APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Chemistry I **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	42111	17214144
Chemistry I Bilingual	4211B	17218144
Chemistry I	060MM	17212144
Chemistry I	061MM	17212144
Chemistry I	062MM	17212144

Important Notes:
It is strongly recommended that the student has successfully completed Algebra I prior to taking ChemistryI.
This course will meet college entrance requirements.

COURSE DESCRIPTION:
This laboratory course* is designed so the student studies chemistry and its applications, especially as applied to the impact on society. He/She investigates substances and how they react with one another. Concepts of study include, but are not limited to, scientific measurement, properties and structure of matter, atomic theory, classification and periodic trends, ionic and covalent bonding, chemical reactions, energy, nuclear chemistry, acids and bases, and solutions. In addition, the student studies how chemistry and Earth and space science are related. Concepts include, but are not limited to, electromagnetic radiation, radioactivity, the structure of the Earth, and groundwater. Scientific thinking and practice (e.g., extensive laboratory activities, critical thinking, and problem solving), science and society, and literacy are integrated throughout 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 refer to and are aligned with the New Mexico Science Standards (NM) and the APS 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.

SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:
- State adopted textbooks and ancillary materials
- Supplementary materials
- Films/videos
- "World of Chemistry," The Annenberg CPGC Collection.1990
  Internet

SUGGESTED TITLES/AUTHORS WEB SITES:
- "Chemical Cuisine." Carolina Biological Supply Co. Terrific Science Press. 2001
- "Chemical Magic from the Grocery Store." A.S. Sae. Kendall/Hunt. 1996
- "Chemistry in the Marketplace 5th Edition." Harcourt Brace, 1998.
- "Decisions Based on Science." Campbell, et al. National Science Teachers Association, 1997
- "One Minute Readings: Issues in Science, Technology, and Society." Addison Wesley, 1992.

- http:://manzano.aps.edu/science/ APS science page
- http:://www.eric.ed.gov/ U. S. Government 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 for 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
		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. Describes the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions (NM-I.I.1). 2. Designs and conducts scientific investigations that include the following: • 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 (NM-I.I.2). 3. Uses appropriate technologies (e.g., computers, calculators, balances, microscopes) to collect, analyze, and communicate scientific data (NM-I.I.3). 4. Conveys results of investigations using scientific concepts, methodologies, and expressions, using • 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 (NM-I.I.4).	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

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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 the following: • 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 (NM-I.I.II.1). 7. Uses scientific reasoning and valid logic recognizing • faulty logic, • cause and effect, • the difference between observation and unsubstantiated inferences and conclusions, and • potential bias (NM-I.I.II.2). 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). 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).	-FOR EXAMPLE- The student designs an experiment using paper chromatography to identify the color/brand of a washable marker. √ descriptive narrative of chromatography √ accurate description of purpose √ logical approach with delineated steps to solving problem √ use of safety glasses √ complete observation of colors and position recorded √ descriptive narrative of conclusion supported by data -AND- Many of the following illustrations address several of these standards.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	14. Uses technologies (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling) to quantify relationships in scientific hypotheses (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 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
	Properties of Matter 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. The student identifies chemically-labeled samples as elements [e.g., copper (Cu), sulfur (S_8)], compounds [(e.g., H_20), salt (i.e., NaCl)], and mixtures (e.g., salt in water, sand and iron). He/She constructs a model of each using colored objects (e.g., red = H, blue = O). √ correct identification of sample √ correct model
	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 notes the volume of Coke and Diet Coke cans, measures the mass of each can, calculates the density of each, and predicts and verifies whether the cans will float or sink in water. √ accurate data for volume and mass √ correct density calculation √ clearly written prediction supported by density calculation √ written description of verification observations
	3. Knows how to use properties to separate mixtures into pure substances (e.g., distillation, chromatography, solubility) (NM-II.I.I.3).	3. See Strand I (Scientific Thinking and Practice) Illustration #1 – 16 example.
	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. Using the Periodic Table (minus the noble gases), the student constructs two graphs: one graph represents electronegativity vs. atomic number for period 3 elements; the other graph represents electronegativity vs. period for group VII. The student states the trends and predicts which element is the most electronegative. √ all elements of graphs present √ accurate graphs √ clear, accurate description of trends √ accurate prediction

