APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Chemistry 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

COURSE AND ADS NUMBERS:

Chemistry I (Analytical)	42121	17214144
Chemistry I (Analytical) Bilingual	4212B	17218144
Chemistry I (Analytical)	060MN	17212144
Chemistry I (Analytical)	061MN	17212144
Chemistry I (Analytical)	062MN	17212144

Important Notes:

It is strongly recommended that the student has successfully completed Algebra I prior to taking Chemistry I.
This course meets college entrance requirements.

COURSE DESCRIPTION:

This laboratory course* exceeds state standards and offers extended opportunities for students. It provides preparation for all subsequent science courses including Advanced Placement courses. The student investigates substances and how they react with one another. Concepts of study include, but are not limited to, scientific measurement, properties and structures of matter, atomic theory, classification and periodic trends, bonding theory, chemical reactions (e.g., general types, acid/base, redox), rates, equilibrium, stoichiometry, energy, (e.g., EMR, bonding), nuclear chemistry, and solubility. In addition the student learns how chemistry and Earth and space science are related by studying electromagnetic radiation, radioactivity, the structure of the Earth, and the groundwater. Scientific thinking and practice (e.g., extensive laboratory activities, critical thinking, problem solving), science and society, and literacy are integrated in all science courses.

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

STRATEGIES:
The "Illustrations" column provides exemplars of the performance standards, strategies, and the best practices suggested by the high school science teachers in the Albuquerque Public Schools. Some illustrations are introductory and others are culminating activities for concepts. Illustrations may be modified for individualized instruction, accessibility of equipment and materials, etc.

ASSESSMENTS:
Assessments include authentic and performance-based assessment, cooperative learning, teacher observations, role playing, checklists, rubrics, tests and exams, formal and informal writing, oral presentations, group discussions, multimedia presentations, projects and demonstrations. The "Illustrations" column also incorporates a variety of assessments. Each laboratory experiment is graded for both accuracy and precision (results) and the student's analysis and discussion of theory (write-up).

SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:
- *Chemfile Mini Guide to Problem Solving* (Holt, Rinehart, and Winston 1998)
- *Chemistry Concepts and Problems: A Self-Teaching Guide, 2nd* Edition (Houk and Post. John Wiley & Sons, Inc. 1996)
- *Chemistry with Calculators* – (Vernier Software & Technology 2002)
- *CRISTAL Lab Program*, (Price Laboratory School and University of Northern Iowa)
- *Laboratory Experiments for Advanced Placement Chemistry* by Sally Vonderbrink (Flinn Scientific, Incorporate 2001)
- *40 Low-Waste, Low-Risk Chemistry Labs by* David Dougan (Walch, J. Weston Publisher August 1999)
- *Uncle Tungsten: Memories of a Chemical Boyhood* by Oliver Sacks (Knopf Publishing Group September 2002)

SUGGESTED TITLES/AUTHORS WEB SITES:
- http::://manzano.aps.edu/science/ APS science page
- http::://www.eric.ed.gov/ U.S. Government resource search tool
- http://www.chemistry.org Many resources including Chemical of the Week, Chemistry Olympiad, and ChemMatters magazine
- http://www.nsta.org National Science Teachers Association web page
- http://164.64.166.11/cilt/standards An online tool provided by NM State Department of Education to plan and map instructional strategies based on NM standards.
- http://164.64.166.11:8080/http/cilt2/login This tool will help organize units and lessons, keep track of which standards you have addressed, and share best practices.
- LISTSERV@MAILER.UWF.EDU Chemistry teachers' list serve. The first line of the message should read only: SUSCRIBE CHEMED-L. This must be done from the address from which you wish to receive chemistry email messages.
- http://intro.chem.okstate.edu/ChemSource/chemsource.html Instructional Resources or Preservice and Inservice Chemistry Teachers
- http://www.chemheritage.org/ The Chemistry Heritage Foundation serves the community of the chemical and molecular sciences and the wider public.

