APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Astronomy I **Course Number:** SEE BELOW

Department: Science **ADS Number:** SEE BELOW

Prerequisites: Successful completion of Algebra I or concurrent enrollment in Algebra I

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

COURSE AND ADS NUMBERS:

Astronomy I	43131	17614144
Astronomy I Bilingual	4313B	17618144
Astronomy I	060MV	17612144
Astronomy I	061MV	17612144
Astronomy I	062MV	17612144

***Important Notes*:** If Astronomy is not the student's first science course, it is highly recommended that he/she has successfully completed chemistry and geometry or be concurrently enrolled in both.

COURSE DESCRIPTION: This laboratory course* is designed to teach the student to develop a clear understading of the universe, Milky Way, stars, solar system, and the Earth's position in these. The student studies the formation of the solar system, workings of the sun, comparison of planets, orientation and placement of the Earth in the Milky Way galaxy, formation of galaxies, theories about cosmology, the Big Bang, and the possibility of life in the universe. The history and development of astronomy, the major tools, including ground-based and space-based telescopes, spectroscopy, are investigated intensely. Astronomy uses algebra and geometry to support a deeper understanding of celestial mechanics, Kepler's and Newton's laws, and methods of measuring stars. The student studies the life cycles of stars, including stellar evolution, supernovae, neutron stars, and black holes. The student examines scientific thinking and practices and how science impacts individuals and society. Literacy strategies (e.g., reading, writing, speaking, research) are integrated throughout the curriculum. A variety of labs, projects, field trips, and the use of the Internet supplement the class activities.

*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 align with the State of New Mexico Science Standards (NM), the Albuquerque Public Schools Mathematics Standards (APS – MA), and the 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 astronomy teachers in the Albuquerque Public Schools (APS).

ASSESSMENTS:

Assessments may include the following: authentic and performance-based assessment, cooperative learning, teacher observations, checklists, tests and exams, formal and informal writing, small group and full class discussions, oral and multimedia presentations, projects, demonstrations, and portfolios. Assessments are based on appropriate rubrics.

SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:

- Current state adopted science textbooks
- Supplementary materials
- Computers and computer software
- Microscopes
- *Astronomy Today* – McMillan, Chaisson – Prentice Hall – 1999 or current edition
- *Laboratory Exercises in Astronomy* – Macmillan – 1976
- *Basic Astronomy Labs* – Huebner/Reynolds/Smith – Prentice Hall – 1996
- *Student Observation Guide with Laboratory Exercises* – Seeds/Holzinger – Prentice Hall – 1995
- *Great Ideas for Teaching Astronomy* – Pompea, Stephen – Brooks Cole Thomson Learning – 2000

SUGGESTED TITLES/AUTHORS WEB SITES:

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 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). 4. Conveys results of investigations using scientific concepts, methodologies, and expressions, including (NM - I.I.I.4; APS – MA IV.5E): • scientific language and symbols, • diagrams, charts, and other data displays, • mathematical expressions and processes (e.g., mean, median, slope, proportionality),	**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 chooses an accepted astronomical premise, designs and performs a controlled experiment using the scientific method to test it. He/She gathers quantitative data for a written or oral report. ✓ 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 insights

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	• 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 atoms) (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; APS – MA IV. 1E). 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).	

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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; APS – MA I.16). 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 CONTENT OF SCIENCE-PHYSICAL SCIENCE
CONTENT STANDARD: The student understands the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

