

APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title Physics I (Analytical) Course Number: SEE BELOW

Department: Science ADS Number: SEE BELOW

Prerequisites: None

Length of Course: One Year Credit/PRI Area: .50 per Sem /Science Grade Level(s): 9 - 12

COURSES AND ADS NUMBERS:

Physics I (Analytical)	43121	17314144
Physics I (Analytical) Bilingual	4312B	17318144
Physics I (Analytical)	060MU	17312144
Physics I (Analytical)	061MU	17312144
Physics I (Analytical)	062MU	17312144

Important Notes:

COURSE DESCRIPTION:

This laboratory class* is designed to exceed state standards and offer extended opportunities for students. It provides preparation for all subsequent science courses including Advanced Placement classes. The student investigates topics of study that include, but are not restricted to, principles of motion, gravitation, heat, light, sound, electricity and magnetism, forces of nature, plate tectonics, and cosmology. As appropriate these topics are examined at scales ranging from atomic to astronomical. The focus is on conceptual understanding and mathematical relationships and applications. 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 New Mexico Science Content, Benchmarks, and Performance Standards, Albuquerque Public Schools Mathematics Standards (Math), and Albuquerque Public Schools Language Arts curriculum (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:

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

Video Series

- The Mechanical Universe (Annenberg)
- Bill Nye The Science Guy (Disney Studios)

SUGGESTED TITLES/AUTHORS WEB SITES:

- <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>
- <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/semester1/c20_wave_fv1.html
- <http://galileo.phys.virginia.edu/%7Eesnp9B/java/Ripple.html>
- http://physics.bu.edu/~duffy/semester1/c21_doppler.html
- http://physics.bus.edu/~duffy/semester1/menu_semester1.html

Approved by HSCA: 12/04

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 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> 1. Describes the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions (NM-I.I.I.1). 2. Designs and conducts scientific investigations that include (NM-I.I.I.2): <ul style="list-style-type: none"> • testable hypotheses, • controls and variables, • methods to collect, analyze, and interpret data, • results that address hypotheses being investigated, • predictions based on results, • re-evaluation of hypotheses and additional experimentation as necessary, and • error analysis. 3. Uses appropriate technologies to collect, analyze, and communicate scientific data (e.g., computers, calculators, balances, microscopes) (NM-I.I.I.3). 4. Conveys results of investigations using scientific concepts, methodologies, and expressions, including (NM-I.I.I.4): <ul style="list-style-type: none"> • scientific language and symbols, • diagrams, charts, and other data displays, • mathematical expressions and processes (e.g., mean, median, slope, 	<p>NOTE: Illustrations include suggested activities for attaining each performance standard. A check for (✓) refers to a key feature to look for while assessing student performance.</p> <p>1 – 4, 6 – 16. 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.</p> <ul style="list-style-type: none"> ✓ proper safety techniques ✓ correct use of equipment ✓ appropriate equipment ✓ evidence of current scientific knowledge ✓ effective communication skills ✓ use of technology ✓ quantitative data ✓ critical thinking and insight

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>proportionality),</p> <ul style="list-style-type: none"> • clear, logical, and concise communication, and • reasoned arguments. <p>5. Understands how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom) (NM-I.I.I.5).</p> <p>6. Understands how scientific processes produce valid, reliable results, including (NM-I.I.II.1):</p> <ul style="list-style-type: none"> • consistency of explanations with data and observations, • openness to peer review, • full disclosure and examination of assumptions, • testability of hypotheses, and • repeatability of experiments and reproducibility of results. <p>7. Uses scientific reasoning and valid logic to recognize (NM-I.I.II.2):</p> <ul style="list-style-type: none"> • faulty logic, • cause and effect, • the difference between observation and unsubstantiated inferences and conclusions, and • potential bias. <p>8. Understands how new data and observations can result in new scientific knowledge (NM-I.I.II.3).</p> <p>9. Critically analyzes an accepted explanation by reviewing current scientific knowledge (NM-I.I.II.4).</p> <p>10. Examines investigations of current interest in science (e.g., superconductivity, molecular machines, age of the universe) (NM-I.I.II.5).</p> <p>11. Examines the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time-consuming experiments such as medical clinical trials), and investigations</p>	<p>5. Refer to Strand III, Illustration 7 and 10</p> <ul style="list-style-type: none"> ✓ organization of data ✓ data supports theory ✓ critical thinking/insights ✓ defense of argument ✓ clear communication ✓ graphic organizers