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
	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 properly designs and performs a controlled experiment using scientific methods, gathers and analyzes data, and reports results in both an oral and written format. ✓ proper safety technique ✓ correct use of appropriate equipment ✓ evidence of current scientific knowledge ✓ organization of data ✓ appropriate analysis of data ✓ reasonable and testable problem ✓ defensible conclusion based on data ✓ quantitative/qualitative data ✓ trials to verify data ✓ theory supported by data ✓ critical thinking and insights ✓ use of technology ✓ effective communication skills ✓ writing conventions -FOR EXAMPLE-

GRADE 9-12	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. 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). 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. 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., superconductivity, molecular machines, age of the universe). (NM – I.I.II.5).	The student tests the pH of an acid sample, verifying by titration. He/She prepares a standard solution of potassium carbonate (dried and weighed to make a 0.100M solution) and determines the amount of acid in the sample by titration with an indicator. The student also determines the dilution ratio for the standard in order to perform the titration accurately. ✓ proper use of equipment and safety precautions ✓ accurate measurement of pH ✓ accurate calculation of acid molarity from pH ✓ accurate calculation for preparation of standard solution ✓ good titration technique ✓ accurate determination of acid molarity with all calculations ✓ precise observations of volume and color changes ✓ clear explanation of results ✓ error analysis **OR** The student prepares a pre-lab write up by including the following: • descriptive title, • purpose, • hypothesis, • materials and information needed, • ordered procedure, and • answers to pre-lab questions. The student determines the molar mass of a gas by measuring the mass of a known volume of a gas. Variables (e.g., temperature, pressure) are determined by a conventional thermometer and barometer. The student may also use calculators with probes and computers for data collection and analysis. ✓ thorough pre-lab write up ✓ clear, concise procedure ✓ proper use of significant figures, data tables, graphs, error analysis ✓ narrative of experimental results ✓ proper use of safety procedures and equipment at all times

GRADE 9-12	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).	

STRAND II: THE RELATIONSHIP BETWEEN THE PHYSCIAL 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
		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 ✓ effective communication
	1. Represents and analyzes relationships using written and verbal expressions, tables, equations, and graphs, and describes the connections among those representations (Math – IA.6). 2. Knows, explains, and uses equivalent representations for algebraic expressions (Math – IA.7).	1, 2. The student properly designs and performs a controlled experiment using scientific methods, gathers and analyzes data, and reports results in both an oral and written format.
	3. Solves (Math – IB. 13): • formulas for specified variables, and • radical equations involving one radical.	3. The student determines the molar mass of a gas by measuring the mass of a known volume of a gas. Variables (e.g., temperature, pressure) are determined by a conventional thermometer and barometer. The student may also utilize AP recommended calculators with probes and computers for data collection and analysis.
	4. Manipulates simple expressions with + and – exponents (Math – IB.16).	4. The student learns the strengths of acids and bases by making pH measurements in the laboratory and seeing the logarithmic relationship of the pH scale.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	5. Identifies the independent and dependent variables from an application problem (Math – IB.6).	5. The student researches the arsenic levels in the Rio Grande aquifer to determine the variation of levels based on the geography and the location of the collected sample. He/She includes in the research the following: • local current conditions, and • future implications of diversion and/or conservation of existing water resources.
	6. Applies quadratic equations to physical phenomena (e.g. acid-base equilibria) (Math – IB.13). 7. Models real-world phenomena using linear and quadratic equations and linear inequalities (Math – IC.1). 8. Understands and uses (Math – IC.2): • operations (e.g., as taking the inverse, finding the reciprocal, taking a root, and raising to a fractional power), and • rules of exponents.	6 – 8. The student determines the molar mass and acid dissociation constant of acetic acid by titration and pH measurement of solutions containing a known mass concentration of acetic acid. The student may also use data and graphing calculators to analyze pH curves obtained in the experiment.
	9. Analyzes characteristics and properties of two and three-dimensional geometric shapes and develops mathematical arguments about geometric relationships (Math – IIA.5).	9. Using patterns from *Molecular Origami*, the student builds paper models of molecules that illustrate molecular geometries, and using his/her knowledge of molecular bonding, accounts for the variety of bond angles.
	10. Demonstrates understanding of the construction of the coordinate plane, knows the names of the origin, coordinates axes and four quadrants, draws and labels them correctly (Math – IIB.1).	10. The student uses a quantum address to orient atomic orbitals for a specific element showing the alignment of orbital geometries on a set of coordinate axes.
	11. Knows the characteristics of a well-designed and well-conducted experiment (Math – IIIA.3): • differentiates between an experiment and an observational study, and • recognizes sources of bias in poorly designed experiments.	11. The student researches Rapa Nui to learn what happened to a civilization that did not properly utilize its available resources. Using this information, he/she investigates the potential of nuts to act as a renewable energy resource.

