

SECONDARY SCIENCE

SC09 Essential Elements of Science

Course #: SC-09	Grade Level: 9
Course Name: Essential Elements of Science	Level of Difficulty: Medium
Prerequisites: NONE	# of Credits: 1

Strand 1: Inquiry Process

“Science as inquiry is basic to science education and a controlling principle in the continuing organization and selection of students’ activities. Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry...” (National Science Education Standards, 1995).

Inquiry Process establishes the basis for students’ learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concepts

Concept 1: Observations, Questions, and Hypotheses

- Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.

Concept 2: Scientific Testing (Investigating and Modeling)

- Design and conduct controlled investigations.

Concept 3: Analysis, Conclusions, and Refinements

- Evaluate experimental design, analyze data to explain results and propose further investigations. Design models.

Concept 4: Communication

- Communicate results of investigations.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C1	Observations, Questions, and Hypotheses	1	Evaluate scientific information for relevance to a given problem.		
		2	Develop questions from observations that transition into testable hypotheses.		
		3	Formulate a testable hypothesis.		
		4	Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C2	Scientific Testing (Investigating and Modeling)	1	Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, and organisms) and behavior in all science inquiry.		
		2	Identify the resources needed to conduct an investigation. <ul style="list-style-type: none"> - Equipment names and uses 		
		3	Design an appropriate protocol (written plan of action) for testing a hypothesis: <ul style="list-style-type: none"> • Identify dependent and independent variables in a controlled investigation. • Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes). <ul style="list-style-type: none"> - Which piece of equipment is most appropriate to use for a given investigation • Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators). <ul style="list-style-type: none"> - Including which kind of graph to make for a given set of data 		
		5	Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C3	Analysis and Conclusions, and Refinements	1	<p>Interpret data that show a variety of possible relationships between variables, including:</p> <ul style="list-style-type: none"> • positive relationship • negative relationship • no relationship <p style="margin-left: 40px;">– e.g., given a set of data does a relationship exist and if so, what kind?</p>	positive relationships negative relationships	
		2	Evaluate whether investigational data support or do not support the proposed hypothesis.		
		3	<p>Critique reports of scientific studies (e.g., published papers, student reports).</p> <p style="margin-left: 40px;">– Peer grading of experiment write-ups</p>		
		4	<p>Evaluate the design of an investigation to identify possible sources of procedural error, including:</p> <ul style="list-style-type: none"> • sample size • trials • controls • analyses <p style="margin-left: 40px;">– e.g. class discussion or written document after experiment completion</p>		
		5	<p>Design models (conceptual or physical) of the following to represent "real world" scenarios.</p> <ul style="list-style-type: none"> • phase change • collisions 		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C3 (cont.)		6	<p>Use descriptive statistics to analyze data, including:</p> <ul style="list-style-type: none"> • mean • frequency • range <p>(see MHS-S2C1-10)</p>		
		7	<p>Propose further investigations based on the findings of a conducted investigation.</p> <ul style="list-style-type: none"> - e.g. class discussion or written document after experiment completion 		
S1C4	Communication	1	<p>For a specific investigation, choose an appropriate method for communicating the results.</p>		
		2	<p>Produce graphs that help communicate data. (See MHS-S2C1-02)</p> <ul style="list-style-type: none"> - Decide what kind of graph would most appropriately represent a given set of data 		
		3	<p>Communicate results clearly and logically.</p> <ul style="list-style-type: none"> - Using complete sentences and correct mechanics 		
		4	<p>Support conclusions with logical scientific arguments.</p> <ul style="list-style-type: none"> - Use data from an experiment to support the conclusion of an experiment 		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Strand 2: History and Nature of Science

Knowledge of the nature of science is central to the understanding of the scientific enterprise” (National Assessment of Educational Progress, 2000).

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concepts

Concept 1: History of Science as a Human Endeavor

- Identify individual, cultural, and technological contributions to scientific knowledge.