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>of phenomena that can be repeated easily and frequently (NM-I.I.II.6).</p> <p>12. Creates multiple displays of data to analyze and explain the relationships in scientific investigations (NM-I.I.III.1).</p> <p>13. Uses mathematical models to describe, explain, and predict natural phenomena (NM-I.I.III.2).</p> <p>14. Uses technologies to quantify relationships in scientific hypotheses (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling) (NM-I.I.III.3).</p> <p>15. Identifies and applies measurement techniques and consider possible effects of measurement errors (NM-I.I.III.4).</p> <p>16. Uses mathematics to express and establish scientific relationships (e.g., scientific notation, vectors, dimensional analysis) (NM-I.I.III.5).</p>	

STRAND II: THE RELATIONSHIP BETWEEN THE PHYSICAL WORLD AND MATHEMATICS**CONTENT STANDARD:** The student understands that the world around him/her can be modeled mathematically.**BENCHMARKS:** A. The student demonstrates how to use mathematics to analyze and solve real world systems.

B. The student uses measurement and mathematics to hypothesize, test, and analyze physical systems.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> 1. Uses pictures, written symbols, oral language and real-world situations and manipulates them interchangeably (Math III.20). 2. Uses trigonometric relationships to determine length and angle measures and translates realistic situation right triangles in order to solve problems (Math III.11, 12). 3. Creates systems of equations in two or three variables and solves them through graphing or linear combination and substitution (Math V.5). 	<p>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.</p> <ul style="list-style-type: none"> ✓ conceptual understanding ✓ mathematical application and relationships ✓ error analysis ✓ adherence of the teacher-directed report guidelines <ol style="list-style-type: none"> 1. See Strand II, Illustration 5, 6: Orbits. 1 – 6. The student solves both written and laboratory physics problems that may include the following: <ul style="list-style-type: none"> • sketches or diagrams • mathematical relationships • algebraic manipulation • vector addition/subtraction • graphing • checking for plausibility • unit analysis 2. See Strand II, Illustration 4, 10 - 13: Non-Equilibrium and Vector Walk. 3, 7. See Strand II, Illustration 4, 10 – 13: Hit the Cup

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>4. Describes real-life problems or events algebraically and graphically using various functions including linear, parabolic, exponential, square, and inverse square (Math V.8).</p> <p>5. Analyzes units to check measurement computations (e.g., unit analysis) (Math III.22).</p> <p>6. Validates the reasonableness of conclusions (e.g., Is a negative time possible?) (Math V.9).</p> <p>7. Develops a hypothesis added on theoretical calculation.</p> <p>8. Applies refinement techniques in measurement to develop upper and lower bounds (Math III.23).</p> <p>9. Uses experimental and theoretical data to represent uncertainty (Math IV.0).</p>	<p>4. See Strand II, Illustration 2.</p> <p>5, 6, 8, 9. See Strand II, all Illustrations.</p> <p>7 – 9. The student compares and contrasts theoretical calculation and experimental measurement.</p>