STRAND III: 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 structure, and reactions of matter.
B. The student understands the transformation and transmission of energy and how energy and matter interact.

GRADE 9–12	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, 4, 8. Using the Periodic Table, the student classifies a set of known/unknown elements according to chemical and physical properties (e.g., metal/nonmetal, gas/solid/liquid, electronegativity, electrical/heat conductivity, ionization, electron configuration, reactivity). ✓ accuracy ✓ proper terminology ✓ proper use of equipment/materials ✓ proper classification of unknowns ✓ persuasive communication of concepts including trends ✓ accurate description of chemical and physical properties
	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. The student measures the volume and mass of a variety of samples (e.g., copper, lead, ice, water, alcohol, styrofoam, brass, cork, wood) and then calculates the density of each sample. ✓ proper use of equipment ✓ correct determination of significant digits in measuring and calculation ✓ precision, accuracy, error analysis ✓ graphic determination of density (i.e., mass vs. volume)
	3. Knows how to use properties to separate mixtures into pure substances (e.g., distillation, chromatography, solubility) (NM – II.I.I.3).	3. The student designs a method for separating a mixture of substances choosing from a variety of techniques (e.g., polarity, boiling/freezing point, precipitation/saturation). ✓ accurate prediction of molecular behavior ✓ successful separation of mixture ✓ evaluation of separation technique ✓ proper use of equipment ✓ application of mathematical relationships
	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. See Strand II (Content of Physical Science) Illustration #1, 4, 8.

GRADE 9–12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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 • atom 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). 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 and 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.	5, 6. The student researches and presents the historical development of the atomic theory, noting how new evidence changes and refines the model. ✓ citations ✓ original work ✓ speaking conventions ✓ effective communication of concepts ✓ explanation of how experiments' evidence correlates to specific models ✓ identification of subatomic particles' characteristics 7. Based on electron configurations and electronegativities, the student predicts bond character. ✓ accuracy of electronic configuration ✓ accurate calculation of electronegativity differences ✓ electronegativity differences equated with bond type (e.g., ionic, covalent, polar/nonpolar) ✓ identification of the number of valence electrons ✓ relationship of percentage of ionic character with bond character 8. See Strand II (Content of Physical Science) Illustration #1, 4, 8. 9, 10, 17. Using a variety of homogeneous substances (e.g., ionic, polar, nonpolar, metallic, covalent), the student determines the melting point/boiling point/conductivity/solubility of each and relates the specific macroscopic property to the arrangement (i.e., energy relationship) of atoms and their bonds. ✓ accurate determination of macroscopic property ✓ relationship of property and phase (i.e., solid, liquid, gas) ✓ arrangement of atoms (i.e., bonds and intermolecular forces) ✓ correlation with specific macroscopic property ✓ energy differences between phases 11. The student graphically represents the relationship between protons and neutrons in the nucleus and graphs the disintegration chain of an unstable isotope. He/She writes an interpretation of each graph. ✓ accuracy of graphs ✓ all elements (e.g., labels, titles, units) of graph present ✓ near one-to-one relationship noted between proton/neutron