Concept 2: Nature of Scientific Knowledge

- Understand how science is a process for generating knowledge.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S2C1	History of Science as a Human Endeavor	2	<i>Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.</i>		
			<ul style="list-style-type: none"> - e.g. Astronomers who were prominent in development of solar system model 		
		3	Analyze how specific changes in science have affected society.		
			<ul style="list-style-type: none"> - e.g. Societal effects resulting from improved telescope 		
		4	Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.		
			<ul style="list-style-type: none"> - e.g. <ul style="list-style-type: none"> • Alternative viewpoints of science • Big Bang theory • Solar System model 		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S2C2		4	<p>Describe how scientists continue to investigate and critically analyze aspects of theories.</p> <ul style="list-style-type: none"> - Development and revision of conceptual models - e.g., <ul style="list-style-type: none"> • Big Bang theory • Solar System model • Particle model • Atomic theory 	conceptual models mental model physical model	

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concepts

Concept 1: Changes in Environments

- Describe the interactions between human populations, natural hazards, and the environment.

Concept 2: Science and Technology in Society

- Develop viable solutions to a need or problem.

Concept 3: Human Population Characteristics

- Analyze factors that affect human populations.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S3C1	Changes in Environments	2	Describe the environmental effects of the following natural and/or human-caused hazards:	urbanization	
		4	Evaluate the following factors that affect the quality of the environment: <ul style="list-style-type: none"> ▪ smoke – How the environment is affected and to what extent 		
S3C2	Science and Technology in Society	1	Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems: <ul style="list-style-type: none"> ▪ Various forms of alternative energy ▪ Greenhouse gases 		
		2	Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.		
		3	Support a position on a science or technology issue.		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Strand 5: Physical Science

The physical science component ... should probe the following major topics: matter and its transformations, energy and its transformations, and the motion of things” (NAEP 2000).

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concepts

Concept 1: Structure and Properties of Matter

- Understand physical, chemical, and atomic properties of matter.

Concept 2: Motions and Forces

- Analyze relationships between forces and motion.

Concept 3: Conservation of Energy and Increase in Disorder

- Understand ways that energy is conserved, stored, and transferred.

Concept 4: Chemical Reactions

- Investigate relationships between reactants and products in chemical reactions.

Concept 5: Interactions of Energy and Matter

- Understand the interactions of energy and matter.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C1	Structure and Properties of Matter	1	Describe substances based on their physical properties.	physical properties	
		2	Describe substances based on their chemical properties.	chemical properties	
		3	Predict properties of elements and compounds using trends of the periodic table (e.g., metals, non-metals, bonding – ionic/covalent).		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C1 (cont.)		6	<p>Describe the following features and components of the atom:</p> <ul style="list-style-type: none"> ▪ protons ▪ neutrons ▪ electrons ▪ mass ▪ number and type of particles <p style="margin-left: 40px;">- Tell the number of protons, neutrons, and electrons in a specified atom</p> <ul style="list-style-type: none"> ▪ structure ▪ organization 		
		8	<p>Explain the details of atomic structure (e.g., electron configuration, energy levels, isotopes).</p>		
S5C2	Motions and Forces	1	<p>Determine the rate of change of a quantity (e.g., rate of erosion, rate of reaction, rate of growth, velocity).</p>		
		2	<p>Analyze the relationships among position, velocity, acceleration, and time:</p> <ul style="list-style-type: none"> • graphically • mathematically 		
		3	<p>Explain how Newton's 1st Law applies to objects at rest or moving at constant velocity.</p>		
		4	<p>Using Newton's 2nd Law of Motion, analyze the relationships among the net force acting on a body, the mass of the body, and the resulting acceleration:</p> <ul style="list-style-type: none"> • graphically • mathematically 		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C2 (cont.)		5	Use Newton's 3 rd Law to explain forces as interactions between bodies (e.g., a table pushing up on a vase that is pushing down on it; an athlete pushing on a basketball as the ball pushes back on her).		
		11	Using the Law of Universal Gravitation, predict how the gravitational force will change when the distance between two masses changes or the mass of one of them changes.		
S5C3	Conservation of Energy and Increase in Disorder	1	Describe the following ways in which energy is stored in a system: <ul style="list-style-type: none"> ▪ mechanical ▪ chemical 		
		2	Describe various ways in which energy is transferred from one system to another (e.g., mechanical contact, thermal conduction, electromagnetic radiation.)		
		3	Recognize that energy is conserved in a closed system.		
		6	Distinguish between heat and temperature.		
		7	Explain how molecular motion is related to temperature and phase changes. <ul style="list-style-type: none"> - Describe the effect on speed and spacing of particles as temperature is changed - Describe particle speed and spacing for solids, liquids, and gases 		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C4	Chemical Reactions	1	<p>Apply the law of conservation of matter to changes in a system.</p> <ul style="list-style-type: none"> - e.g. Measuring mass before and after a reaction in a closed system 		
		2	<p>Identify the indicators of chemical change, including formation of a precipitate, evolution of a gas, color change, absorption or release of heat energy.</p>		
		3	<p>Represent a chemical reaction by using a balanced equation.</p> <ul style="list-style-type: none"> - e.g. Given a balanced equation after a reaction has been completed, determine from which reactants each part of the product was derived - Balance simple equations—no polyatomics like nitrate or carbonate required. 		
		4	<p>Distinguish among the types of bonds (i.e., ionic, covalent, metallic, hydrogen bonding).</p> <ul style="list-style-type: none"> - Concentrate on ionic and covalent only. Identify that these bonds do occur and how electrons are involved. 		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