STRAND III: 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 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> 1. Understands how heat can be transferred by conduction, convection, and radiation, and how heat conduction differs in conductors and insulators (NM-II.I.II.4). 2. 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.(NM-II.I.II.6) 3. Understands that electromagnetic waves carry energy that can be transferred when they interact with matter (NM-II.I.II.7). 	<p>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.</p> <ul style="list-style-type: none"> ✓ conceptual understanding ✓ mathematical application and relationships ✓ error analysis ✓ adherence of the teacher-directed report guidelines <ol style="list-style-type: none"> 1. Heat – The student participates in or observes a demonstration on heat and creates a poster or other illustration comparing and contrasting the transfer and behavior of heat demonstrating calorimetry. Re: http://feh.eng.ohio-state.edu/Labs/HeatTransfer/HeatTransfer.html 2. Pendulum – The student discovers the relationship between the period of a pendulum vs. mass, length, and amplitude. He/She graphs the measurements and compares the results. 3, 14 – 16. (Waves and Vibrations) <ul style="list-style-type: none"> • Ripple Tank – In a lab or demonstration environment, the student observes wave properties such as reflection, refraction, and interference. He/She applies the geometry and mathematics of interference to the observed waves in the tank. • Slinky Lab – Slinky – The student determines the relationships between velocity, frequency, wavelength, tension, harmonics, and reflections using slinky toys. He/She makes quantitative measurements and solves various parameters using wave and velocity equations.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>4. Understands the concept of equilibrium (i.e., thermal, mechanical, and chemical) (NM-II.I.II.11).</p>	<ul style="list-style-type: none"> • Speed of Sound – The student determines the speed of sound using a resonant column and derives mathematics of the system. • Doppler Shift – In a lab or demonstration environment, the student experiences the Doppler effect via a buzzer whirled about on a string. The student solves the Doppler equation for velocity or frequency for several scenarios. • Diffraction Demo – The student observes diffraction using a laser and a diffraction grating. The student calculates either the spacing, angle or wavelength using the diffraction equation. • Spectroscopy – The student utilizes spectroscopes (typically borrowed from the chemistry teacher) to examine emission spectra of different gases and relates the spectra to the Rydberg equation and introduces color theory. • E-M Spectrum Research – The student compares the wavelength and frequency ranges to physical objects comparable in size to the wavelength. He/She discusses the application of the Bragg equation and calculates for various wavelengths. <p>4, 10 - 13 (Mechanics)</p> <ul style="list-style-type: none"> • Equilibrium – The student predicts and/or finds the balance point of various configurations of objects, which may or may not be different shapes, and applies mathematics of torque. • Non-Equilibrium – The student constructs vector diagrams for moving objects in which the forces are not in equilibrium. Friction forces and motion on an inclined plane are included. • Hit the Cup - The student predicts the landing position of a ball bearing using a stopwatch, an incline, a meter stick, and a table. The student measures and calculates the speed of the ball from conservation of energy. Re:http://cougar.slvhs.slv.k12.ca.us/~pboomer/labsphys/physlabook/lab8.html • Vector Walk – The student walks displacement vectors written on index cards as read by the teacher. The teacher or student shuffles the cards and repeats the activity. After this activity the student creates a vector diagram of a given route (e.g., from the student's home to the classroom). • Speed Walk – The student walks at constant velocity, then constant acceleration, on the football field. He/She chooses velocity and then an acceleration and calculates the time to cover a set distance. • Graph Matching – The student walks in such a way as to have

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>5. Knows that there are four fundamental forces in nature: gravitation, electromagnetism, weak nuclear force, and strong nuclear force (NM-II.I.III.1).</p> <p>6. 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.2).</p> <p>7. 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).</p>	<p>his/her motion match a graph displayed on a screen. (The activity can also be done as CBL.) He/She calculates the velocity and acceleration from the graph.</p> <ul style="list-style-type: none"> • Free Fall – The student drops objects of different masses and shapes from a given height to discover and compare factors that do and do not influence free fall. He/She graphs the measurements of height and time and compares them against motion equations. <p>5, 6. (Forces of Nature)</p> <ul style="list-style-type: none"> • Force Comparison – The student calculates and compares the gravitational attraction and electrostatic attraction forces for two particles, including scenarios such as the force to balance repulsion and gravitational attraction and the amount of charge to equal the Earth-Moon gravitational force. • Orbits – The student draws an elliptical orbit on paper and at several points draws gravitational force and velocity vectors to scale. He/She draws orbits, measures distances, and calculates F_g at 3 points and uses the velocity formula for an ellipse to calculate and then draw velocity vectors. <p>7.</p> <ul style="list-style-type: none"> • Bed of Nails – The student compares the concept of pressure to force. He/She measures or estimates the area of the nail point and calculates the pressure for a given individual. Re: http://solomon.physics.sc.edu/~tedeschi/demo/demo22.html • Marshmallow – The student determines the relationship between applied force and size, by placing a mini marshmallow in a large syringe and increasing/reducing pressure. The student measures the applied force with a scale and graphs the observed size of the marshmallow. Re: http://scied.unl.edu/pages/mamres/pages/demos/denver/swelling_syringes.html • Balloon in Oven/Freezer – The student discovers the relationship between temperature and pressure using a balloon. He/She measures and graphs the temperature and volume of the balloon and compares them to the Ideal Gas Law value. • Hovercraft – The student views a demonstration of force and pressure concepts using an inexpensive hovercraft, which is massed and creates a free body diagram.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>8. 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).</p> <p>9. Explains how electric currents cause magnetism and how changing magnetic fields produce electricity (e.g., electric motors, generators) (NM-II.I.III.5).</p> <p>10. Represents the magnitude and direction of forces by vector diagrams (NM-II.I.III.6).</p> <p>11. 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) NM-II.I.III.7).</p> <p>12. Applies Newton’s Laws to describe and analyze the behavior of moving objects, including (NM-II.I.III.8):</p> <ul style="list-style-type: none"> • displacement, velocity, and acceleration of a moving object, • Newton’s Second Law, $F = ma$ (e.g., momentum and its conservation, the motion of an object falling under gravity, the independence of a falling object’s motion on mass), and • circular motion and centripetal force. <p>13. Describes relative motion using frames of reference (NM-II.I.III.9).</p> <p>14. Describes wave propagation using amplitude, wavelength, frequency, and speed (NM-II.I.III.10).</p> <p>15. Explains how the interactions of waves can result in interference, reflection, and refraction (NM-II.I.III.11).</p> <p>16. Describes how waves are used for practical purposes (e.g., seismic data, acoustic effects, Doppler effect) (NM-II.I.III.12).</p>	<p>8, 9. (Electricity and Magnetism)</p> <ul style="list-style-type: none"> • Electromagnets - The student constructs electromagnets and discovers the relationship between current, number of turns, and magnetic field strength. He/She measures and graphs force vs. current/turns using scale to develop a relationship. • DC Motors – The student constructs a simple motor to discover the properties of electricity and magnetic fields and measures and graphs the RPM and torque vs. current to develop a relationship. • Generator – The student demonstrates the operation of a generator and compares it to the operation of an electric motor and measures and graphs the generator output vs. RPM to develop a relationship. • Balloon – The student experiences electrostatic attraction and repulsion by rubbing balloons against cloth and examines the mathematical relationship between charge and repulsion.

