

Norton City Schools Standards-Based Science Course of Study 2003

HIGH SCHOOL ELECTIVE

ADVANCED PLACEMENT PHYSICS (USED AS A YEAR-LONG OR BLOCK-SCHEDULED COURSE)

Physical Sciences Standard (PS)

11-12 Benchmarks	Grade Level Indicators and Sub-Objectives	Teaching Strategies/Resources
<p>By the end of the 11-12 program, the student will,</p> <p><u>Physical Sciences</u></p> <ul style="list-style-type: none"> ★ Recognize that some atomic nuclei are unstable and will spontaneously break down. (PS-B) ★ Describe how atoms and molecules can gain or lose energy only in discrete amounts. (PS-C) ★ Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems. (PS-D) ★ Summarize the historical development of scientific theories and ideas within the study of physical sciences. (PS-E) 	<p>By the end of Eleventh/Twelfth Grades, the student will:</p> <p><u>Nature of Matter</u></p> <ul style="list-style-type: none"> ★ Explain how all matter tends toward more disorganized states and describe real world examples (e.g., erosion of rocks and expansion of the universe). (PS-12-3) ★ Recognize that at low temperatures some materials become superconducting and offer little or no resistance to the flow of electrons. (PS-12-4) <p><u>Forces and Motion</u></p> <ul style="list-style-type: none"> ★ Describe real world examples showing that all energy transformations tend toward disorganized states (e.g., fossil fuel combustion, food pyramids and electrical use). (PS-11-3) ★ Explain how electric motors and generators work (e.g., relate that electricity and magnetism are two aspects of a single electromagnetic force). Investigate that electric charges in motion produce magnetic fields and a changing magnetic field creates an electric field). (PS-11-4) ★ Use and apply the laws of motion to analyze, describe and predict the effects of forces on the motions of objects mathematically. (PS-12-5) ★ Recognize that the nuclear forces that hold the nucleus of an atom together, at nuclear distances, are stronger than the electric forces that would make it fly apart. (PS-12-6) ★ Recognize that nuclear forces are much stronger than electromagnetic forces, and electromagnetic forces are vastly stronger than gravitational forces. The strength of the nuclear forces explains why 	

