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.	3
CR2a The course design provides opportunities for students to develop an understanding of the foundational principles of thermodynamics in the context of the big ideas that organize the curriculum framework.	9
CR2b The course design provides opportunities for students to develop an understanding of the foundational principles of fluids in the context of the big ideas that organize the curriculum framework.	9-10
CR2c The course design provides opportunities for students to develop an understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.	6
CR2d The course design provides opportunities for students to develop an understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.	7-8
CR2e The course design provides opportunities for students to develop an understanding of the foundational principles of magnetism and electromagnetic induction in the context of the big ideas that organize the curriculum framework.	8-9
CR2f The course design provides opportunities for students to develop an understanding of the foundational principles of optics in the context of the big ideas that organize the curriculum framework.	10-11
CR2g The course design provides opportunities for students to develop an understanding of the foundational principles of modern physics in the context of the big ideas that organize the curriculum framework.	11
CR3 Students have opportunities to apply AP Physics 2 learning objectives connecting across enduring understandings as described in the curriculum framework. These opportunities must occur in addition to those within laboratory investigations.	6-11
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.	4
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.	6-11
CR6a The laboratory work used throughout the course includes a variety of investigations that support the foundational AP Physics 2 principles.	6-11
CR6b The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.	6-11
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.	3-5
CR8 The course provides opportunities for students to develop written and oral scientific argumentation skills.	3, 5

COURSE DESCRIPTION

The AP Physics course is designed to meet the objectives of a college level general physics course and to prepare the student to seek credit and/or appropriate placement in college physics. It is designed for the academically talented and mature student who have completed the appropriate math courses. Students enrolled in this course will understand the fundamentals of physics and become competent in solving complex physics problems. Students will develop the ability to think clearly and logically and will be able to express these capabilities in both written and oral form. The problem-solving strategies obtained during this course will prepare students for careers in the sciences, medicine, engineering, and other technical fields. This course is arranged around the seven big ideas and seven science practices articulated in the AP Physics curriculum framework and meets all of the standards designated by the College Board.

COURSE GOALS

- to provide college-level physics instruction in order to prepare students for the AP exam and/or appropriate placement in a college physics course.
- to provide college-level laboratory experience where students:
    - manipulate equipment and materials to make relevant observations and collect data;
    - use collected data to form conclusions and verify hypotheses;
    - communicate and compare results and procedures both formally and informally
- to prepare students to be independent and critical thinkers who are able to function in a scientific and technological world
- to analyze scientific and societal problems using scientific problem solving skills
- to gain an understanding of the six big ideas and meet the learning objectives that are outlined in the AP Physics Curriculum Framework.

SEVEN BIG IDEAS

1. Objects and systems have properties such as mass and charge. Systems may have internal structure.
2. Fields existing in space can be used to explain interactions.
3. The interactions of an object with other objects can be described by forces.
4. Interactions between systems can result in changes in those systems.
5. Changes that occur as a result of interactions are constrained by conservation laws.
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.
7. The student can use representations and models to communicate scientific phenomena and solve scientific problems.

SEVEN SCIENCE PRACTICES

1. The student can use representations and models to communicate scientific phenomena and solve scientific problems.
2. The student can use mathematics appropriately.
3. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
4. The student can plan and implement data collection strategies in relation to a particular scientific question.
5. The student can perform data analysis and evaluation of evidence.
6. The student can work with scientific explanations and theories.
7. The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

TEXTBOOK AND RESOURCES

Cutnell, John and Kenneth Johnson. *Physics. 9th edition.* Hoboken, NJ: John Wiley and Sons, 2012. [CR1]

Hieggelke, Curtis, David Maloney, and Thomas O'Kuma. *Ranking Task Exercises in Physics.* San Francisco, CA: Pearson, 2008.

Hieggelke, Curtis, David Maloney, Tomas O'Kuma, and Stephen Kanim. *TIPERs: Sensemaking Tasks for Introductory Physics.* Upper Saddle River, NJ: Pearson, 2014.

Alabama Science in Motion lab and materials.

CLASSROOM SCHEDULE AND REQUIREMENTS

The AP Physics class meets 5 days per week for 96 minutes allowing for lecture, discussion and a strong laboratory component. In order to allow for more time for laboratory time and other activities, many topics are presented in a flipped classroom format. [CR6a]
Topics are covered using PowerPoint presentations in a discussion format. Students are also arranged in study groups to allow for inquiry based learning. The learning groups are used to work through free response questions from past exams. Grades will be determined from tests, quizzes, and laboratory reports/presentations.