STRAND IV: 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 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> 1. Understands the scale and contents of the universe, including (NM-II.III.I.1): <ul style="list-style-type: none"> • range of structures from atoms through astronomical objects to the universe, and • objects in the universe such as planets, stars, galaxies, and nebulae. 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). 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). 	<p>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.</p> <ul style="list-style-type: none"> ✓ conceptual understanding ✓ mathematical application and relationships ✓ error analysis ✓ adherence of the teacher-directed report guidelines <ol style="list-style-type: none"> 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) 2. <ul style="list-style-type: none"> • Solar System – The student shows the size and distance of objects in the solar system, scaled to the size of the campus. • Solar Walk – The student walks around a central student at various distances and speeds mimicking planetary motion. Re: http://www.astronomes.com/planetarium/englishplanetarium.html 3 – 6. Web Quest – The student embarks upon a teacher directed web quest to research, run online simulations, and write a report. The student determines the topic, researches, and presents findings in a report format. <ul style="list-style-type: none"> ✓ understanding of the task ✓ adherence to the process ✓ summary of research ✓ list of links

<p>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).</p> <p>5. Explains how objects in the universe emit different electromagnetic radiation and how this information is used (NM-II.III.I.5).</p> <p>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).</p> <p>7. Explains plate tectonic theory and understand the evidence that supports it (NM-II.III.II.5).</p> <p>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).</p> <p>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).</p> <p>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):</p> <ul style="list-style-type: none"> • 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). 	<p>4. Balloon – The student examines the expansion of the universe by inflating a balloon with dots and waves drawn on it. The student listens to a talk on the Hubble Parameter and calculates the velocity of various distant objects.</p> <p>7, 10. Plate Tectonics – The student examines plate theory, manifestations, and impact of plate motion by researching, graphing, and analyzing volcanism, topography, and seismicity for various sites and boundaries. The student listens to lectures about paleomagnetism and the Curie temperature and with the class discusses heat sources (e.g.,radioactivity, residual heat of formation, solar energy). Re: http://www.gsw.edu/~daskren/plates/ptlab.html http://www.pbs.org/wgbh/aso/tryit/tectonics/#</p> <p>8. Cosmos – The student demonstrates understanding of stellar processes and evolution by viewing relevant clips from Carl Sagan's series, "Cosmos," reflecting and later answering and discussing focus questions Re: http://www.maa.mhn.de/Scholar/star_evol.html</p> <ul style="list-style-type: none"> • Luminosity – The student demonstrates understanding of the relationship between luminosity and spectrum via a light bulb driven from a variable power supply. <p>The student demonstrates an understanding of lifetime (average, half-life) for a radioactive material, considering implications for radioactive wastes, applying radioactive count data in a graph to lifetime, and creating and examining macroscopic analogs to chain reactions (e.g., like mousetrap/Ping Pong™ ball arrangements), and gaining the concept of a chain reaction. He/She derives the half-life equation and applies it to a variety of problems, solving for half-life, original mass, or remaining mass. The student relates various forms of radioactive decay (e.g., alpha, beta) to the nucleus. Re: http://dev.nsta.org/ssc/moreinfo.asp?id=966</p>
