research includes an explanation of the process of nuclear fission, the basic operation of a nuclear reactor, how a chain reaction works and how magnetic and inertial confinements can provide thermonuclear power. Students have to discuss safety, cost-effectiveness, and environmental impact including wildlife and human health. The culmination activity is a debate moderated by the students themselves.

Learning Objective 5.G.1.1 The student is able to apply conservation of nucleon number and conservation of electric charge to make predictions about nuclear reactions and decays such as fission, fusion, alpha decay, beta decay, or gamma decay.

In the four-week period between the AP Exam and year-end, the course work will be focused in two primary areas:

1. Preparation for the AP II Exam
2. Summary activities

Students are tasked with designing and testing an apparatus or a structure, similar to a Science Olympiad event. Some examples are bridges, catapults, etc. Rules and limitations regarding materials and dimensions are set (LO 1.C.1.1, 3.A.3.3, 3.B.1.2). Students are given the opportunity to test and refine their project. The finished products are then showcased in a competitive, yet friendly setting. **[CR3] [CR4]**