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

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Understands how heat can be transferred by conduction, convection, and radiation, and how heat conduction differs in conductors and insulators (NM - II.I.II.4). 2. Understands that the ability of energy to do something useful (work) tends to decrease (and never increases) as energy is converted from one form to another.(NM - II.I.II.6). 3. Understands that electromagnetic waves carry energy that can be transferred when they interact with matter (NM - II.I.II.7). 4. Understands the concept of equilibrium (i.e., thermal, mechanical, and chemical) (NM - II.I.II.11).	1 – 4, 8 – 10. The student sketches a scale drawing of the cross section of the sun and outlines the processes occurring in the different regions (e.g., the nuclear fission occurring in the core, radiation in the radiative zone, massive heat flow in the convective zone). He/She includes an accurate radius, temperature, and density for each zone and describes how energy is transferred from one zone to the next. ✓ accuracy and scale of drawing, including all regions ✓ detail of descriptive processes ✓ correct labeling ✓ proper units used on quantities ✓ clear communication of the transference of energy
	5. Knows that there are four fundamental forces in nature: gravitation, electromagnetism, weak nuclear force, and strong nuclear force (NM - II.I.III.1).	5 – 7. Through lectures and discussions the student is introduced to the fundamental forces of nature and how matter (e.g., quarks, subatomic particles, atoms, compounds) evolved from their interactions and is condensed (e.g., primordial nucleosynthesis) in the early universe. To build on this prior knowledge, the student researches further the epochs of the early universe and presents either individually or in groups to the rest of the class. ✓ listening skills ✓ thorough research ✓ completeness of epoch reporting ✓ proper citation of sources ✓ teamwork/collaboration ✓ effective presentation
	6. Knows that every object exerts gravitational force on every other object and how this force depends on the masses of the objects and the distance between them (NM - II.I.III.2).	6, 10 – 13. The student completes a variety of lab activities that deal with planetary orbits:

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	7. Knows that materials containing equal amounts of positive and negative charges are electrically neutral, but that a small excess or deficit of negative charges produces significant electrical forces (NM - II.I.III.3). 8. 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). 9. Explains how electric currents cause magnetism and how changing magnetic fields produce electricity (e.g., electric motors, generators) (NM - II.I.III.5). 10. Represents the magnitude and direction of forces by vector diagrams (NM - II.I.III.6). 11. Knows that when one object exerts a force on a second object, the second object exerts a force of equal magnitude and in the opposite direction on the first object (i.e., Newton's Third Law) (NM - II.I.III.7). 12. Applies Newton's Laws to describe and analyze the behavior of moving objects, including (NM - II.I.III.8): • displacement, velocity, and acceleration of a moving object, • Newton's Second Law, $F = ma$ (e.g., momentum and its conservation, the motion of an object falling under gravity, the independence of a falling object's motion on mass), and • circular motion and centripetal force. 13. Describes relative motion using frames of reference (NM - II.I.III.9). 14. Describes wave propagation using amplitude, wavelength, frequency, and speed (NM - II.I.III.10). 15. Explains how the interactions of waves can result in interference, reflection, and refraction (NM - II.I.III.11). 16. Describes how waves are used for practical purposes (e.g., seismic data, acoustic effects, Doppler effect) (NM - II.I.III.12).	• an ellipse lab dealing with Kepler's Laws (e.g., draw and measure a variety of ellipses labeling the dimensions and calculating the periods) • math labs dealing with equivalence ratios (e.g., conversions dealing with dimensional analysis) • labs dealing with Newton's Laws of Motion and gravitation (e.g., a separate lab for each law and then a combining lab involving Newton's law of gravitation) • centripetal labs (e.g., spinning weights on a string through a tube) • rocket labs (e.g., wind-up toys measuring elastic tension) The student follows standard lab procedures submitting lab write-ups which include his/her hypothesis, data, calculations, and conclusions. After completion of the labs, the student engages in different activities (e.g., models of planets, models to show planetary distances, comparison and contrasts of Newton's Laws with Einstein's laws of gravity) to demonstrate understanding of the main concepts. ✓ completion of all lab activities ✓ written lab reports ✓ clear communication ✓ required tasks 14 – 16. The student conducts thorough investigation of properties of electromagnetic spectrum that includes wave motion and interference reflection and refraction patterns leading to in-depth study of spectroscopy. In lab situations the student investigates a variety of bright line spectra produced by heated elemental gases, measures the wave lengths, records on a data table, and uses the collected information to determine the identity of the element and calculate the energies of the bright lines. ✓ proper use and care of equipment ✓ safety procedures ✓ accurate readings ✓ comparisons