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	Structure of Matter 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 • 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 • atoms held together by proton-electron electrical forces (NM-II.I.I.6).	5, 6. The student chooses one aspect of the development of the atomic theory from ancient Greeks to the present time to research. He/She describes how the model was modified to account for new evidence. Using student input, a timeline of the development is constructed. √ accurate research √ description of evidence that caused the model to change √ description of how the model was modified √ participation in timeline 6, 11, 16, 18 Also see Strand IV (Science and Society) #1, 3, 4, 7, 8, 10-15, 17, 18.
	7. Explains how electrons determine the properties of substances through • 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 (NM-II.I.I.7). 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).	7, 8. Using manipulatives (e.g., model kits, gumdrops, Styrofoam balls), and the Periodic Table, the student creates models of ionic and covalent compounds clearly representing the difference between an ordered arrangement of ions and covalent bonds. √ accuracy of compound structure √ accurate classification of compound
	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).	9, 10. Using several liquids of various viscosities (e.g., hexane, ethanol, water, ethylene glycol, glycerin) and their structural formulas, the student predicts the order of increasing viscosity and relates this to the boiling point of the liquid. The student manipulates (e.g., swishes, drops in glass beads) the samples to check for viscosity. Using the appropriate resource, he/she locates and records the boiling point of each sample. √ accurate statement of viscosity trends √ clear, accurate explanations of relationship between viscosity and structural formula √ clear explanation of relationship between boiling point and type and arrangement of atoms and their bonds 9. See Strand IV (Science and Society) #2-4, 8, 10, 11, 14.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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).	10, 16, 17, 18, 19: See Strand IV (Science and Society) #2-4, 6, 8, 10, 11, 14, 17, 18.
	11. Knows that some atomic nuclei can change, including the following: • spontaneous decay, • half-life of isotopes, • fission, • fusion (e.g., the sun), and • alpha, beta, and gamma radiation (NM-II.I.I.11).	11. As part of a class experiment, the student flips three pennies. The teacher collects all pennies showing tails. The student records the data (i.e., total number of pennies in circulation at the beginning of the activity and after each flip) on a data table. The student continues to record the data after each flip until there are no pennies left in circulation. He/She uses the data table to construct a graph of pennies in circulation vs. the number of flips, writing a description of how this activity relates to spontaneous decay and half life of atomic nuclei. √ participation √ accurate graph √ all elements of graph present √ clear, accurate description √ proper identification of the half life of "pennium" (i.e., number of flips)
	Chemical Reactions 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 – 15. A week before the following experiment, the student puts half of a bottle of fresh hydrogen peroxide into a closed, vented (e.g., pinhole in the top) container. He/She places this container into direct sunlight. The student leaves the other half of the fresh hydrogen peroxide in the closed brown bottle. After a week has passed, the student adds a catalyst (e.g., yeast, MnO_2). After observing the reaction, the student writes a complete balanced equation for the decomposition of H_2O_2. He/She writes a narrative comparing and contrasting the decomposition rates of the two hydrogen peroxides. √ correct identification of reaction type √ clear, accurate description of observation √ accurate chemical equation written and balanced √ identification of variables affecting reaction rate 12-15, 24. See Strand IV(Science and Society) #1-4, 14, 18

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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 • conservation of mass, and • products of common reactions (NM-II.I.I.14).	13, 16 – 19. The student prepares a hot pack (e.g., purchased/made from CaCl dissolved in H_2O and a cold pack (e.g., purchased/made from NH_4NO_3) dissolved in water, measuring the change in temperature when placed in beakers of water. He/She classifies each as an endothermic or exothermic and the type of energy (e.g., potential of bonds, kinetic) and describes his/her observation on a macroscopic level, relating this to motion on the atomic scale. √ clear, accurate description of relationship including the following: • heat flows from hot to cold • change in temperature is change in kinetic energy • energy is stored in bonds √ accurate calculation of temperature change √ accurate classification
	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. See Strand II (Content of Physical Science) Illustration #12 – 15.
	Energy Transformation and Transfer 16. Identifies different forms of energy, including kinetic, gravitational (i.e., potential), chemical, thermal, nuclear, and electromagnetic (NM-II.I.II.1). 17. Explains how thermal energy (i.e., 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. See Strand IV (Science and Society) Illustration #10 – 16. 16 – 19. See Strand II (Content of Physical Science) Illustration #13, 16-19.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	Interactions of Energy and Matter 20. Understands that electromagnetic waves carry energy that can be transferred when they interact with matter (NM-II.I.II.7). 21. 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 the following: • origin and potential hazards of various forms of electromagnetic radiation, and • energy of electromagnetic waves carried in discrete energy packets (i.e., photons) whose energy is inversely proportional to wavelength (NM-II.I.II.8). 22. Knows that each kind of atom or molecule can gain or lose energy only in discrete amounts (NM-II.I.II.9). 23. Explains how wavelengths of electromagnetic radiation can be used to identify atoms, molecules, and the composition of stars (NM-II.I.II.10). 24. Understands the concept of equilibrium (i.e., thermal, mechanical, and chemical) (NM-II.I.II.11).	20 – 23. The student conducts the flame test with a variety of elements, observing the color and the line spectrum. He/She relates the observation on the macroscopic scale to the movement of electrons on the atomic level. The student researches and describes applications of electromagnetic radiation to the identification of unknowns (e.g., drugs, composition of stars, elements). √ proper use of lab equipment and safety procedures √ clear description of observation including a drawing of line spectrum √ clear description of how the color is related to electron movement • quantum of energy • energy, frequency, and wavelength (i.e., color) related to electron movement √ line spectrum specific to each element √ well-written narrative of application 21. See Strand IV(Science and Society) #1, 3, 4, 17, 18. 23. See Strand II (Content of Physical Science) Illustration #20 – 23. 24. Using a pan of hot water, the student gently heats a beaker of water that is covered with plastic wrap, creating a closed system, and places a watch glass on top of the plastic wrap. He/She puts a cube of ice on the watch glass and observes what happens, writing a short narrative describing the changes that occur. The student then explains the following statement to a partner: "Much change is no change." √ proper use of equipment and safety procedures √ identification of opposing processes √ clear, detailed description of observation √ relationship between macroscopic observation and microscopic activity.

