APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Physics B AP **Course Number:** 43161

Department: Science **ADS Number:** 17354944

Prerequisites: Successful completion (C or better) of Algebra II is highly recommended

Length of Course: One Year **Credit/PRI Area:** .50 per Sem/Science **Grade Level(s):** 11 - 12

Important Notes:

COURSE DESCRIPTION: This laboratory course* is designed to give an overview of six major areas of physics: mechanics, electricity and magnetism, waves, optics, nuclear physics, thermodynamics, and fluids. This course fulfills New Mexico's third-year science requirement and is designed to be the equivalent of a college introductory level trigonometry-based physics course. It is an intense course of study stressing mathematical skills, study skills, critical thinking skills, and time management skills. At the completion of this course, the student is strongly encouraged to take the AP exam. The student who demonstrates sufficient qualification on this exam may receive college-level science credit. The student planning on majoring in science or engineering should be aware that Physics B-AP does not replace a college-level calculus-based physics class. Physics B-AP gives the student an excellent conceptual and mathematical understanding of physics, and increased success in a calculus-based college physics class. Literacy strategies are integrated throughout the curriculum.

* Lab Courses: A minimum of 250 minutes per week of directed class activity for 36 weeks, 40% of which must be lab oriented, for a total of 150 clock hours (90 hours of class plus 60 hours of lab) shall be required for one (1) unit of credit, excluding passing period. [APS Procedural Directives, Section I – Instruction, Basis for offering credit].

References in parentheses following each performance standard refer to and are aligned with the State of New Mexico Science Standards and the Albuquerque Public Schools Language Arts Standards (APSLA).

STRATEGIES:
The "Illustrations" column in the program of studies provides exemplars of the performance standards, strategies, and best practices suggested by the science teachers in the Albuquerque Public Schools.

ASSESSMENTS:
The "Illustrations" column also incorporates a variety of assessments and "check for" items, suggested by science education teachers. Assessments include the following: authentic and performance-based assessment, cooperative learning, teacher observations, role playing, checklists, rubrics, tests, quizzes and exams, laboratory work, formal and informal writing, individual and peer conferences, small group and full class discussions, oral and multimedia presentations, projects, demonstrations, and portfolios/notebooks.

SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:

- *College Physics* - Jerry D. Wilson, Anthony J. Buffa - Prentice Hall, 5th edition – 2002
- *Conceptual Physics: Concept-Development Practice Book* - Paul Hewitt, Pearson - Prentice Hall, 3rd edition - 1997
- *Conceptual Physics: Practicing Physics* - Paul G. Hewitt, Addison-Wesley - Educational Publishers, Workbook edition – 1998
- *Physics* – Douglas C. Giancoli – Prentice Hall, 6th Edition - 2004
- *The Princeton Review: Cracking the AP Physics B & C Exams* - Steven A. Leduc - Princeton Review - 2004-2005

Video Series:

- *The Mechanical Universe* (Annenberg)
- *Bill Nye The Science Guy* (Disney Studios)
- *The Elegant Universe (NOVA - WGBH)*
- *Cosmos (PBS – Koch Entertainment)*

SUGGESTED TITLES/AUTHORS WEB SITES:

- www.collegeboard.com
- http://feh.eng.ohio-state.edu/Labs/HeatTransfer/HeatTransfer.html
- http://particleadventure.org/particleadventure/frameless/unseen.html
- http://cougar.slvhs.slv.k12.ca.us/~pboomer/labsphys/physlabook/lab8.html
- http://www.arachnoid.com/gravitation/index.html – online demo
- http://school.discovery.com/lessonplans/programs/temperatureandpressure/
- http://micro.magnet.fsu.edu/electromag/java/faraday2/
- http://www.physicsclassroom.com/Class/neewtlaws/U2L4a.html
- http://www.phy.ntnu.edu.tw/java/relativeVelocity/relativeVelocity.html
- http://physics.bu.edu/~duffy/semster1/c20_wave_fvl.html
- http://galileo.phys.virginia.edu/%7Esnp9B/java/Ripple.html – online demo
- http://physics.bu/edu/~duff/semester1/c21_doppler.html – online demo on Doppler
- http://physics.bus.edu/~duffy/semester1/menu_semester1.html – simulations

Approved by HSCA: December 08, 2004

STRAND I: SCIENTIFIC THINKING AND PRACTICE
CONTENT STANDARD: The student understands the processes of scientific investigations and uses inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