GRADE 9–12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		✓ ratio and stability ✓ identification of nucleus changes due to types of decay prediction of relative stability of isotope ✓ clear communication of findings ✓ writing conventions
	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).	12, 14. The student represents a chemical reaction by building a model (e.g., ball and stick, drawing) and writing a symbolic equation that represents the model (or vice versa). ✓ conservation of mass (i.e., atoms before reaction is equal to atoms after reaction) ✓ valid formula (i.e., correct reactants and products) ✓ correct symbols ✓ equation represents model; model represents equation
	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). 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.	13. The student performs an investigation of numerous types of chemical reactions, making qualitative observations (e.g., temperature/color/ phase/odor change). He/She writes an accurate description of observations and a proper conclusion including a chemical equation. ✓ accurate written description ✓ correct classification of reaction type ✓ exothermic or endothermic label applied accurately ✓ proper conclusion ✓ writing conventions ✓ concept clearly communicated ✓ accurate balanced chemical equation
	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).	15. The student dips a constant length of magnesium ribbon in solutions of 0.5M HCl at intervals ranging from 0 – 80 seconds. He/She determines the reaction rate by graphing the concentration of acid based on drops of 0.25M KOH plus indicator vs. time. When the graph is finished, the student writes a paragraph describing the graph. He/She changes one variable (e.g., concentration, surface area, catalyst, reactant, temperature) and measures any change in the reaction rate. Using this new data, the student writes a description that compares and contrasts the two rates. ✓ all elements of graphs present ✓ accurate graphs ✓ clear, accurate description of the graphs ✓ clear, accurate description of how variable change affects rate

GRADE 9–12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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. 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).	16, 18. The student diagrams and describes the change of energy from an energy source (e.g., nuclear fuel, renewable resources, fossil fuels, chemical reactions) to useable energy. The student investigates, writes, and presents the impact of energy usage on society, informed opinion (pro and con) on the impact of energy usage. ✓ description of New Mexico's role in the development and potential of energy sources ✓ recognition of the limits of these technologies ✓ accurate diagram of energy flow chart showing forms of energy ✓ career choices ✓ recognition of any bias of information sources ✓ effective presentation 18. The student performs two reactions (e.g., NaOH pellets in water, NaOH pellets in HCl) and measures the heat of each reaction in kilocalories per mole. He/She adds the two reactions together, predicts the heat of reaction for NaOH (aq)+ HCl (aq), and verifies prediction experimentally. ✓ proper safety precautions and use of equipment ✓ accurate measurement ✓ accurate calculation of heat of reaction ✓ reasonable prediction based on data ✓ error analysis ✓ prediction compared and contrasted with experiment results 19. Using a boiling water bath, the student heats a variety of unknown metals, places in a calorimeter, and measures the change in water temperature. He/She calculates the specific heat to determine the identification of each metal. ✓ proper safety procedures and use of equipment ✓ accuracy and precision of measurements stated ✓ accuracy (e.g., calculation of specific heat, percentage of error, identification of metal) ✓ clear description of the relationship between macroscopic observations and activity on the atomic scale