STRAND III: THE CONTENT OF EARTH AND SPACE SCIENCE
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
	1. Understands the scale and contents of the universe, including • range of structures from atoms through astronomical objects to the universe, and • objects in the universe such as planets, stars, galaxies, and nebulae (NM-II.III.I.1).	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. √ accuracy of diagram √ identification of fusion type (e.g., proton-proton, CNO, triple alpha) √ accurate prediction of previous/next stage in life cycle -AND- See Strand II (Content of Physical Science), Illustration #20 – 23.
	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

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		3, 5, 7. ALSO see Strand IV (Science and Society) #1, 3, 4, 7, 8, 10-15, 17, 18.
	4. Describes the internal structure (e.g., core, mantle, crust) of Earth 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 √ precise description of plate boundaries √ accurate prediction of locations for earthquakes and volcanoes -AND- 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 √ accurate identification of boundaries
	5. Understands the changes in Earth's past and the investigative methods used to determine geologic time, including • rock sequences, relative dating, fossil correlation, and radiometric dating, and • geologic time scales, historic changes in life forms, and the evidence (e.g., radiometric methods, tree rings, paleomagnetism) for absolute ages (NM-II.III.II.4).	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
	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 • the major rock types (i.e., sedimentary, igneous, metamorphic) and	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

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	their formation, and • natural resources (e.g., minerals, petroleum) and their formation (NM-II.III.II.10). 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.12).	√ 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 8. See Strand IV (Science and Society) #2-4, 8, 10, 11, 14.

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 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	Science and Technology 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 (e.g., microscopes and cellular structure; telescopes and understanding of the universe) enable further advances in science (NM-III.I.I.2).	1. See Strand III (Content of Earth and Space Science) Illustration #8. 2. See Strand II (Content of Physical Science), Illustration #5, 6. 2-4, 6, 8, 10, 11, 14, 17, 18. The student researches and writes a narrative on refrigeration methods, both early and recent. It should include: • how the phase and energy changes for Freon and other CFCs resulted in more efficient and practical methods; • how access to refrigeration methods changed society, and • how the CFCs affected the ozone layer (discovered later). ✓ clear narrative of early and recent refrigeration methods ✓ clear description of energy types and transfers with phase changes ✓ clear narrative societal changes with access to refrigeration ✓ accurate and scientifically-sound description of how CFCs affect the ozone layer. 2-4, 8, 10, 11, 14. The student researches and writes a narrative on the chemistry and reasons for adding oxygenating substances to gasoline. The student researches then compares and contrasts the benefits of the ground water problems associated with the addition of ethanol versus MTBE gasoline. The student discusses the political/environmental/ industrial pressures that led to the decisions to use these additives. ✓ clear explanation of the chemistry behind the use of the additives ✓ clear description of the ground water problems with MTBE ✓ accurate description of the solubility of MTBE ✓ clear narrative of societal issues that led to the use of the additives