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		✓ analysis ✓ effective communication ✓ proper format of work (e.g., proper units, significant digits, percent of error) OR Working in small groups, the student builds a reflecting or refracting telescope, calculates the refractive, reflective, and defractive properties of the components used in the telescope, and presents a model to the rest of the class. ✓ resolving capabilities of the telescope ✓ accurate determination of telescope's focal properties ✓ teamwork/collaboration ✓ effective presentation **Note**: For this project the instructor may use lab fee money to purchase items or the student may on his/her own purchase inexpensive lenses and mirrors. The student teams do all of the work outside of the regular class period. OR The student uses the H-R diagram (e.g., plot of the absolute magnitudes of stars against their spectral types) in an exercise that permits him/her to explore the family relations among the stars in the sky. The premise is that the student discovers that there are many different kinds of stars of different brightness, surface temperature, and size and that these properties are not immediately apparent to the casual observer (See p. 193 of *Teaching Resources* for complete details.). After completion of the exercise, the student writes a summary of what he/she learned. ✓ completion of exercise ✓ accurate plotting and curve drawing ✓ synthesis ✓ effective communication

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

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

GRADE 9 - 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. After viewing diagrams and photos, the student creates flow charts to show the relationship of sizes (e.g., Earth to sun, solar system to galaxy) and constructs atomic structure models of the solar system to show sizing from atomic nuclei to galaxies. The student uses models to determine the next closest star or galaxy and applies mathematical concepts (e.g., scientific notation, metric system, light years conversions) to explain concepts. ✓ creativeness ✓ accuracy ✓ clear explanations ✓ real-world applications
	2. Predicts changes in the positions and appearances of objects in the sky (e.g., moon, sun) based on knowledge of current positions and patterns of movements (e.g., lunar cycles, seasons) (NM - II.III.I.2).	2. Through participation in a variety of labs (e.g., lunar phase, transit of Venus, constellation), the student learns about eclipses of the moon and sun, star positions, and seasons of the year. He/She makes comparisons (e.g., summer constellations vs. winter constellations) and is able to draw and label the tilt of the Earth. ✓ active participation in all labs ✓ analysis
	3. Understands how knowledge about the universe comes from evidence collected from advanced technology (e.g., telescopes, satellites, images, computer models) (NM - II.III.I.3).	3. The student uses technology (e.g., Internet) to access photos and images from satellites, actual technical specifications/workings of ground-based and space-based telescopes, and presents a visual display (e.g., model, poster, diagrams) to the class. ✓ technological skills ✓ effective visuals ✓ clarity in explanations

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	4. Describes the key observations that led to the acceptance of the Big Bang theory and that the age of the universe is over 10 billion years (NM - II.III.I.4).	4. In a whole class discussion the student reviews the basic properties of the main types of normal galaxies, the basic differences between active and normal galaxies, uses the Hubble Constant or Doppler shift to describe how fast the universe is expanding and how it is used to derive distances to the most remote objects in the observable universe, and discusses the possibilities of finding other advanced civilizations in the galaxy. He/She employs multiple diagrams to enhance understanding. See also Strand II, the 2nd illustration. ✓ active participation in discussions ✓ effective visuals ✓ articulation of ideas
	5. Explains how objects in the universe emit different electromagnetic radiation and how this information is used (NM - II.III.I.5).	5. In either an oral or written format the student explains stellar evolution and life to include an identification of current satellites, electromagnetic spectrums that are used to locate them, what kinds of satellites are located, and the different celestial objects (e.g., Black Hole, gamma, quasars) that exist. ✓ inclusion of all required concepts ✓ effective communication
	6. Examines the role that New Mexico research facilities play in current space exploration (e.g., Very Large Array, Goddard Space Center) (NM - II.III.I.7).	6. If school resources permit, the student takes a field trip to the Very Large Array or the Atomic Museum. Prior to the trip the student participates in a discussion and views slides of what he/she will see upon the visit. After the trip the student responds in a variety of ways (e.g., write a story, answer questions) to what he/she observed. If resources are limited, the student gains knowledge and understanding by going to either the University of New Mexico's (UNM) observatory or the Career Enrichment Center's (CEC) observatory. ✓ appropriate behaviors ✓ active participation in discussions ✓ effective communication Option: Before the student takes the trip or in lieu of the trip, the student writes out one question he/she is curious about, researches the answer to it, and presents findings to the class. ✓ thorough research ✓ appropriate response to question ✓ effective presentation

