APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: AP Chemistry **District Course Number:** 44132

Department: Science **NM STARS Number:** 17254144

Prerequisites: Chemistry I and successful completion of Algebra II is strongly recomended

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

Important Notes:

The College Board states that "The AP Chemistry course is designed to be taken only after the successful completion of a first course in high school chemistry. It is strongly recommended that credit in a first-year high school chemistry course be a prerequisite for enrollment in an AP Chemistry class. In addition, the recommended mathematics prerequisite for an AP Chemistry class is the successful completion of a second-year algebra course.." Please see apcentral.collegeboard.com.

To be approved as an instructor for AP Chemistry, the teacher must attend an AP Chemistry Summer Institute, and have his/her syllabus for the course approved by the College Board.

COURSE DESCRIPTION: This laboratory course* is designed to be the equivalent of the general chemistry course usually taken during the first college year. The student attains a depth of understanding of fundamentals and a reasonable competence in dealing with chemical problems. The student acquires the abilities to think clearly and to express his/her ideas orally and in writing with clarity and logic. The student examines the structure of matter, kinetic theory of gases, chemical equilibria, chemical kinetics, and the basic concepts of thermodynamics. At the completion of this course, the student is strongly encouraged to take the AP exam. The student who demonstrates sufficient qualifications on this exam may receive college level credit and advance to upper level course work in chemistry at the college level.

* 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 refers to and are aligned with the State of New Mexico Science Standards (NM) and Albuquerque Public Schools Language Arts Standards (APS-LA).

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:

- *Chemistry9th ed* - R. Chang - McGraw Hill - 2006
- *Chemistry 7th ed* - S. Zumdahl - Houghton Mifflin - 2007
- *Chemistry and Chemical Reactivity* 6th ed.- J.C. Kotz, et.al., - Brooks/Cole - 2005
- *Chemistry: Molecules, Matter, and Change* - L. Jones, et.al., - Freeman - 2000
- *Chemistry: The Central Science* - T.L. Brown, et.al., - Prentice Hall - 2003
- *General Chemistry* - D. Ebbing, et.al., - Houghton Mifflin - 2002
- *General Chemistry* - K.W. Whitten, et.al., - Saunders - 2000
- *Principles of Modern Chemistry* - D. W., Oxtoby, et.al., - Books/Cole - 2003

Lab Manual

- *Experiment Chemistry* - James F. Hall - Houghton Mifflin

Journals and Periodicals

- *Journal of the American Chemical Society*
- *Scientific American*
- *Nature*
- *Science*

SUGGESTED TITLES/AUTHORS WEB SITES:

- www.apcentral.collegeboard.com - The Teachers' Resources section of AP Central™ has a searchable database of chemistry resources.
- http://www.chemweb.com - provides activities for the chemistry classroom.
- http://webserver.lemoyne.edu/faculty/giunta/ - posts the texts of several classic papers from the history of chemistry, and also contains pointers to a few other chemistry-related sites.
- http://jchemed.chem.wisc.edu?JCEWWW/index.html - Journal of Chemical Education.
- http://chemistry.about.com/mbody.htm - provides ideas and resources for the chemistry classroom.

Approved by HSCA: 01/08

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
	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): • 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).	**NOTE: Illustrations include suggested activities for attaining each performance standard. A check (√) refers to a key feature to look for while assessing student performance.** 1-16. The student listens to or participates in chemistry demonstrations or properly designs and performs a controlled experiment that tests an accepted principle in chemistry using a recognized scientific method. He/She collects quantitative data for a written or oral report of results and conclusions. ✓ 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 ✓ appropriate controls