BENCHMARKS:
A. The student uses accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
B. The student understands that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.
C. The student uses mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		NOTE: Illustrations include suggested activities for attaining each performance standard. A check (√) refers to a key feature to look for while assessing student performance. The student listens to or participates in a physics demonstration or properly designs and performs a controlled experiment using a recognized scientific method, gathers data, and reports results in both an oral and written format.
	1. Describes, designs, and conducts scientific investigations using appropriate technology to subsequently convey results using scientific concepts in various data displays (NM-I.I.I.1,2,4). 2. Uses mathematical models to describe, explain, and predict natural phenomena (NM-I.I.II.I). 3. Identifies and applies measurement techniques and considers possible effects of measurement errors (NM-I.I.III.4). 4. Uses mathematics to describe, explain, and predict natural phenomena, and to express and establish scientific relationships (e.g., scientific notation, vectors, dimensional analysis) (NM-I.I.III.5).	1 - 4. The student participates in the labs described in Strand II. He/She properly designs, conducts, and conveys scientific investigations and applies the required skills and techniques to convey the results. ✓ proper safety techniques ✓ correct use of equipment ✓ evidence of current scientific knowledge ✓ effective communication skills ✓ use of technology ✓ critical thinking and insights

STRAND II: THE CONTENT OF SCIENCE-PHYSICAL SCIENCE
CONTENT STANDARD: The student understands the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

BENCHMARKS: A. The student understands the transformation and transmission of energy and how energy and matter interact.
B. The student understands the motion of objects and waves and the forces that cause them.

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		NOTE: The student participates in a set of hands-on activities directed towards an understanding of performance standards both at the conceptual and mathematical level. After each of the activities, the student submits a written report discussing results, conclusions, and sources of error and participates in a discussion relevant to the activity. ✓ conceptual understanding ✓ mathematical application ✓ error analysis ✓ adherence of the teacher-directed report guidelines
	1. Uses kinematics to understand motion in one and two dimensions, including vectors, vector algebra, components of vectors, magnitude and direction of vector forces, coordinate systems and frames of reference, displacement, velocity and acceleration (NM-II.I.III.6). 2. Applies Newton's laws of motion to single objects and systems of objects both statically and dynamically in terms of displacement, velocity, and acceleration, including friction and centripetal force and understands the concept of equilibrium (NM-II.I.II. 8, 11). 3. Understands the relationships between work, energy and power (NM-II.I.II.6). • work-energy theorem, conservative forces, conservation of energy. 4. Knows how to apply linear momentum and conservation of linear momentum to systems of particles (NM-II.I.III.8), and knows that when one object exerts a force on a second object, the second object exerts a force of equal magnitude and in the opposite direction on the first object (i.e., Newton's Third Law: Conservation of Momentum) (NM-II.I.III.7, 8). 5. Analyzes uniform circular motion and torque (NM-II.I.II.8).	1 - 7. Newtonian Mechanics • Hit the Cup – The student predicts where an object will land after having rolled off a table using basic kinematics equations. • Collision – The student analyzes vector conservation of momentum in the collision of objects, (e.g., air track, or metal balls on ramp). • Whirligig – The student swings an object to determine tangential velocity and centripetal force. • Bleacher Run – The student walks and runs up bleachers and calculates work and power. • Hooke's Law – The student analyzes the dynamics of a mass on a spring to determine mass, amplitude, and spring constant. • Pendulum Lab – The student investigates the relationships between period and mass, length, and amplitude. • Orbit Lab – The student draws orbits and shows velocities and forces.