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STRAND V: 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 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> 1. Knows how science enables technology but also constrains it, and recognizes the difference between real technology and science fiction (e.g., rockets vs. antigravity machines; nuclear reactors vs. perpetual-motion machines; medical X-rays vs. Star-Trek tricorders) (NM-III.I.I.1). 2. Understands how advances in technology enable further advances in science (e.g., microscopes and cellular structure, telescopes and understanding of the universe) (NM-III.I.I.2). 3. Evaluates the influences of technology on society (e.g., communications, petroleum, transportation, nuclear energy, computers, medicine, genetic engineering) including both desired and undesired effects, and including some historical examples (e.g., the wheel, the plow, the printing press, the lightning rod) (NM-III.I.I.3). 4. Understands the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment) (NM-III.I.I.4). 5. Understands that applications of genetics can meet human needs and can create new problems (e.g., agriculture, medicine, cloning) (NM-III.I.I.5). 6. Analyzes the impact of digital technologies on the availability, creation, and dissemination of information (NM-III.I.I.6). 7. Describes how human activities have affected ozone in the upper atmosphere and how it affects health and the environment (NM-III.I.I.7). 	<ol style="list-style-type: none"> 1. Using a predetermined set of questions, the student participates in a Science Fiction – Science Fact Trivia game. He/She provides justification for each response given. <ul style="list-style-type: none"> ✓ individual participation ✓ support for response 2 – 4, 6, 10. The student researches a particular technological item (e.g., CD’s, golf clubs, elevators, guitars, motors/generators) and either oral or in written format presents the origin of that item, changes based on technology, and the pros and cons of the development. <ul style="list-style-type: none"> ✓ thorough research ✓ all required components ✓ accuracy ✓ analysis and organization ✓ effective presentation <p>Option: If the written approach is taken, the instructor of the class can collaborate with the language arts teachers to work on the writing elements and conventions. This can be a dual project that satisfies certain requirements of both classes.</p> 5, 7, 11, 14 – 16. The student examines current news items (e.g., articles, TV, newspapers) on ethics issues (e.g., nuclear waste). In small or large group discussions, the student discusses the particular stances, what ideas are out there, and benefits of having the information or advancement of the new knowledge. <ul style="list-style-type: none"> ✓ accurate account of news item ✓ differing viewpoints

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>8. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM-III.I.I.8).</p> <p>9. Describes how scientific knowledge helps decision makers with local, national, and global challenges [e.g., Waste Isolation Pilot Project (WIPP), mining, drought, population growth, alternative energy, climate change] (NM-III.I.I.9).</p> <p>10. Describes major historical changes in scientific perspectives (e.g., atomic theory, germs, cosmology, relativity, plate tectonics, evolution) and the experimental observations that triggered them (NM-III.I.I.10).</p> <p>11. Knows that societal factors can promote or constrain scientific discovery (e.g., government funding, laws and regulations about human cloning and genetically modified organisms, gender and ethnic bias, AIDS research, alternative-energy research) (NM-III.I.I.11).</p> <p>12. Explains how societies can change ecosystems and how these changes can be reversible or irreversible (NM-III.I.I.12).</p> <p>13. Describes how environmental, economic, and political interests impact resource management and use in New Mexico (NM-III.I.I.13).</p> <p>14. Describes New Mexico's role in nuclear science (e.g., Manhattan Project, WIPP, national laboratories) (NM-III.I.I.14).</p> <p>15. Identifies how science has produced knowledge that is relevant to individual health and material prosperity (NM-III.I.I.15).</p> <p>16. Understands that reasonable people may disagree about some issues that are of interest to both science and religion (e.g., the origin of life on Earth, the cause of the Big Bang, the future of Earth) (NM-III.I.I.16).</p> <p>17. Identifies important questions that science cannot answer (e.g., questions that are beyond today's science, decisions that science can only help to make, questions that are inherently outside of the realm of science) (NM-III.I.I.17).</p>	<p>9, 12, 13, 17. The student listens to a guest speaker (e.g., someone from the Sandia Labs, PNM) talk about local environmental issues (e.g., What are the issues associated with processing and/or storing nuclear waste? What are the considerations of alternate energy sources?). After the lecture the student develops an action plan that deals with a particular school environment problem (e.g., conservation of water). The plan must outline specifically what is to be done, how the plan affects the problem, and the benefits of the plan.</p> <ul style="list-style-type: none"> ✓ understanding of an issue ✓ viability of plan ✓ specifics ✓ problem solving