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	4. Conveys results of investigations using scientific concepts, methodologies, and expressions, including (NM - I.I.I.4): • scientific language and symbols, • diagrams, charts, and other data displays, • mathematical expressions and processes (e.g., mean, median, slope, proportionality), • clear, logical, and concise communication, and • reasoned arguments.	1-4, 15, 16. See Strand II, Illustration set 9, 12, 14, 27.
	5. Understands how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atoms) (NM - I.I.I.5).	1-5. See Strand II, Illustration set 12, 13, 15, 23.
	6. Understands how scientific processes produce valid, reliable results, including (NM - I.I.II.1): • 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.	
	7. Uses scientific reasoning and valid logic to recognize (NM - I.I.II.2): • faulty logic, • cause and effect, • the difference between observation and unsubstantiated inferences and conclusions, and • potential bias.	7. See Strand V, Illustration set 4, 5, 7.
	8. Understands how new data and observations can result in new scientific knowledge (NM - I.I.II.3).	
	9. Critically analyzes an accepted explanation by reviewing current scientific knowledge (NM - I.I.II.4).	
	10. Examines investigations of current interest in science (e.g., super conductivity, molecular machines, age of the universe) (NM - I.I.II.5).	

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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 of phenomena that can be repeated easily and frequently (NM - I.I.II.6). 12. Creates multiple displays of data to analyze and explain the relationships in scientific investigations (NM – I.I.III.1). 13. Uses mathematical models to describe, explain, and predict natural phenomena (NM - I.I.III.2). 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). 15. Identifies and applies measurement techniques and considers possible effects of measurement errors (NM - I.I.III.4). 16. Uses mathematics to express and establish scientific relationships (e.g., scientific notation, vectors, dimensional analysis) (NM - I.I.III.5).	12-16. See Strand II, Illustration set 5, 6, 11, 16, 20-22, 24-26.

STRAND II: THE CONTENT OF 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 properties, underlying structures, and reactions of matter.
B. The student understands the transformation and transmission of energy and how energy and matter interact.
C. The student understands the motion of objects and waves and the forces that cause them.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Classifies matter in a variety of ways (e.g., element, compound, mixture, solid, liquid, gas, acidic, basic, neutral) (NM - II.I.I.1).	1, 7, 8, 10. The student participates in a thorough discussion and review of the classifications of elements on the periodic table (i.e., phases, types, groups, periods, blocks, families, electron configurations, and typical oxidation states) and bonding concepts. The student explains and summarizes the predicted formation of numerous binary compounds by electron transfer or sharing. ✓ proper classification of elements on the periodic table ✓ ability to determine an element's oxidation state ✓ prediction of the correct formulas of resulting compounds
	2. Identifies, measures, and uses a variety of physical and chemical properties (e.g., electrical conductivity, density, viscosity, chemical reactivity, pH, melting point) (NM - II.I.I.2).	2. In a lab situation the student receives a mixture of known substances (e.g., sand, salt, iron) and predicts what physical properties can be used to separate them. The student then devises a procedure to separate the substances. After trying the procedure, he/she evaluates the effectiveness of his/her technique. ✓ proper identification of properties ✓ use of appropriate techniques to separate ✓ evaluation of results addressing technique success and failure
	3. Knows how to use properties to separate mixtures into pure substances (e.g., distillation, chromatography, solubility) (NM - II.I.I.3).	3, 13, 15, 16, 24-26. The student standardizes by titration a sodium hydroxide solution (NaOH) using a determinately prepared acid (0.100*M* HCl). Then he/she uses the NaOH to titrate an unknown solid monoprotic acid to determine its molecular mass (and/or the percentage of acetic acid in vinegar). ✓ accuracy of measurements ✓ proper problem-solving procedures ✓ appropriate use of units, significant digits, and conversions ✓ summary with supporting logical conclusions ✓ adherence to safety guidelines