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	6. Analyzes oscillating systems (NM-II.I.III.8). • simple harmonic motion and energy relationships, and • mass on a spring, pendulums, and other oscillation	
	7. Applies Newton's gravitation to circular satellite orbits and knows that every object exerts gravitational force on every other object and how this force depends on the masses of the objects and the distance between them (NM-II.I.III.1, 2).	
	8. Explains the behavior of fluids and their interactions with objects (NM-II-I-III.11). • hydrostatic pressure, buoyancy, fluid flow continuity, Bernoulli's equation.	8. Fluid Mechanics • Buoyancy Lab – The student extends Hooke's Law Lab to find density of fluid.
	9. Understands the mechanical equivalent of heat, heat transfer, thermal expansion, and the difference between temperature and heat (NM-II.I.III.11).	9 - 11. Thermodynamics • Specific Heat – The student uses calorimetry to determine an unknown heat capacity (**Note:** calorimetry is not tested on the APB exam). • PV Diagrams – The student interprets a variety of teacher-supplied PV diagrams with an extension to student-created diagrams.
	10. Applies the kinetic model and ideal gas law to systems of gases and understands the relationship between force and pressure and how the pressure of a volume of gas depends on the temperature and the amount of gas (NM-II.I.III.4).	
	11. Understands how heat can be transferred by conduction, convection, and radiation, that heat conduction differs in conductors and insulators, and determines thermodynamic relationships of PV diagrams and heat engines using the 1^{st} and 2^{nd} laws of thermodynamics (NM-II.I.II.4). • understands that the ability of energy to do something useful (work) tends to decrease (and never increases) as energy is converted from one form to another (2nd law of thermodynamics) (NM-II.I.II.6)	
	12. Calculates charge, field, and potential of point charges and planar charge distributions, using Coulomb's law and knows that materials containing equal amounts of positive and negative charges are electrically neutral, but that a small excess or deficit of negative charges produces significant electrical forces (NM-II.I.III.3, 5).	12 - 16. Electricity and Magnetism • Electric Fields – The student measures and plots equipotential lines of various physical configurations with either semiconducting paper or conducting fluid. • Balloon Electrostatics – The student calculates forces and charges on two balloons suspended by a thread. • Capacitors – The student constructs capacitors with paper and aluminum foil, and calculates and measures charge and capacitance.
	13. Determines charge, voltage, capacitance, area, and spacing of parallel plate capacitors.	

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	14. Solves for current, voltage, resistance, and power in steady state direct current circuits, including capacitors in circuits – steady state. 15. Applies magnetostatics to determine the forces on moving charges or current-carrying wires in magnetic fields, including long current-carrying wires (NM-II.I.II.7). 16. Describes electromagnetic induction using Faraday's Law and Lenz's Law and explains how electric currents cause magnetism and how changing magnetic fields produce electricity (e.g., electric motors, generators) (NM-II.I.III.5). • diagrams and calculates electric and magnetic fields. 17. Identifies the properties of traveling waves and standing waves such as amplitude, wavelength, frequency and speed including the Doppler effect and superposition and that electromagnetic waves carry energy that can be transferred when they interact with matter (NM-II.I.II.7; (NM-II.I.III.10). • calculates velocity, frequency, wavelength, and amplitude. 18. Knows the electromagnetic spectrum and the concept of dispersion of light (NM-II.III.I.5). 19. Calculates interference, diffraction, reflection and refraction effects and describes how waves are used for practical purposes (e.g., seismic data) (NM-II.I.III.11, 12).slits and gratings. 20. Uses geometric optics to predict images due to reflection, plane and curved mirrors, and lenses (NM-II.I.III.11). • applies Snell's Law to various substances. 21. Understands and explains the photoelectric effect and the concept of wave particle duality • interprets an electron energy level diagram. 22. Predicts nuclear reactions using conservation of mass number and charge and mass-energy equivalence and knows that there are four fundamental forces in nature: gravitation, electromagnetism, weak nuclear force, and strong nuclear force (NM-II.I.III.1).	• Ohm's Law – The student connects bulbs in a series of parallel configurations to a battery to calculate and measure current, voltage, and power. An extension activity includes the addition of resistors to the circuit. • Electromagnet – The student constructs electromagnets and discovers the relationship between current, number of turns, • and magnetic field strength. 17 - 20. Waves and Optics • Slinky – The student determines the relationships between velocity, frequency, wavelength, tension, harmonics, and reflections using slinky toys. • Diffraction – The student calculates wavelengths or slit spacing of a diffraction grating. • Index of Refraction – The student uses geometry to determine the index of refraction of an unknown substance. This lab also includes reflection and total internal reflection. 21 - 22. Atomic and Nuclear Physics • Spectroscopy – The student utilizes spectroscopes borrowed from the chemistry teacher to examine emission spectra of different gases.

STRAND III: THE CONTENT OF SCIENCE-EARTH AND SPACE
CONTENT STANDARD: The student understands the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.