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	<p>greater amounts of energy are released from nuclear reactions (e.g., from atomic and hydrogen bombs and in the sun and other stars). (PS-12-7)</p> <p>★ Describe how the observed wavelength of a wave depends upon the relative motion of the source and the observer (Doppler effect). If either is moving towards the other, the observed wavelength is shorter; if either is moving away, the observed wavelength is longer (e.g., weather radar, bat echoes and police radar). (PS-12-8)</p> <p>★ Describe how gravitational forces act between all masses and always create a force of attraction. Recognize that the strength of the force is proportional to the masses and weakens rapidly with increasing distance between them. (PS-12-9)</p> <p><u>Nature of Energy</u></p> <p>★ Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts. (PS-12-13)</p> <p><u>Historical Perspectives and Scientific Revolutions</u></p> <p>★ Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity). (PS-12-14)</p> <p>★ Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe). (PS-12-15)</p> <p><u>Sub-Objectives to Meet Indicators:</u></p> <p>Mechanics</p> <ul style="list-style-type: none">• Describe and utilize basic units of the metric system.• Convert simple metric units into each other.• Discuss the idea that motion is relative.• Differentiate between scalar and vector quantities, including both distance	
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	<p>and displacement and speed and velocity.</p> <ul style="list-style-type: none"> • Distinguish between velocity and acceleration. • Plot and/or interpret experimental data on position versus time graphs and velocity versus time graphs. • Solve simple speed and displacement problems with equations and/or graphs. • Explain Newton’s First Law of Motion, incorporating the concept of inertia. • Distinguish among mass, volume, and weight. • Explain Newton’s Second Law of Motion and apply it to the relationships among net force, mass, and acceleration. • Solve simple problems using Newton’s Second Law of Motion. • Explain Newton’s Third Law of Motion and identify action-reaction forces. • Explain why action-reaction forces do not cancel each other out to prohibit the motion of an object. • Describe the effects of friction on an object. • Apply Newton’s laws to describe the motion of objects at rest, moving at a constant velocity, and accelerating. • Distinguish between components and resultant. • Explain projectile motion using vectors and change in momentum. • Compare and contrast momentum and impulse. • Compare and contrast impulses for different scenarios, including bouncing. • Explain the relationship between impulse and change in momentum. • Explain the Law of Conservation of Momentum. • Apply the Law of Conservation of Momentum to collisions and explosions. • Solve simple problems using the Law of Conservation of Momentum. • Determine the amount of work done on an object. • Compare and contrast mechanical, gravitational, potential, and kinetic energy. • Solve simple problems using the definitions of potential and kinetic energy. • Explain and apply the Law of Conservation of Energy. • Solve simple problems using the Law of Conservation of Energy. • Explain the work-energy theorem. 	
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	<ul style="list-style-type: none">• Compare the relationship between speed and distance using the work-energy theorem.• Distinguish between rotational motion and revolving motion.• Distinguish between rotational speed and linear speed.• Compare and contrast centripetal force and centripetal acceleration.• Identify centripetal forces.• Determine the center of gravity of an object.• Explain the role of inertia, or how centrifugal forces have no role, in the motion of spinning objects.• Determine whether or not an object will tip.• Solve simple problems using the definition of torque and equilibrium.• Explain rotational inertia.• Explain and apply the Law of Conservation of Angular Momentum.• Define the Universal Law of Gravitation.• Explain the Inverse Square Law.• Apply the Universal Law of Gravitation to calculate changes in gravitational forces between two masses.• Explain the idea of weightlessness as an example of free-fall.• Explain how a satellite is able to orbit. <p>Electricity and Magnetism</p> <ul style="list-style-type: none">• Define the concept of charge and state the SI unit for charge.• Explain the basic properties of charge including attraction, repulsion, and conservation.• Distinguish between insulators and conductors.• Differentiate among charging by friction, conduction, and induction.• Explain the concept of electric field, including how to determine its direction.• Explain the concept of electric shielding, that the electric field inside a charged conductor is zero.• Compare and contrast volt, electric current, and electric resistance.• Explain Ohm's Law.• Solve simple problems using Ohm's law.• Calculate equivalent resistances for series and parallel combinations of resistors.• Interpret simple schematic diagrams and be able to distinguish between parallel and series circuits.	
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- Perform simple circuit analyses on series and parallel circuits.
 - Explain the Domain Theory of Magnetism.
 - Determine magnetic field strengths and directions.
 - Distinguish between an electromagnet and an earth magnet.
 - Explain what factors determine the strength of an electromagnet.
 - Determine the direction of a magnetic field around current-carrying conductors.
 - Calculate an induced EM using Faraday's Law.
- Heat and Thermodynamics**
- Compare and contrast the concepts of heat, temperature, and thermal energy.
 - Determine the direction of an induced current.
 - Solve problems using Faraday's Law.
 - Explain how Lenz's Law determines and controls the amount of induced current.
 - Explain thermal expansion and coefficients of expansion.
 - Solve thermal expansion problems.
 - Explain the concepts of specific and latent heat.
 - Solve problems using specific and latent heat.
 - Explain phase changes and temperature changes when heat is added to or taken from a substance.
 - Explain the First Law of Thermodynamics.
 - Compare and contrast adiabatic, isothermal, isometric, and isobaric processes.
 - Apply the First Law of Thermodynamics to heat engines.
 - Interpret schematic diagrams of heat engines and refrigerators.
 - Explain the Second Law of Thermodynamics.
 - Explain entropy as it relates to heat engines.
- Sound and Sound Waves**
- Distinguish between harmonic and periodic motion.
 - Compare and contrast amplitude, frequency, and period.
 - Determine the period of a harmonic oscillating spring.
 - Determine the period of a pendulum.
 - Calculate displacement, velocity, and acceleration for harmonic motion.
 - Distinguish between longitudinal and transverse waves.
 - Explain the properties and characteristics of waves, including reflection,

