SCIENCE DEPARTMENT **PHYSICS H: COURSE #441**

The Department's Educational Philosophy

We believe that students should be exposed to the process of scientific inquiry so they can acquire and interpret scientific knowledge, and begin to realize the wider applicability of scientific problem-solving methods. By making the laboratory the focal point of learning, we seek to foster students' appreciation for the experience of doing science.

Guiding Principles

- Students must be able to collect and analyze data and formulate hypotheses.
- Inductive and deductive problem-solving skills are central to science education.
- An effective program in science addresses the limitations of data and conclusions.
- Students should be able to use or design a strategy for testing scientific concepts.
- A comprehensive science program will emphasize the delicate checks and balances in man's abiotic and biotic environments and the stresses upon these ecosystems, which could affect the destiny of the world.
- Science is integrally related to mathematics.
- An effective science program builds students' ability to communicate accurately and precisely.
- An effective science program stresses both cooperative and independent learning.

PHYSICS H: COURSE #441

Course Frequency: Full-year course, eight times per six-day cycle
Credits Offered: Six
Prerequisites: Calculus (taken concurrently)

Background to the Curriculum

This is a calculus-based physics course that is very lab-oriented. The main text is Fundamentals of Physics, 4th Edition by Halliday, Resnick and Walker, which is commonly used in college first-year physics courses. Labs are used extensively to both introduce and reinforce the key concepts being studied. This course is mathematically challenging, and the students are expected to be able to apply the concepts studied to new situations. While it is not an AP course, the first half of the year covers the mechanics portion of the AP Physics C exam. (The Physics C exam has two portions, graded separately: Mechanics and Electricity & Magnetism.)

Core Topics / Questions / Concepts/ Skills

Kinematics
Newton's Laws
Momentum
Work and Energy
Rotational Mechanics
Oscillations
Astronomy
Universal Gravitation
Special Relativity
Electrostatics
Electric Circuits
Magnetism (if time permits)
Waves and Sound (if time permits)
Light and Optics (if time permits)

Course-End Learning Objectives

Students will:

Kinematics

1] Distinguish between and solve problems involving position, velocity, and acceleration.
2] Create and interpret graphs of motion (position vs. time, velocity vs. time, and acceleration vs. time).
3] Convert vectors between unit-vector form, component form, graphical form and magnitude/direction.
4] Add and subtract vectors, both graphically and analytically.
5] Solve a variety of word problems concerning projectile motion, circular motion, and relative motion.

Newton's Laws

1] State, explain and give examples of Newton's 3 Laws of Motion.
2] Compare and contrast mass and weight.
3] Construct an appropriate free-body diagram for any given situation/word problem.
4] Distinguish between static and kinetic friction, what they depend on, and their effects on the motion of an object.
5] Solve a variety of word problems involving multiple applied forces, tensions, and frictional forces.

Work and Energy

1] Explain and apply the Work-Kinetic Energy Theorem.
2] Explain and apply the Law of Conservation of Energy.
3] Explain how simple machines work in terms of energy principles.
4] Distinguish between kinetic and potential energy and power.

Momentum

1] Explain the concept of conservation of momentum. Use examples to support your explanation
2] Correctly use and apply the ideas of impulse, momentum, and collisions, in one and two dimensions.
3] Compare and contrast elastic collisions with inelastic collisions.

Rotational Mechanics

1] Correctly use and apply the equations and concepts of kinematics, Newton's Laws, momentum and energy to rotating objects.
2] Calculate and explain the idea of moment of inertia.
3] Apply the concepts of angular momentum and energy to everyday situations, such as why tops and Frisbees work.

Oscillations

1] Derive, explain and apply the general equation for simple harmonic motion.
2] Solve the equations of motion in a variety of situations to determine the period of oscillation.

Astronomy

1] Compare and contrast the main models of the solar system and explain why people either rejected or supported a particular model.
2] Identify and explain the significance of several historical figures prominent in the development of astronomical knowledge.
3] Apply Kepler's Laws of Planetary Motion to a variety of situations.
4] Identify and explain the astronomical observations that were being modeled by the various planetary systems.

Universal Gravitation

1] Explain and apply Newton's Law of Universal Gravitation.
2] Derive and apply Kepler's Laws of Planetary Motion.
3] Derive and apply equations for energy based on Universal Gravitation.

Special Relativity

1] State and explain the two postulates of special relativity.
2] Explain the significance of special relativity in terms of our understanding of time and space.
3] Explain the significance of special relativity in terms of our understanding of mass and energy.
4] Apply the ideas of Lorentz transformations and simultaneity to a variety of situations.
5] Derive and apply equations for time dilation, length contraction and the Doppler Shift.

Electrostatics

1] Explain and differentiate the three main ways of charging an object: by friction, induction, and conduction.
2] Construct and interpret sketches of electric field lines and equipotential lines.
3] Explain and apply Coulomb's Law in a variety of situations.
4] Differentiate between an insulator and a conductor.
5] Differentiate between electric potential and electric potential energy and between electric force and electric field.

Electric Circuits

1] Explain and apply the relationships between charge, current, resistance, voltage and power.
2] Explain what is meant by "Ohm's Law" and describe why some things obey and others do not.
3] Apply the laws of conservation of charge and conservation of energy to a circuit.
4] Qualitatively and mathematically analyze a circuit of resistors.

Magnetism

1] Explain and differentiate between magnetism and electric charge.
2] Explain and apply Faraday's Law of Induction.
3] Explain and apply the Biot-Savart Law.

Properties of Waves

1] Differentiate between wave motion and particle motion.
2] Compare and contrast the various types of waves and the media through which they travel.
3] Measure, calculate and apply the various characteristics of waves (e. g., amplitude, frequency, wavelength, speed)
4] Explain and apply the concept of wave superposition to a variety of situations.
5] Explain and apply the laws of reflection and refraction to a variety of situations.

Sound

1] Measure the speed of sound in a variety of ways.
2] Explain and apply how musical instruments work.

Light

1] Explain and apply the electromagnetic properties of light.
2] Explain and apply Snell's Law.
3] Differentiate between adding colors with light and with pigments; explain how we perceive colors.
4] Construct and interpret ray diagrams for lenses and mirrors.
5] Analytically solve for a variety of problems involving lenses and mirrors.

Assessment

- Tests: 3-4 per term using multiple choice, problem solving and short answer
- Quizzes: 1-5 per term using multiple choice, problem solving and short answer
- Labs: several per term, but no formal write up
- Other assessments could include lab practicums or engineering projects.

Materials and Resources

Halliday, Resnick and Walker, Fundamentals of Physics, 4th Edition (1993), John Wiley and Sons.
Hewitt, Conceptual Physics, 1st Edition (1987), Addison Wesley.