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	4. Describes trends in properties (e.g., ionization energy or reactivity as a function of location on the periodic table, boiling point of organic liquids as a function of molecular weight) (NM - II.I.I.4).	4, 7, 8 Using prior knowledge of atomic structure and of the periodic table, the student distinguishes the nature (i.e., atomic radius, ionization energy, electronegativity, reactivity, relative melting and boiling points) of numerous elements and compounds. ✓ relation of periodic properties to periodic table position ✓ accurate determination of the relative reactivity of elements ✓ accurate prediction of the relative melting/boiling points of various elements and compounds
	5. Understands that matter is made of atoms and that atoms are made of subatomic particles (NM - II.I.I.5). 6. Understands atomic structure, including (NM - II.I.I.6): • most space occupied by electrons, • nucleus made of protons and neutrons, • isotopes of an element, • masses of proton and neutron 2000 times greater than mass of electron, and, and • atoms held together by proton-electron electrical forces. 7. Explains how electrons determine the properties of substances by (NM - II.I.I.7): • interactions between atoms through transferring or sharing valence electrons, • ionic and covalent bonds, and • the ability of carbon to form a diverse array of organic structures. 8. Makes predictions about elements using the periodic table (e.g., number of valence electrons, metallic character, reactivity, conductivity, type of bond between elements) (NM - II.I.I.8).	5, 6, 11, 16, 23-25, 27. . As an introduction to the four fundamental forces, student addresses scalar and vector properties with emphasis on Newtonian mechanics (3 laws of motion, frames of reference of motion, relationships between electrical –charge motion - and magnetism). After participating in an in-depth interactive lecture on the four fundamental forces (i.e., gravity, weak, electromagnetic, strong), the electromagnetic spectrum, and the formation of atoms (nucleosynthesis) from subatomic particles in the early universe and in stars, as well as the energies involved, the student graphs the nucleons (proton number versus neutron number) showing stable and unstable isotopic arrangements. The student further graphs or charts the decay processes (e.g., alpha, beta, gamma, neutron capture) by which unstable isotopes become stable. Using known half-lives of unstable isotopes, the student calculates age of samples from isotope ratios. In the same unit he/she views a demonstration on the detection of decay using a Geiger counter. Student mathematically compares the equation of gravity with Coulomb's Law (electromagnetic force) examining similarities and differences between the two equations: attractive force between masses, $F = G(m_1 x m_2)/r^2$, versus the attractive and repulsive forces between charged particles, $F = k(q_1 x q_2)/r^2$. ✓ accuracy of graphs ✓ clarity of descriptions and explanations regarding forces of attraction, radiations and radioactivity ✓ evaluation of the type, energy, and time associated with numerous emissions and absorptions ✓ proficiency in the proper use of units, significant figures, and conversions in all calculations ✓ correct identification of force factors ✓ correct use of appropriate equation in context

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	9. Understands how the type and arrangement of atoms and their bonds determine macroscopic properties (e.g., boiling point, electrical conductivity, hardness of minerals) (NM - II.I.I.9). 10. Knows that states of matter (i.e., solid, liquid, gas) depend on the arrangement of atoms and molecules on their freedom of motion (NM – II.I.I.10). 11. Knows that some atomic nuclei can change, including (NM - II.I.I.11): • spontaneous decay, • half-life of isotopes, • fission, • fusion (e.g., the sun), and • alpha, beta, and gamma radiation. 12. Knows that chemical reactions involve the rearrangement of atoms and that they occur on many timescales (e.g., picoseconds to millennia) (NM - II.I.I.12). 13. Understands types of chemical reactions (e.g., synthesis, decomposition, combustion, redox, neutralization) and identifies them as exothermic or endothermic (NM - II.I.I.13).	9, 12, 14, 30. After review and discussion of compound formation, formula analysis, and gas laws, the student quantitatively decomposes a small amount of Alka-Seltzer® tablet, measuring the amount of carbon dioxide gas evolved. From the number of moles of CO_2, he/she determines the mass percentage of sodium bicarbonate present in the sample. ✓ proper use of Dalton's law to determine the dry CO_2 volume ✓ use of the proper form of the ideal gas equation to determine the moles CO_2 gas evolved ✓ determination of the correct stoichiometry to determine the mass of $NaHCO_2$ in the sample ✓ correct determination of the mass percent of $NaHCO_2$ in the tablet ✓ comparison of mass percent with that claimed by the manufacturer 12, 13, 15, 26. The student in a lab situation, using a "clock reaction" such as sodium bisulfite and potassium iodate solutions, determines the following: • the order of the reaction by systematic varying of the potassium iodate concentration, • the effect of temperature on the rate of reaction, and • devises and performs a procedure for determining the reaction rate dependence on sodium bisulfite concentration. ✓ accuracy of measurements ✓ adherence to proper safety guidelines ✓ proper problem-solving procedures ✓ appropriate use of units, significant digits, and conversions ✓ summary with supporting reasoned conclusions ✓ accuracy in relating the reaction rate to temperature and concentration ✓ correct determination in the balanced equation and how the equilibrium shifts with changes in concentration and temperature