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	<p>refraction, diffraction, and interference.</p> <ul style="list-style-type: none"> • Solve problems incorporating wave speed, frequency, and wavelength. • Explain the relationship between intensity and intensity level (decibels). • Explain the relationship between frequency and pitch. • Solve problems involving intensity levels. • Explain the human hearing thresholds of audibility while incorporating the dependence upon frequency. • Distinguish harmonics from pictorial representations of waves. • Calculate fundamental frequencies and harmonics for both closed and open pipes. • Explain resonance and distinguish between resonance and sympathetic vibrations. • Solve problems involving the Doppler Effect. • Calculate beats and beat frequencies. <p>Light</p> <ul style="list-style-type: none"> • Distinguish among reflection, refraction, diffraction, and interference. • Determine when each of the above do or do not occur. • Define angle of incidence and normal. • Calculate angles of reflection. • Distinguish among plane, concave, and convex mirrors. • Determine the focal length of a curved mirror. • Determine image characteristics using the mirror equation. • Draw ray diagrams for the different types of mirrors. • Explain spherical aberration and explain how to correct for it. • Explain the concept of index or refraction. • Calculate angles of refraction using Snell's Law. • Distinguish between converging and diverging lenses. • Determine the focal length of a thin lens. • Determine image characteristics using the Lens Equation. • Explain chromatic aberration and how to correct it. • Explain the significance of Thomas Young's Double Slit experiment. • Distinguish between polarized and non-polarized light. • Solve problems for single, double, and multiple-slit diffraction patterns. • Explain why thin-film interference occurs. • Solve problems for Brewster's angle. • Explain why the sky appears blue, clouds appear white, and 	
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	<p style="text-align: center;">sunsets/sunrises appear red.</p> <p>Modern Physics</p> <ul style="list-style-type: none"> • Explain the intent and outcome of the Michelson-Morley experiment. • State Einstein’s two postulates of Special Relativity. • Explain time dilation. • Explain the twin-trip dilemma. • Explain mass increase. • Solve problems using length contraction. • Solve problems using relativistic mass and kinetic energy. • Solve problems using time dilation. • Explain Einstein’s $E=mc^2$. • Explain the relationship between wavelength and intensity for thermal radiation. • Calculate the energy of a photon. • Explain the photoelectric effect and its significance in determining the characteristics of light. • Explain the relationship between the kinetic energy of a photoelectron and the frequency of the light source. • Explain the relationship between the current produced during the photoelectric effect and the intensity of the light source. • Distinguish between the predicted classical outcomes of the photoelectric effect and the actual experimental outcomes. • Explain and theoretically defend the dual nature of light. • Explain Bohr’s theory of the Hydrogen atom. • Compare and contrast emission and absorption spectra. • Explain Rutherford’s gold foil experiment and state its significance. • Find atomic numbers and mass numbers on the periodic table and explain how these are determined for each element. • List the distinguishing characteristics of watch of various types of radiation Calculate binding energies for specific isotopes. • Compare and contrast nuclear fission and nuclear fusion. • Explain the differences in the energy released for fission and fusion. • Explain why nuclear fission results in radioactive waste. • Explain why nuclear fusion does not result in radioactive waste. • Explain and interpret energy level diagrams. • Calculate emitted or absorbed frequencies from emission or absorption 	
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	<p>spectra.</p> <ul style="list-style-type: none">• Explain why large nuclei become unstable.• Explain what an isotope is.• Solve problems using half-life information.• Explain the concept of binding energy.• Explain and calculate De Broglie wavelengths.• Determine orbital radii for single electrons.• Write balanced nuclear reaction equations.• Explain why nuclear fusion is presently not a source of energy.• Determine orbital radii for single electrons.	
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