SECONDARY SCIENCE

SC09 Essential Elements of Science

Students should know and be able to...					
Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C4 (cont.)		10	<p>Explain the energy transfers within chemical reactions using the law of conservation of energy.</p> <ul style="list-style-type: none"> - Simply that the energy on the reactant side must equal the energy on the product side. 		
		11	<p>Predict the effect of various factors (e.g., temperature, concentration, pressure, catalyst) <u>on the equilibrium state</u> and on the rates of chemical reaction.</p> <ul style="list-style-type: none"> - Not to include equilibrium state 		
		12	<p>Compare the nature, behavior, concentration, and strengths of acids and bases.</p> <ul style="list-style-type: none"> - Describe pH scale - Define an acid and a base - Identify the pH of household items - Acid rain 		
S5C5	Interactions of Energy and Matter	1	<p>Describe various ways in which matter and energy interact (e.g., photosynthesis, phase change.)</p> <ul style="list-style-type: none"> - Overlaps with S5C3 PO7 - Includes phase change, not photosynthesis 		
		4	<p>Describe the basic assumptions of kinetic molecular theory.</p>		
		5	<p>Apply kinetic molecular theory to the behavior of matter (e.g., gas laws).</p>		
		6	<p>Analyze calorimetric measurements in simple systems and the <u>energy involved in changes of state</u></p>		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

Strand 6: Earth and Space Science

“Earth science is the study of the planets, Earth’s composition, processes, environments and history, focusing on the solid Earth, and its interaction with air and water” (NAEP 2000).

Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, the solar system, and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

Concepts

Concept 1: Geochemical Cycles

- Analyze the interactions between the Earth’s structures, atmosphere, and geochemical cycles.

Concept 2: Energy in the Earth System (Both Internal and External)

- Understand the relationships between the Earth’s land masses, oceans, and atmosphere.

Concept 3: Origin and Evolution of the Earth System

- Analyze the factors used to explain the history and evolution of the Earth.

Concept 4: Origin and Evolution of the Universe

- Analyze the factors used to explain the origin and evolution of the universe.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S6C4	Origin and Evolution of the Universe	1	Describe the Big Bang Theory as an explanation for the origin of the universe.		
		2	Describe the fusion process that takes place in stars. – Fusion is a process that releases an enormous amount of energy and in the process, hydrogen is converted to helium	fusion	
		4	Compare the evolution (life cycles) of stars of different masses (low and high mass).		

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.

Plain text denotes Mesa Public Schools guidelines and/or performance objective.

Bold text denotes exact wording and punctuation from the Arizona Academic Content Standard. The bulleted items with a performance objective indicate specific content to be taught.

Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.