BENCHMARKS: A. The student examines the scientific theories of the origin, structure, contents, and evolution of the solar system and the universe, and their interconnections.
B. The student examines the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		NOTE: The student participates in a set of hands-on activities directed towards an understanding of performance standards both at the mathematical application and relationships levels. After each of the activities, the student submits a written report and/or discusses results, conclusions, and sources of error and participates in a discussion relevant to the activity. ✓ conceptual understanding ✓ mathematical application and relationships ✓ error analysis ✓ adherence of the teacher-directed report guidelines
	1. Understands the scale and contents of the universe, including (NM-II.III.I.1): • range of structures from atoms through astronomical objects to the universe, and • objects in the universe such as planets, stars, galaxies, and nebulae.	1. Powers of Ten – The student watches the video, "The Powers of Ten," and answers in writing focused questions. He/She calculates the magnitude difference between various objects. Re: (http://microcosm.web.cern.ch/microcosm/P10/english/P-8.html) 1 – 3. (From Strand II – 1-7. Newtonian Mechanics) • Orbit Lab – The student draws orbits and shows velocities and forces. The student understands the scale of the universe, celestial cycles and seasons, and technology used for observation. 1, 4, 8. The Elegant Universe – The student watches the video, "The Elegant Universe," and answers in writing focused questions. • Scale and contents of the universe • Key observations leading to acceptance of the Big Bang • Stellar processes
	2. Predicts changes in the positions and appearances of objects in the sky (e.g., moon, sun) based on knowledge of current positions and patterns of movements (e.g., lunar cycles, seasons) (NM-II.III.I.2).	2, 3, 4, 8, 9, 10. Cosmos – The student demonstrates understanding of cosmological observations and theories by viewing relevant clips from Carl Sagan's series, "Cosmos," reflecting and later answering and

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	3. Understands how knowledge about the universe comes from evidence collected from advanced technology (e.g., telescopes, satellites, images, computer models) (NM-II.III.I.3).	discussing focus questions. ✓ knowledge of celestial cycles and seasons ✓ evidence from advanced technology ✓ key pieces of evidence supporting the big bang theory ✓ stellar processes and evolution ✓ earth's energy systems and convection
	4. Describes the key observations that led to the acceptance of the Big Bang theory and that the age of the universe is over 10 billion years (NM-II.III.I.4).	
	5. Explains how objects in the universe emit different electromagnetic radiation and how this information is used (NM-II.III.I.5).	5. (From Strand II - 21-22.) Atomic and Nuclear Physics • Spectroscopy – The student utilizes spectroscopes borrowed from the chemistry teacher to examine emission spectra of different gases.
	6. Examines the role that New Mexico research facilities play in current space exploration (e.g., Very Large Array, Goddard Space Center) (NM-II.III.I.7).	6. Web Quest – The student embarks upon a teacher directed web quest to research and write a report of the role of New Mexico research in current space exploration. The student presents findings in a report format. ✓ understanding of the task ✓ adherence to the process ✓ summary of research ✓ list of links
	7. Explains plate tectonic theory and understand the evidence that supports it (NM-II.III.II.5). 8. Describes how stars are powered by nuclear fusion, how luminosity and temperature indicate their age, and how stellar processes create heavier and stable elements that are found throughout the universe (NM-II.III.I.6).	7, 10. Plate Tectonics – The student examines plate theory, manifestations, and impact of plate motion by analyzing the mechanisms involved during the course of the following Labs (from Strand II): • Hooke's Law – The student analyzes the dynamics of a mass on a spring to determine mass, amplitude, and spring constant. • Slinky – The student determines the relationships between velocity, frequency, wavelength, tension, harmonics, and reflections using slinky toys. • Collision – The student analyzes vector conservation of momentum in the collision of objects, (e.g., air track, or metal balls on ramp). • Buoyancy Lab – The student extends Hooke's Law Lab to find density of fluid.

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	9. Knows that Earth's systems are driven by internal (i.e., radioactive decay and gravitational energy) and external (i.e., the sun) sources of energy (NM-II.III.II.6). 10. Describes convection as the mechanism for moving heat energy from deep within Earth to the surface and discuss how this process results in plate tectonics, including (NM-II.III.II.7): • geological manifestations (e.g., earthquakes, volcanoes, mountain building) that occur at plate boundaries, and • impact of plate motions on societies and the environment (e.g., earthquakes, volcanoes).	9. (From Strand II: 9 - 11. Thermodynamics) • Specific Heat – The student uses calorimetry to determine an unknown heat capacity (Note: calorimetry is not tested on the APB exam). • PV Diagrams – The student interprets a variety of teacher-supplied PV diagrams with an extension to student-created diagrams.

STRAND IV: SCIENCE AND SOCIETY
CONTENT STANDARD: The student understands how scientific discoveries, inventions, practices, and knowledge influence and are influenced by individuals and societies.

BENCHMARK: The student examines and analyzes how scientific discoveries and their applications affect the world and explains how societies influence scientific investigations and applications.