	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., wheel, plow, printing press, 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).	3, 4. See Strand II (Content of Physical Science) Illustration #20 - 23. 1, 3, 4, 17, 18. The student researches and writes a narrative about the discovery of x-rays and subsequent x-ray technology, uses, hazards, and benefits. ✓ clear narrative of discovery ✓ several examples of the uses of x-rays ✓ hazards and benefits described 1, 3, 4, 7, 8, 10-15, 17, 18. The student participates in public advocacy for or against the opening of a uranium mine in New Mexico (e.g., public service announcement, newspaper op-ed piece, brochure, radio show, debate). The piece is supported by scientific principles and includes the following: • description of uranium mining and processing • properties of uranium including radioactivity with nuclear equations and half-life • uses of uranium including Manhattan Project, depleted uranium, radiometric dating • alpha, beta, gamma radiation • disposal, including WIPP • risks analysis ✓ thoroughness ✓ accuracy ✓ relevance to local interest ✓ appropriate nuclear equation ✓ accurate simple half-life calculations ✓ clear communication ✓ persuasive argument based on accepted scientific reasoning 1-4, 14, 18. The student researches and writes a short narrative on the Haber-Bosch process and how its breakthrough impacted agriculture and the world food supplies. ✓ clearly written background narrative ✓ accurate balanced chemical equations ✓ detailed discussion of equilibrium, exo- and endo-thermic reactions catalysts, and other factors that affect the rate of reaction and shift the equilibrium. ✓ descriptive narrative of the impact
	5. Analyzes the impact of digital technologies on the availability, creation, and dissemination of information (NM-III.I.I.6).	5, 6. See Strand III (Content of Earth and Space Science) Illustration #8.

	6. Describes how human activities have affected ozone in the upper atmosphere and how it affects health and the environment (NM-III.I.I.7).	
	7. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM-III.I.I.8).	7. See Strand III (Content of Earth and Space Science) Illustration #5.
	Science and Society 8. 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).	8, 11, 12, 14 – 18. See Strand III (Content of Earth and Space Science) Illustration #8.
	9. 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).	9. See Strand II (Content of Physical Science), Illustration #5, 6.
	10. Knows that societal factors (e.g., government funding, laws and regulations about human cloning and genetically modified organisms, gender and ethnic bias, AIDS research, alternative-energy research) can promote or constrain scientific discovery (NM-III.I.I.11). 11. Explains how societies can change ecosystems and how these changes can be reversible or irreversible (NM-III.I.I.12). 12. Describes how environmental, economic, and political interests impact resource management and use in New Mexico (NM-III.I.I.13). 13. Describes New Mexico's role in nuclear science (e.g., Manhattan Project, WIPP, national laboratories) (NM-III.I.I.14). **Science and the Individual** 14. Identifies how science has produced knowledge that is relevant to individual health and material prosperity (NM-III.I.I.15).	10 – 17. 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. He/She 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 technologies √ accurate diagram of energy flow chart showing forms of energy and corresponding careers √ recognition of bias in information source
	15. 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).	15. See Strand III (Content of Earth and Space Science) Illustration #3, 5, 6.
	16. 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).	16. See Strand II (Content of Physical Science) Illustration #5, 6.

	17. 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).	17. See Strand III (Content of Earth and Space Science) Illustration #8.
	18. 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. The student researches chromatography and writes a narrative description of its applications in science careers (e.g., forensics, medicine, environmental science, drug testing). √ accurate description of chromatography √ citation of at least two applications √ examples of careers in which chromatography is used √ writing conventions √ appropriate information extracted from references (e.g., class notes, text, electronic media) -AND- See Strand III (Content of Earth and Space Science) Illustration #8. -AND- See Strand IV (Science and Society) Illustration 10 – 17.

STRAND V: LITERACY
CONTENT STANDARD: The student communicates chemical 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 text, • reads and rereads to decode meaning, and • reviews and summarizes essential elements of text for overview.	1, 3 - 6, 8. See Strand IV (Science and Society) Illustration #10 - 17. -AND- 1, 6 – 8. See Strand III (Content of Earth and Space Science) Illustration #8. -AND- 1, 3 - 5, 7. See Strand IV (Science and Society), Illustration #18.
	2. Identifies and uses roots, prefixes, and suffixes to determine 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 (Scientific Thinking and Practice) Illustration #1 – 16.
	4. Develops increased competence in using the writing process to create a final product (APS – LA III.1).	4, 5. See Strand I (Scientific Thinking and Practice) Illustration #1 – 16. -AND- See Strand III (Content of Earth and Space Science) Illustration #6, 7.

GRADE 9-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	5. Develops increased competence in using elements of effective writing (APS – LA III.2). 6. Supports an informed opinion: (APS – LA III.6): • uses appropriate language, reasoning, and organizational structure for the audience and purpose, • provides relevant and convincing reasons, uses various types of evidence, and • demonstrates an awareness of possible questions, concerns, or counterarguments.	6. See Strand I (Scientific Thinking and Practice) Illustration #1 – 16. -AND- See Strand IV (Science and Society) Illustration #10 - 17. -AND- See Strand III (Content of Earth and Space Science) Illustration #8.
	7. Responds to a variety of written, electronic, and other media (APS – LA III.7).	7. See Strand III (Content of Earth and Space Science) Illustration #8. -AND- See Strand IV (Science and Society), Illustration #8.
	8. Develops increased competence with speaking and language conventions (APS – LA IV.3).	8. See Strand IV (Science and Society) Illustration #10 - 17. -AND- See Strand III (Content of Earth and Space Science) Illustration #8.