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	7. Explains plate tectonic theory and understands the evidence that supports it (NM - II.III.II.5).	7, 9, 10. The student researches information on plate tectonics (See Strand I, the illustration for performance standard #5 and Strand II, the 1st illustration). The student accomplishes this through a variety of activities: • construction of concept maps, • precut continent maps with designated fossils specific to a time period and arranged according to fossil evidence and glacial striations, • explanation of the development of the plate tectonic theory from the original continental drift to the current plate tectonic model, • guest speakers (e.g., Natural History Museum) discuss the geological history of New Mexico, • discussion to answer the essential question "How was the Earth formed?"; • discussion on the formation of the solar system followed by construction of models that label the Earth's layers, • research the impact of earthquakes on society (e.g., building codes), • construction of a wall using basic materials to test its strength, • study of building materials used by 3rd world countries (e.g., India's use of bamboo in building) and relate this to New Mexico's use of adobes in building, • radioactive decay labs, • experiments in physical and chemical weathering, and • development of rock cycle diagrams. The student submits written summaries of each activity completed. ✓ active participation in discussions ✓ completion of required activities ✓ evidence of understanding ✓ effective communication
	8. Describes how stars are powered by nuclear fusion, how luminosity and temperature indicate their age, and how stellar processes create heavier and stable elements that are found throughout the universe (II.III.I.6).	8. See Strand II, the 4th illustration that uses the H-R diagram (# 14 – 16).

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	9. Knows that Earth's systems are driven by internal (i.e., radioactive decay and gravitational energy) and external (i.e., the sun) sources of energy (NM - II.III.II.6). 10. Describes convection as the mechanism for moving heat energy from deep within Earth to the surface and discusses how this process results in plate tectonics, including (NM - II.III.II.7): • geological manifestations (e.g., earthquakes, volcanoes, mountain building) that occur at plate boundaries, • impact of plate motions on societies and the environment, and (e.g., earthquakes, volcanoes).	9. After an in-depth lecture on the four fundamental forces (i.e., gravity, weak, electromagnetic, strong), the electromagnetic spectrum, the formation of atoms (nucleosynthesis) from subatomic particles in the early universe and in stars, as well as the energies involved, the student graphs (with teacher demonstrations) the nucleons (proton # vs. neutron #) showing stable and unstable isotopic arrangements. He/She further graphs or charts the decay processes (e.g., alpha, beta, gamma, neutron capture) by which unstable isotopes become stable. In the same unit the student observes 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 ✓ proper use of units, significant figures, and conversions ✓ application of information

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
	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. The student views a current movie (e.g., *Jurassic Park, Star Wars*) and, as he/she views the movie, makes a list of what is science and what is science fiction. After the movie the student participates in a discussion and gives his/her views providing support for his ideas. ✓ observation skills ✓ accuracy ✓ support for position
	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 the illustration for performance standards # 14 – 16 and Strand III, the illustration for performance standard # 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, 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).	3, 4. Working alone or in a small group, the student dismantles a modern electrical appliance/device (e.g., CD player, radio, toaster, cell phone) and proceeds to figure out where all the parts came from originally. The student or team compiles a list of parts with the origination of each part and presents findings to the class. If each group is doing the same thing, then the groups might compare findings. ✓ active participation ✓ thorough and accurate research ✓ teamwork/collaboration ✓ effective presentation OR The student discusses in either whole class or small groups the use of radioactive materials (e.g., uranium) for medicinal purposes, its use as nuclear fuel for power plants, and the price to be paid for disposal of its waste products.