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Understands the scientific foundations of common technologies (e.g., radio, aircraft, rockets, X-rays, light) (NM-III.I.I.4).	1 - 4. The student participates in interactive lectures, integrating Science and Society performance standards with content relative to the field of study that includes question and answer sessions. The student develops a graphic organizer representing major milestones in physics. ✓ understanding by participation ✓ correct and/or accurate responses to questions and answers ✓ application of process 1. The student develops a How – Works presentation, including its origins, and delivers it to Physics I students. ✓ understanding of physics concepts ✓ presentation of accurate information in an intelligible manner ✓ notes based on presentation
	2. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM-III.I.I.8).	2. The student researches a specific use of radioactivity and creates a poster to present to the class. Topic ideas may include Applications in Space, Fusion, Health Physics and Radiological Health, Nuclear Fuel, Nuclear Waste, Radiation Instruments. ✓ use of research strategies (e.g., note taking, outlining, draft, final product, citation of sources) ✓ well-designed and accurate poster ✓ presentation techniques
	3. Describes major historical changes in scientific perspectives (e.g., atomic theory, cosmology, relativity) and the experimental observations that triggered them (NM-III.I.I.10).	3. The student reads articles from different time periods (e.g., decades) on a specific topic to trace the changing perspectives over a time period. One good site is http://www.project2061.org/tools/sfaaol/chap10.htm. After investigating the changing perspective, the student creates an organizational tool (e.g., timeline, flow chart) depicting the changes. ✓ accurate summary of perspective ✓ appropriate organizational tool to depict perspectives ✓ bibliography of sources

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	4. Describes New Mexico's role in nuclear science (e.g., Manhattan Project, VLA, Trinity Site, White Sands) (NM-III.I.I.14).	4. The student visits the site http://www.vivanewmexico.com/science.html, chooses one of the topics on the site, and transfers the information into a PowerPoint presentation to give to the class. ✓ accurate guideline observations for presentation (e.g., slide design, logical order, font) ✓ accurate information

STRAND V: LITERACY
CONTENT STANDARD: The student communicates physics principles through reading, writing, and speaking opportunities.

BENCHMARK: The student demonstrates proficiency in reading comprehension, specialized vocabulary, and a variety of writing and speaking requirements.

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Develops and demonstrates proficiency with the following strategies to approach reading for information across content areas (APSLA I.1): • scans reading selection to determine whether a text contains relevant information, • uses the headings and subheadings of the material to make predictions and to validate comprehension of text, • reads and rereads to decode meaning, and • reviews and summarizes essential elements of text for overview.	1, 3, 6, 7. The student selects and reviews a series of current science articles from an appropriate science journal or teacher-approved website and follows the steps outlined below. Step 1: • Identifies the author and locates any biographical information that provides insight into who he/she is. • What perspective does the author bring to the book (e.g., university professor, expert in the field, classroom educator)? Step 2: Reads the article and in writing answers questions that apply to his/her article. • What isn't clear or easy to understand? • What does the author(s) expect you to know? • What is the author trying to say? • What is the author's message? Step 3: Writes a 50-70-word summary including why the article is interesting or important. ✓ completion of the steps ✓ proper use of referencing author's thoughts ✓ use of bibliographic format for each article (Based on *Questioning The Author: An Approach For Enhancing Student Engagement With Text* by I. Beck, et.al., International Reading Association, Newark, DE)
	2. Identifies and uses roots, prefixes, and suffixes to determine meaning of words (APS LA I.4). 3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APS LA II.2).	2, 4, 5. The student writes extensions of labs or demonstrations presented in Strands II and III. ✓ conceptual understanding ✓ lab writing process ✓ logical organization

GRADE 11 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	4. Develops increased competence in using the writing process to create final products (APS LA III.1) 5. Develops increased competence in using elements of effective writing (APS LA IIIl.2). 6. Supports an informed opinion (APS – LA III.6): • uses appropriate language, reasoning, and organizational structure for the audience and purpose, • provides relevant and convincing reasons, uses various types of evidence, and • demonstrates an awareness of possible questions, concerns, or counterarguments. 7. Responds to a variety of written, electronic, and other media (APS LA III.7). 8. Develops increased competence with speaking and language conventions (APS LA IV.3).	8. Throughout the labs and demonstrations presented in Strands II and III, the student participates in small groups and class discussions. ✓ active participation in discussions ✓ relevant questioning ✓ comprehension of lab concepts Although the above examples represent specific instances where the literacy standards are met, multiple opportunities are presented throughout the year and throughout the curriculum where the student demonstrates reading, speaking, writing, and research strategies. They are reflected in every strand.