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>18. Understands that scientists have characteristics in common with other individuals (e.g., employment and career needs, curiosity, desire to perform public service, greed, preconceptions and biases, temptation to be unethical, core values including honesty and openness) (NM-III.I.I.18).</p> <p>19. Knows that science plays a role in many different kinds of careers and activities (e.g., public service, volunteers, public office holders, researchers, teachers, doctors, nurses, technicians, farmers, ranchers) NM-(III.I.I.19).</p>	<p>18,19. Careers</p> <ul style="list-style-type: none"> • Integrated consistently in the curriculum throughout the year is the career connection. Current textbooks interject the “real-life” aspect and applications in almost every chapter, and the instructor takes every opportunity to include this through either personal experiences or through questioning (e.g., What does a technician do? What is a physicist?). The student talks about his personal career interest and explains where science is used in this career (e.g., mechanics, vet, park ranger). • Either as a school-wide project or class project, the student participates in a Career Day Fair. The student listens to a variety of speakers (e.g., engineer, technician, physicist, research scientist) in the science fields talk about aspects of their jobs. After the fair the student in either orally or written format, summarizes one career. <ul style="list-style-type: none"> ✓ individual participation ✓ listening skills ✓ personal connections ✓ scientific significance to career fields ✓ effective presentation

STRAND VI: 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 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>1. Develops and demonstrates proficiency with the following strategies to approach reading for information across content areas (APSLA I.1):</p> <ul style="list-style-type: none"> • 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. <p>2. Identifies and uses roots, prefixes, and suffixes to determine meaning of words (APSLA I.4).</p> <p>3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APSLA II.2).</p>	<p>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.</p> <p>Step 1:</p> <ol style="list-style-type: none"> a. Identify the author and locate any biographical information that provides insight into who he/she is. b. What perspective does the author bring to the book (e.g., university professor, expert in the field, classroom educator)? <p>Step 2: Read the article and in writing answer questions that apply to your article:</p> <ol style="list-style-type: none"> a. What isn't clear or easy to understand? b. What do the author(s) expect you to know? c. What is the author trying to say? d. What is the author's message? <p>Step 3: Write a 50-70-word summary including why the article is interesting or important.</p> <ol style="list-style-type: none"> a. completion of the steps b. proper use of referencing author's thoughts c. use of bibliographic format for each article <p>(Based on <i>Questioning The Author: An Approach For Enhancing Student Engagement With Text</i> by I. Beck, et. al., International Reading Association, Newark, DE)</p> <p>2, 4, 5. The student writes extensions of labs or demonstrations presented in Strands II and III.</p> <ul style="list-style-type: none"> ✓ conceptual understanding ✓ lab writing process ✓ logical organization

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>4. Develops increased competence in using the writing process to create a final product (APSLA III.1).</p> <p>5. Develops increased competence in using elements of effective writing (APSLA III.2).</p> <p>6. Supports an informed opinion (APS – LA III.6):</p> <ul style="list-style-type: none"> • 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. <p>7. Responds to a variety of written, electronic, and other media (APSLA III.7).</p> <p>8. Develops increased competence with speaking and language conventions (APSLA IV.3).</p>	<p>8. Throughout the labs and demonstrations presented in Strands II and III, the student participates in small groups and class discussions.</p> <ul style="list-style-type: none"> ✓ active participation in discussions ✓ relevant questioning ✓ comprehension of lab concepts <p>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.</p>