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		OR The student conducts research (e.g., Internet, library) on the first TV and how it worked (i.e., cathode ray tubes) and presents findings to the class in an oral or written format. An option would be to research the Scantron machine and determine how it is that it can read graphite markings.
	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. Through lectures, text readings, and discussion, the student learns about genetic engineering, how it can be used to degrade toxic waste, and the biotechnology being used to clean up waste and environmental pollution (e.g., mining and coal wastes). This information is used to tie in and connect with the resources in New Mexico. ✓ comprehension of the main ideas ✓ connections ✓ citation of examples
	6. Analyzes the impact of digital technologies on the availability, creation, and dissemination of information (NM - III.I.I.6).	6. The student participates in a discussion citing examples of advances in technology over the past several decades. In each example given the student explains the advances made from the old to the present. Depending on the sequence of how content is presented, the student can use examples from previous study or experiments, namely, computers, TVs, telescopes, seismographs, Global Positioning Systems, lasers, nanotechnology, etc. ✓ relevant examples ✓ defense of rationale
	7. Describes how human activities have affected the ozone in the upper atmosphere and how it affects health and the environment.	7, 9, 12, 13. The student completes labs that deal with the greenhouse effect and mapping of ozone holes over Australia. He/She also participates in discussions citing specific examples (e.g., use of freon, CFC, and refrigerants in the atmosphere). ✓ active participation in discussions ✓ relevant examples ✓ clear explanations OR The student investigates how humans are altering the atmosphere (e.g., particle pollution, light pollution, chemical pollution) and making it more difficult to see and collect data from the stars. The student includes information on ozone depletion and reports on the possible impact and whether it can be changed (e.g., social, political, and economical aspects).

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		✓ thorough research ✓ relevant information ✓ clear communication of information ✓ effective delivery ✓ implications
	8. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM - III.I.I.8). 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).	8. See Strand III, illustration # 9. OR If school resources permit, the student takes a field trip to the Very Large Array or the Atomic Museum. Prior to the trip the student participates in a discussion and views slides of what he/she will see upon the visit. After the trip the student responds in a variety of ways (e.g., write a story, answer questions) to what he/she observed. If resources are limited, the student gains knowledge and understanding by going to either the University of New Mexico's (UNM) observatory or the Career Enrichment Center's (CEC) observatory. ✓ appropriate behaviors ✓ active participation in discussions ✓ effective communication Option: Before the student takes the trip or in lieu of the trip, the student writes out one question he/she is curious about, researches the answer to it, and presents findings to the class. ✓ thorough research ✓ appropriate response to question ✓ effective presentation
	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).	10, 11. The student researches and presents the history and development of the solar system models from ancient beliefs through Ptolemy's geocentric model and the Copernican heliocentric model, including contributions of Galileo, Kepler, and Newton. Presentations include visuals (e.g., PowerPoint, pictures). ✓ thorough research ✓ descriptions of how and why the models changed with increasing knowledge ✓ effective presentation ✓ connections ✓ visuals ✓ clear communication

