

WRHS Science Curriculum Syllabus

Course Name: Advanced Topics in Physics

Grade Level: 11 & 12

Course Description:

This course is intended to be a more rigorous treatment of topics such as mechanics, properties of matter, an introduction to thermodynamics, wave theory, electromagnetic interactions, and/ or modern physics with an emphasis on mathematical techniques in problem solving and data analysis. Specific topics will be identified during the year. Labs will be done on a regular basis. Computers will be used in the data collection process. This course is designed for students who are considering a physics or engineering major in college. **An Individual Experimental Research Project in Physics is REQUIRED for this course.**

Links to Student Expectations:

- All students will develop skills to utilize technology to gather, to evaluate, to assimilate, and to present information.
- All students will utilize critical thinking skills to identify and to provide resources to solve a problem.
- All students will learn to communicate critically, persuasively, and personally in both oral and written expression.
- All students will be able to make decisions and solve problems using logical processes (e.g., scientific method, induction, deduction, syllogism, etc.).
- All students will develop skills to promote a sense of confidence in tackling the rigors of standardized tests such as the required MCAS and optional AP, SAT.

Interdisciplinary Connections:

The topics and concepts investigated in this advanced physics course can provide a better understanding and help explain observations and theories in other areas such as mathematics, chemistry, biology and physiology, engineering and technology, astronomy, cosmology, environmental science, computer programming, data collection and analysis. It can also help provide a background in discussing topics in non-science fields such as history, English, and societal issues.

I. Essential Questions for Course

- What are the basic corollaries that underlie the very foundation of classical physics, and provide the starting point for the era of modern physics?
- How has the atomic theory evolved into what it is today?
- How has our perception of the universe evolve into what it is today?

- How has the duality of the nature of light unfolded to become the basis for the Quantum Theory of the atom?
- What is the Photoelectric Effect, and how has it contributed to the development of Modern Physics?
- How has Albert Einstein been instrumental in the history of physics and science in general?
- What is the difference between special and general relativity?
- At what point do the laws of conventional physics break down and must be replaced with the probabilistics of quantum mechanics?
- Can Quantum Mechanics and General Relativity coexist in our description of the universe?
- What is the particle hierarchy in the field of high-energy physics?
- What are the practical implications for our study and construction of very high-energy particle accelerators?
- What is String Theory and how is it able to address the current state of cosmology?

II. Student Objectives

- To develop listening and note taking skills in a scientific and technical context.
- To think clearly and logically toward the solution of abstract problems.
- To communicate graphically, mathematically, and orally.
- To translate statements from English to mathematics, and vice versa.
- To work with, learn from, and teach each other through the various activities employed.
- To become proficient in the use of the calculator and computer.
- To test yourself to assess your progress.
- To apply laws of classical and modern physics to solve physical problems.
- To represent concrete physical situations by abstract models.
- To develop a foundation necessary to enter a technically-oriented college, and pursue a possible technical or scientific career.

III. Suggestions for Instruction

- Lectures (including A/V devices for enhanced presentation)
- Discussions (class, small group, etc.)
- Handouts
- Laboratory exercises
- Detailed major long-term group projects
- Teacher conducted demonstrations
- Videos (instructional, documentary, etc.)
- Movies (science/engineering themes)
- Internet sites

- Community outreach (professional scientists, engineers, post-secondary students, business and industry leaders, etc.)

IV. Suggestion for Assessment

- Regular block testing for comprehension of specific objectives
- Quarterly comprehensive examinations
- Laboratory reports (formal and informal)
- Individual project progress checks
- Comprehensive midyear and final examinations

V. Curriculum

- Review of basic mechanics
- Mechanical energy
- Thermal energy and thermodynamics
- Simple Harmonic Motion
- Wave theory
- Sound
- Light (Reflection and refraction/ geometric optics)
- Light (Other properties)
- Electricity and the electric field (Static)
- Electricity (current/ D.C. & A.C.)
- Magnetism and the magnetic field
- Electromagnetic radiation
- Electromagnetic induction
- Atomic structure and properties
- Introduction to quantum mechanics
- Nuclear structure and reactions
- High-energy particle physics
- Special relativity
- General relativity and astrophysics
- Cosmology and string theory

VI. Lesson Extensions

- Although this course will be presented and assessed at the same level for all students, students may opt for Honors credit by submitting a year-long research project. This project will require certain time-based submissions (topic selection, hypothesis, literature review, journal checks, etc.). The project will begin at the start of the school year, and continue through February, when it will be presented to the class, and possibly at the school science fair. Top placements at this fair will compete at the regional science fair in March.