GRADE 9–12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	20. 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 (photons) whose energy is inversely proportional to wavelength. 21. Knows that each kind of atom or molecule can gain or lose energy only in discrete amounts (NM – II.I.II.9). 22. Explains how wavelengths of electromagnetic radiation can be used to identify atoms, molecules, and the composition of stars (NM – II.I.II.10). 23. Understands the concept of equilibrium (i.e., thermal, mechanical, and chemical) (NM – II.I.II.11).	20 – 23. The student observes and draws the emission spectrum (e.g., flame test, gas tubes) of an element. He/She determines the wavelength and calculates the frequency and energy of each line, relating the observation and calculation to the electron transition energy on the atomic scale. The student researches how electromagnetic radiation (EMR) is used to identify atoms, molecules, and star composition. ✓ clear description and drawing of observation ✓ accurate calculations of frequency and energy ✓ good description of relationship including the following: • discrete energy packets (i.e., photons) • gain or loss of energy (i.e., absorption and emission) • electron energy levels • relationship to emission spectrum ✓ clear description of how EMR is used 23. The student performs an equilibrium reaction (e.g., ferric iron + thiocyanate/ferric thiocyanate; starch and sodium hydroxide with methylene blue and indigo carmine) and observes the colors. Given the reaction equation and colors, he/she predicts how the equilibrium shifts when the system is stressed. The student stresses the system by changing the concentration of reactants/products and observes the changes to verify prediction. ✓ use of safety procedures ✓ clear, detailed observation ✓ reasonable prediction of shift with explanation ✓ observations that relate to change of concentrations

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.

BENCHMARK: 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
	1. Understands the scale and contents of the universe, including (NM-II.III.II.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. The student constructs a scale model in powers of 10 of objects in the universe from extremely small (e.g., atoms) to extremely large (e.g., galaxies). ✓ accuracy of scale ✓ accurate placement of objects (e.g., proton, molecule, red giant) within scale
	2. Explains how objects in the universe emit different electromagnetic radiation and how this information is used (NM – II.III.I.5).	2. The student generates/interprets an HR (i.e., Hertzsprung-Russell) diagram from absolute stellar luminosity and temperature. He/She relates the position of the star on the diagram to a stage in its life cycle. ✓ accurate diagram ✓ identification of fusion type (e.g., proton-proton, CNO, triple alpha) ✓ accurate prediction of previous/next stage in life cycle
	3. Recognizes that radiometric data indicate that Earth is at least 4 billion years old and that Earth has changed during that period (NM – II.III.II.2).	3, 5, 6. The student constructs/interprets a graph of atomic mass vs. atomic number from an isotope (e.g., U-238) to stable lead. He/She determines how the age of the Earth relates to relative abundance of isotopes. ✓ accurately dated sample ✓ accurate identification of alpha and beta emissions -AND- See Strand II (Content of Physical Science) Illustration #11.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	4. Describes the internal structure of Earth (e.g., core, mantle, crust) and the structure of Earth's plates (NM – II.III.II.3).	4. The student creates and labels a diagram of the Earth from the core outward to the ionosphere, including relative size, phase, and composition of each layer. He/She writes a description of how the convection temperature causes plate movement, and based on this description, predicts the location of volcanoes and earthquakes. ✓ correct order of layers ✓ accuracy of relative size and composition ✓ accurate description of plate boundaries ✓ accurate prediction of locations for earthquakes and volcanoes **-AND-** 4 – 7. The student separates a soil sample into three portions. Using portion A, the student determines the water content by dehydration; portion B, the iron content by magnetic separation; and portion C, the sand, silt, clay content by density separation. ✓ physical vs. chemical separation procedures ✓ samples laved as mixture or compound ✓ accurate calculations 4, 6. The student uses lab observations to model the tectonic process. He/She uses a hot plate to warm various substances (e.g., pea soup, Karo syrup with glitter, water with dye) and relates the convection process to the tectonic process, correlating the observations with boundaries (i.e., divergent, convergent, transformational). ✓ accurate correlations and descriptions ✓ correct identification of boundaries
	5. Understands the changes in Earth's past and the investigative methods used to determine geologic time, including (NM – II.III.II.4): • rock sequences, relative dating, fossil correlation, and radiometric dating, and • geologic time scales, historic changes in life forms, and the evidence for absolute ages (e.g., radiometric methods, tree rings, paleomagnetism).	5. Using a timeline/written description, the student compares and contrasts different radiometric techniques (e.g., carbon dating, potassium-argon, uranium-lead). ✓ proper correlation of dating technique with geologic time period