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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).	14. If resources permit, the student takes a field trip to WIPP. He/She looks at the formation of halite (i.e., salt - a nonmetallic mineral resource) and discusses why it is a good medium to put nuclear waste in. ✓ local connections ✓ clear communication See also Strand III, the illustration for the performance standard # 6.
	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).	15 – 17. The student examines current events [e.g., Astronomy Picture of the Day (APOD), websites, newspapers] in astronomy, new discoveries, Hubble pictures, and close asteroid encounters. In small or large groups the student reports the new information emphasizing its importance. ✓ accurate account of news items ✓ relevant information ✓ significance clearly communicated ✓ effective presentation of information
	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 an astrophysicist do? What is an environmental geologist?). The student talks about his/her personal career interest and explains where science is used in this career (e.g., museum curator, chemical engineer, planetarium director). OR 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., astronomer, museum curator, geologist) in the science fields talk about aspects of their jobs. After the fair the student either orally or in written format summarizes one career field that held special interest to him/her highlighting the science connection.

GRADE 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		Options: The student helps in the organization of the event by suggesting and contacting some of the guest speakers. Some of these speakers could be personal connections that he/she has (e.g., parents, former students). ✓ individual participation ✓ listening skills ✓ personal connections ✓ scientific significance to career fields ✓ effective presentation OR The student investigates and reports on an important person from the late 1800s through present time (e.g., Annie Cannon, Williamina Fleming, Ejnar Hertzsprung, Hubble) who is connected to the development of the classification of stars. The presentation includes, in addition to the normal historical, biographical information, how the individual's life created a new career in scientific fields. ✓ relevant information ✓ significance of individual's work to science ✓ thorough research ✓ effective communication ✓ captivating delivery

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 9 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		Note: The very nature of science courses entails that the student be involved in research, exploration, and experimentation This requires the student to read through his/her research studies; write up findings in the form of lab reports; work with other students collaboratively, requiring whole or small group discussions; listening to others' viewpoints whether it be through print, video, or guest speaker; and display data in an organized fashion. Consequently, literacy strategies are reflected in every strand. The following citations illustrate specific examples of these strategies; although, numerous opportunities are presented throughout the year and throughout the curriculum.
	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. See Strand I illustration; Strand IV, the illustration for performance standard # 5; and Strand IV, the illustration for performance standards # 5 and # 15 –17.
	2. Identifies and uses roots, prefixes, and suffixes to determine meaning of words (APS – LA I.4).	
	3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APS – LA II.2).	
	4. Develops increased competence in using the writing process to create a final product (APS – LA III.1).	4 – 7. See Strand I illustration; See Strand II, the illustration for performance standards # 3, 4, 7, 9, 14; Strand II, the illustration for performance standards # 6, 10 – 13; and
	5. Develops increased competence in using elements of effective writing (APS – LA III.2).	Strand III, the illustrations for performance standards # 5, # 6 and # 7, 9, 10.

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). 8. Develops increased competence with speaking and language conventions (APS – LA IV.3). 9. Listens to and analyzes a presentation or discussion (APS – LA V.1). 10. Conducts research and collects data from in-depth field studies (APS – LA VI.1). 11. Obtains and sends information electronically to support advanced research (APS – LA VI.2). 12. Uses a variety of technology (APS – LA VI.5). 13. Recognizes and continues to use the elements of formal citations to document sources (APS – LA VI.6). 14. Accesses appropriate style manuals as research guides (APS – LA VI.7). 15. Synthesizes information from multiple research studies to draw conclusions and inferences that go beyond those found in any of the individual studies (APS – LA VI.9). 16. Synthesizes and organizes information from a variety of sources to inform and persuade an audience (APS – LA VI.9).	8. See Strand I illustration; Strand III, the illustration for performance standard # 5; Strand IV, the illustration for performance standards # 3, 4, # 6, and # 10, 11, and # 15 – 17. 9. See Strand II, the illustration for performance standard # 5 - 7; Strand III, 1st illustration; Strand IV, 1st illustration and the illustrations for performance standards # 6 and # 18, 19. 10 – 16. See Strand I illustration; Strand II, the illustration for performance standards # 14 – 16; Strand III, 3rd illustration and illustration for performance standards # 7, 9, 10; and Strand IV, the illustration for performance standards # 3,4, and #10, 11.