LABORATORY

The laboratory component of this course is designed to be the equivalent of a college laboratory experience. Two to three students comprise one lab group. The laboratory activities are investigative in nature and require students to follow or develop procedures, make observations, record, manipulate, process and graph both quantitative and qualitative data obtained during experimentation. At least six labs per year will be inquiry based allowing students to employ the seven science practices outlined in the AP Physics curriculum framework. A minimum of 25% of student contact time will be spent doing hands-on laboratory activities. [CR5]

The students use guided–inquiry (GI) or open–inquiry (OI) in the design of their laboratory investigations. Some labs focus on investigating a physical phenomenon without having expectations of its outcomes. In other experiments, the student has an expectation of its outcome based on concepts constructed from prior experiences. In application experiments, the students use acquired physics principles to address practical problems. Students also investigate topic-related questions that are formulated through student designed/selected procedures.

Students work in lab groups; each student group must present their results to the class and defend their results. They will also evaluate one other group's approach to the problem and offer a critique of their procedures and results. [CR8]
Each student must submit a lab report which is turned in at the conclusion of each activity, then graded and returned. The report must include the following components: [CR7]

- Statement of the problem
- Hypothesis
- Discussion or outline of how the procedure will be carried out
- Data collected from the experiment
- Data analysis
- Conclusion including error analysis
- Peer review (if included in this lab)

Students are required to keep the reports in an organized lab notebook. This lab notebook will kept by the students for the entire year and must include the completed lab reports as well as the raw data tables and any notes made during the execution of the labs done in the course. [CR7]

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 [CR3]

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

ACTIVITY: Quantum Wave Interference

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 APPLICATION [CR4]

ACTIVITY 1. Fluid Applications

DESCRIPTION:

Students write a series of questions that they wonder about related to buoyancy and density in real world contexts. In teams of two, the students select one research question. They have two class periods to post their results of the research on a Google Doc. Each team presents their information and any sources of data found to the class. Sample questions are:

- How do metal ships float?
- Will a ship full of oil float differently than an empty ship?
- If an oil tanker develops a leak, why does it sink?
- How will a ship float in fresh water as opposed to salt water?
- How and why do hot air balloons work?
- Would hydrogen balloons float better than balloons filled with hot air?

Learning objective 1.e.1.1

The student is able to predict the densities, differences in densities, or changes in densities under different conditions for natural phenomena and design an investigation to verify the prediction.

Learning objective 1.e.1.2

The student is able to select from experimental data the information necessary to determine the density of an object and/or compare densities of several objects.

Learning objective 3.C.4.2

The student is able to explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions.

ACTIVITY 2. Laser Applications

DESCRIPTION:

Students first investigate how a laser works using the PhET Laser simulation (http://phet. colorado.edu/en/simulation/lasers). The simulation helps the students understand how absorption and spontaneous and stimulated emission work.

Students will be able to explain how these factors: intensity and wavelength of the lamp, the mirror reflectivity, and the lifetimes of the excited states of the atom influence the laser. After writing their observations, they conduct online research to submit a paper that will demonstrate their ability to read and synthesize scientific literature about the applications of lasers in modern medicine. Common research topics of applications include vision correction (LASIK surgery), tattoo removal, and varicose vein treatments.

Learning objective 5.B.8.1

The student is able to describe emission or absorption spectra associated with electronic or nuclear transitions as transitions between allowed energy states of the atom in terms of the principle of energy conservation, including characterization of the frequency of radiation emitted or absorbed.

3. SCIENTIFIC ARGUMENTATION [CR8]

In the course, students become familiar with the three components of scientific argumentation. The first element is the claim, which is the response to a prediction. A claim provides an explanation for why or how something happens in a laboratory investigation. The second component is the evidence, which supports the claim and consists of the analysis of the data collected during the investigation. The third component consists of questioning, in which students examine and defend one another's claims. Students receive explicit instruction in posing meaningful questions that include questions of clarification, questions that probe assumptions, and questions that probe implications and consequences. As a result of the scientific argumentation process, students are able to revise their claims and make revisions as appropriate.

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.