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	14. Knows how to express chemical reactions with balanced equations that show (NM - II.I.I.14): • conservation of mass, and • products of common reactions. 15. Describes how the rate of chemical reactions depends on many factors that include temperature, concentration, and the presence of catalysts (NM - II.I.I.15). 16. Identifies different forms of energy, including kinetic, gravitational (potential), chemical, thermal, nuclear, and electromagnetic (NM - II.I.II.1). 17. Explains how thermal energy (heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature (NM - II.I.II.2). 18. Understands that energy can change from one form to another (e.g., changes in kinetic and potential energy in a gravitational field, heats of reaction, hydroelectric dams) and knows that energy is conserved in these changes (NM - II.I.II.3). 19. 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). 20. Explains how heat flows in terms of the transfer of vibrational motion of atoms and molecules from hotter to colder regions (NM - II.I.II.5). 21. 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.). 22. Understands that electromagnetic waves carry energy that can be transferred when they interact with matter (NM - II.I.II.7). 23. Describes the characteristics of electromagnetic waves (e.g., visible light, radio, microwave, X-ray, ultraviolet, gamma) and other waves (e.g., sound, seismic waves, water waves), including (NM - II.I.II.8): • origin and potential hazards of various forms of electromagnetic radiation, and • energy of electromagnetic waves carried in discrete energy packets	14, 16, 18. The student builds a number of simple voltaic (galvanic) cells, using a variety of elements as electrodes, and then using a multimeter (voltmeter), tests the cell potentials (voltages), determines the half reactions involved, and categorizes the elements in an electromotive series from most to least reactive. ✓ accuracy of measurements ✓ appropriate use and care of equipment ✓ adherence to proper safety procedures ✓ correct oxidation and reduction half reactions ✓ percent error of cell potentials 17, 19-20. The student performs basic coffee cup calorimetry experiments to determine any one or all of the following: • specific heat capacities of a sampling of substances and unknowns, • the enthalpy of fusion of ice, para-dichlorobenzene, or some other substance, • the enthalpy of reaction or formation (Mg and HCl), • the enthalpy of vaporization of water by the condensation of steam, • freezing point depression of a solution, and • boiling point elevation of a solution. ✓ accuracy of measurements ✓ proper problem solving procedures ✓ adherence to proper safety guidelines ✓ appropriate use of units, significant digits, and conversions ✓ summary with supporting reasoned conclusions ✓ critical thinking and insight in results and conclusions 21-25, 29-32, 36-38. After listening to lectures on energy levels, quantum mechanics, and electron transitions, the student, in a lab situation, using a spectrometer, spectrograph, or diffraction grating, measures the angle of various bright-line emissions from either flames or gas discharge tubes. Then using an appropriate equation, he/she calculates the wavelength, frequency and energies of the emissions. ✓ accuracy of measurements ✓ proper problem-solving procedures ✓ appropriate use of units, significant digits, and conversions