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	6. 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). 7. Describes the composition and structure of Earth's materials, including (NM – II.III.II.10): • the major rock types (i.e., sedimentary, igneous, metamorphic) and their formation, and • natural resources (e.g., minerals, petroleum) and their formation. 8. Explains how the availability of ground water through aquifers can fluctuate based on multiple factors (i.e., rate of use, rate of replenishment, surface changes, and changes in temperature) (NM – II.III.II.22).	6, 7. The student writes a description of the rock cycle, explaining how it is driven by external (e.g., weathering, sedimentation, vulcanism) and internal (e.g., pressure, temperature) energies. He/She identifies a a major rock type (i.e., sedimentary, igneous, metamorphic) and where it would fit in the cycle. Using a graph of Bowan's reaction series, the student describes how mineral crystallization is related to temperature and pressure. ✓ correct identification of sample ✓ accurate identification of the process that created rock/mineral ✓ writing conventions ✓ clear communication of ideas 8. The student researches factors that deplete/replenish/contaminate the water/atmosphere, focusing on local political and economic decisions (e.g., Chama diversion project, xeriscaping, water use for golf courses/ Balloon Fiesta Park, smog control, air regulations and monitoring, CFCs, Superfund sites, water pollution). As part of a group, he/she incorporates findings into a presentation to the class. After all of the presentations have been made, the student participates in a discussion/ debate of the issues. ✓ participation ✓ clear communication of ideas ✓ accurate information ✓ logical conclusions ✓ use of technology ✓ effective presentation -AND- The student measures the hardness of water caused by dissolved calcium and magnesium ions using and EDTA titration. Harness is a function of the geologic formation through which it flows. Water flowing though a limestone aquifer demonstrates high hardness. The student collects water samples from various locations to demonstrate trends in calcium and magnesium concentration.

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
	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. See Strand III, Illustration #8.
	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).	2. See Strand II, Illustration #5, 6.
	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).	3, 4. See Strand II, Illustration #16, 18.
	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).	5, 6. See Strand III, Illustration #8.
	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.8).	7. See Strand II, Illustration #16, 18. See Strand III, Illustration #3. 5. 6
	8. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM – III.I.I.8).	8. See Strand II, Illustration #16, 18. See Strand III, Illustration #8.

GRADE 9-12	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).	9. See Strand II, Illustration #5, 6.
	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).	10 – 16. See Strand II, Illustration #16, 18.
	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).	15. See Strand III (Content of Earth and Space Science) Illustration #3, 5, 6
	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).	16. See Strand II (Content of Physical Science) Illustration #5, 6.
	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).	17. See Strand III (Content of Earth and Space Science) Illustration #8.
	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).	18. See Strand II (Content of Physical Science) Illustration #16, 18.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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).	19. See Strand III (Content of Earth and Space Science) Illustration #8.

STRAND VI: LITERACY
CONTENT STANDARD: The student communicates chemistry 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
	1. Develops and demonstrates proficiency with the following strategies to approach reading for information across content areas(APS – LA 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 the text, • reads and rereads to decode meaning, and • reviews and summarizes essential elements of text for overview.	1, 3 - 6, 8. See Strand II, Illustration #16, 18. 1, 4 – 8. See Strand III, Illustration #8.
	2. Identifies and uses roots, prefixes, and suffixes to determine the meaning of words (APS – LA I.4).	2. The student relates science vocabulary and nomenclature to Greek and Latin roots (e.g., homogeneous/heterogeneous mixture, exotherm/ endotherm, hypochlorite/perchlorate, ferrous/ferric, tin/stannous). ✓ accuracy ✓ application
	3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APS – LA II.2).	3 – 6. See Strand I, Illustration #1 – 16.
	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 (APS – LA III.2).	4, 5. See Strand III , Illustration #6, 7.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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).	7. See Strand II, Illustration #16, 18.
	8. Develops increased competence with speaking and language conventions (APS – LA IV.3).	8. See Strand II, Illustration #16, 18. Strand III, Illustration #8.
	Note: The above standards are aligned with 9th grade language arts.	