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	(photons) whose energy is inversely proportional to wavelength. 24. Knows that each kind of atom or molecule can gain or lose energy only in discrete amounts (NM - II.I.II.9). 25. Explains how wavelengths of electromagnetic radiation can be used to identify atoms, molecules, and the composition of stars (NM - II.I.II.10). 26. Understands the concept of equilibrium (i.e., thermal, mechanical, and chemical) (NM - II.I.II.11). 27. Knows that there are four fundamental forces in nature: gravitation, electromagnetism, weak nuclear force, and strong nuclear force (NM - II.I.III.1). 28. 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). 29. Knows that materials containing equal amounts of positive and negative charges are electrically neutral, but a small excess or deficit of negative charges produces significant electrical forces (NM - II.I.III.3). 30. 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). 31. Explains how electric currents cause magnetism and how changing magnetic fields produce electricity (e.g., electric motors, generators) (NM - II.I.III.5).	✓ summary with well-reasoned conclusions 26. Student characterizes a system in equilibrium with regard to the composition of the reaction mixture. Student calculates the concentration of reactants and products present in the system, then predicts the effects of: • adding more reactant. • adding more product. • heating the reaction mixture. • removing one reactant. • removing a product. • change in pressure. Student uses the equilibrium constant K to calculate concentrations of reactants and products after the system has changed to determine if his/her predictions are correct. ✓ correct use of equlibrium constant ✓ predictions based on LeChatlier's Principle 28. 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. ✓ conceptual understanding ✓ mathematical application and relationships ✓ error analysis

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	32. Represents the magnitude and direction of forces by vector diagrams (NM - II.I.III.6). 33. 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). 34. Applies Newton's Laws to describe and analyze the behavior of moving objects, including: • 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) • circular motion and centripetal force (NM - II.I.III.8) 35. Describes relative motion using frames of reference (NM - II.I.III.9). 36. Describes wave propagation using amplitude, wavelength, frequency, and speed (NM - II.I.III.10). 37. Explains how the interactions of waves can result in interference, reflection, and refraction (NM - II.I.III.11). 38. Describe how waves are used for practical purposes (e.g., seismic data, acoustic effects, Doppler effect) (NM - II.I.III.12).	32-35.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. 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 Fg at 3 points and uses the velocity formula for an ellipse to calculate and then draw velocity vectors. ✓ conceptual understanding ✓ mathematical application and relationships ✓ error analysis

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

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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.	1-4. After participating in an in-depth interactive lecture on the four fundamental forces (gravity, weak, electromagnetic, strong), the electromagnetic spectrum, and the formation of atoms (nucleosynthesis) from subatomic particles in the early universe and in stars, as well as the energies involved, the student graphs the nucleons (proton number versus neutron number) showing stable and unstable isotopic arrangements. The student graphs or charts the decay processes (e.g., alpha, beta, gamma, neutron capture) by which unstable isotopes become stable. Using known half-lives of unstable isotopes, the student calculates age of samples from isotope ratios. In the same unit the student views a demonstration on the detection of decay using a Geiger counter. ✓ accuracy of graphs ✓ clarity of descriptions and explanations regarding forces of attraction, radiations and radioactivity ✓ evaluation of the type, energy, and time associated with numerous emissions and absorptions ✓ proficiency in the proper use of units, significant figures, and conversions in all calculations
	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). (II.III.I.2).	2. Student observes the position of the moon against the background stars daily for a specific time period. Students then report their results in a diagram that shows the changes in the relative position of the moon.
	3. Understands how knowledge about the universe comes from evidence collected from advanced technology (e.g., telescopes, satellites, images, computer models). (II.III.I.3). 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. (II.III.I.4).	3, 4, 10. Student researches the relative abundance of elements in the universe, and use this data to introduce the Big Bang theory as an explanation of the relative abundances of hydrogen, deuterium, and helium. Student creates a radioactive decay graph demonstrating the change of one element into daughter elements.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	5. Explains how objects in the universe emit different electromagnetic radiation and how this information is used (NM - II.III.I.5).	5. See Strand II, Illustrations for 21-25.
	6. 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. Examines the role that New Mexico research facilities play in current space exploration (e.g., Very Large Array, Goddard Space Center) (II.III.I.7).	3, 5, 7. Students will research various sources of electromagnetic energy, the processes that form that energy, and what type of technology is used to detect that energy. Students will include what facilities are located in New Mexico, and determine the information that each of these facilities provide to the scientific community.
	8. Recognizes that radiometric data indicates that Earth is at least 4 billion years old and that Earth has changed during that period (NM - II.III.II.2).	6 8. See Strand II, Illustration set 5, 6, 11, 16, 20-22, 24-26.
	9. Explains plate tectonic theory and understand the evidence that supports it. (NM – II.III.II.5). 10. 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). 11. Describe 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 (II.III.II.7): • geological manifestations (e.g., earthquakes, volcanoes, mountain building) that occur at plate boundaries • impact of plate motions on societies and the environment (e.g., earthquakes, volcanoes).	9-11. The student examines plate theory and plate motion by researching, graphing, and analyzing volcanism, topography, and seismicity for various sites and boundaries. The student participates in class discussion about heat sources (e.g., radioactivity, residual heat of formation, solar energy) and the effects of density, state of matter, and heat affect plate movement.

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. 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).	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. ✓ individual participation ✓ support for response
	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).	2 – 4, 6, 10. The student researches a particular technological item (e.g., CD's, golf clubs, elevators, guitars, motors/generators) and either orally or in written format presents the origin of that item, changes based on technology, and the pros and cons of the development. ✓ thorough research ✓ all required components ✓ accuracy ✓ analysis and organization ✓ effective presentation
	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). 8. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM - III.I.I.8).	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 the benefits of having the information or advancement of the new knowledge. ✓ accurate account of news item ✓ differing viewpoints

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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). 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). 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). 12. Explains how societies can change ecosystems and how these changes can be reversible or irreversible (NM - III.I.I.12). 13. Describes how environmental, economic, and political interests impact resource management and use in New Mexico (NM – III.I.I.13). 14. Describes New Mexico's role in nuclear science (e.g., Manhattan Project WIPP, national laboratories) (NM - III.I.I.14). 15. Identifies how science has produced knowledge that is relevant to individual health and material prosperity (NM - III.I.I.15). 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). 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).	9, 12, 13, 17. The student listens to a guest speaker (e.g., someone from 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. ✓ understanding of an issue ✓ viability of plan ✓ specifics ✓ problem-solving skills

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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). 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).	18,19. 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 insert that in, whether it be through personal experiences or through questioning (e.g., What does a technician do? What is a physicist?). The student talks about his/her 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 oral or written format summarizes one career. ✓ individual participation ✓ listening skills ✓ personal connections ✓ scientific significance to career field ✓ effective presentation

STRAND V: LITERACY
CONTENT STANDARD: The student communicates scientific 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: • Identify the author and locate 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: Read the article and take notes. Step 3: Write a summary including why the article is interesting or important or controversial in nature and provides his/her opinion on the topic. ✓ 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* - I. Beck, et. al., - International Reading Association, Newark, DE)
	2. Identifies and uses roots, prefixes, and suffixes to determine meaning of words (APSLA I.4).	2. Given formulas, the student categorizes inorganic or organic compounds, Greek and Latin roots, prefixes, and suffixes. ✓ correct answers
	3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APSLA II.2).	3-5. The student maintains a portfolio to include journals reflecting on labs, conclusions, data, day-to-day commentaries, and a record of demonstrations and lab experiences. He/She submits the information on a disk or CD. ✓ actual lab experiences ✓ journal entries with required components

		3, 8. The student participates in study groups tutoring other students by explaining labs and demonstrations or reviewing the content learned and practicing problem solving techniques. ✓ knowledge of content ✓ ability to explain concepts in simple terms 1, 4, 5, 7, 10. 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. ✓ understanding of the task ✓ adherence to the process ✓ summary of research ✓ list of links
	4. Develops increased competence in using the writing process to create a final product (APS LA III.1). 5. Develops increased competence in using elements of effective writing (APSLA III.2). 6. Supports an informed opinion (APSLA 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 (APSLA III.7). 8. Develops increased competence with speaking and language conventions (APSLA IV.3).	4, 5. The student writes extensions of labs or demonstrations presented in Strands II and III. ✓ conceptual understanding ✓ lab writing process ✓ logical organization