DRAFT

Science Course Level Expectations:

A Framework for Instruction and Assessment

The *Science Course Level Expectations* outline related ideas, concepts, skills and processes that form the foundation for understanding and learning science. It includes updates to the April, 2005 K-12 *Science Grade Level Expectations*. In addition, it provides a framework to bring focus to teaching, learning, and assessing science. The Course Level Expectations (CLEs) for Physical Science, Physics I, Chemistry I, Biology I, and Earth & Space Sciences outline rigorous science expectations for students enrolled in **traditional** or **integrated** courses that will prepare them for success in college, the workplace, and effective participation in civic life.

Since the Outstanding Schools Act of 1993, several documents have been developed prior to the 2005 K-12 *Grade Level Expectations* to aid Missouri school districts in creating curriculum that will enable all students to achieve their maximum potential. Those include:

- The *Show-Me Standards* which identify broad content knowledge and process skills for all students to be successful as they continue their education, enter the workforce, and assume civic responsibilities
- The *Framework for Curriculum Development* which provides districts with a "frame" for building curricula using the *Show-Me Standards* as a foundation
- The *Assessment Annotations for the Curriculum Frameworks* which identify content and processes that should be assessed at the local and state level in grades 4, 8, and 10 mathematics

Essential content, aligned to state and national documents that support inquiry-based instruction, included in the Grade and Course Level Expectations should be addressed in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations. Each Grade and Course Level Expectation is aligned to the Show-Me Content and Process Standards (1996). A Depth-of-Knowledge level will be assigned to each grade or course level expectation before formal adoption of this document. The Depth of Knowledge identifies the highest level at which the expectation will be assessed, based upon the demand of the GLE/CLE. Depth-of-Knowledge levels include: Level 1-recall; Level 2-skill/concept; Level 3-strategic thinking; and Level 4-extended thinking.

Sources: National Science Education Standards (NRC); Project 2061 (AAAS) Benchmarks for Science Literacy and Atlas: Research related to science education (e.g., Driver's work re: misconceptions); Show Me Standards, Framework for Curriculum Development in Science, and MAP documents; National Assessment of Education Progress (NAEP) Science Framework; Curriculum documents from school districts and other states.

Important resources for districts' use as they develop curriculum and assessments and plan instruction include: the Project 2061 (AAAS) Benchmarks (online at http://www.project2061.org/tools/benchol/bolintro.htm) and ATLAS (a compendium of concept maps showing grade-level appropriateness, sequencing of expectations in order to build conceptual understanding, and connections across science strands); Young People's Images of Science and Making Sense of Secondary Science by Rosalind Driver et al. (both present research related to student misconceptions K-12); The National Science Education Standards (online at http://www.nap.edu/readingroom/books/nses/html/); How Students Learn Science (available from the National Research Council (The National Academies Press)

SCOPE AND SEQUENCE

This is one model of a curriculum scope and sequence. Grade level expectations for grades K-8 are clustered into suggested units and arranged to support development of conceptual understanding. School district personnel are encouraged to adapt this model as necessary in order to better meet the needs of their students. The Expectations described in Strand 7: Inquiry and Strand 8: Science/Technology/Human Activity should be made a priority and integrated throughout every teaching unit in each of the other strands. Grade-span assessments will be administered in science at grades 5, 8, and 11 in the spring of the 2007-2008 school year. Beginning no later than spring 2009, students completing Biology I (or its equivalent) will be administered the Biology I end-of-course assessment. The development and administration of future end-of-course assessments is dependent upon decisions of the State Board of Education and state funding.

	Kindergarten	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	9, 10, 11
Strand 1 Matter & Energy	Properties of Matter Investigating Sound	Properties of Matter: Mass and Temperature	Properties of Rocks and Soil Forms of Energy: Sound	Investigating States of Matter Earth, Sun and Moon	Mixtures and Solutions Forms of Energy: Electrical Circuits		Properties of and Changes in Matter Forms of Energy: Light and Sound	Forms of Energy: Heat, Electricity, and Magnetism Energy Transformations	Physical and Chemical Properties and Changes of Matter	Atomic Theory and Changes in Matter Energy Forms and Transfer
Strand 2 Force & Motion	Change in Position	Investigating Motion	Forces and Motion		Laws of Motion	Work and Simple Machines		Force, Motion, and Work		Interactions between Energy, Force, and Motion
Strand 3 Living Organisms	Plants and Animals Parent-Offspring Relationships	Characteristics of Plants and Animals	Life Cycles of Animals	Plants		Classification of Plants and Animals	Characteristics of Living Organisms		Cells and Body Systems Disease Reproduction and Heredity	Diversity and Unity Among Organisms Cellular Processes Genetics and Heredity
Strand 4 Ecology	Weather and Seasons			Food Chains	Interactions among Organisms and their Environments		Ecosystems and Populations			Interdependence of Organisms and their Environment Matter and Energy in the Ecosystem Biological Evolution
Strand 5 Earth Systems	Weather and Seasons	Observing Water and Weather	Earth Materials: Rocks and Soil	Investigating States of Matter	Changes in the Earth's Surface	Water Cycle and Weather	Internal Processes and External Events Earth's Resources	Weather and Climate	Rock Cycle and Plate Tectonics	Components and Structure of Earth's Systems Interactions among Earth's Systems and Processes of Change Effect of Human Activity on Earth's Resources
Strand 6 Universe	Objects in the Sky			Earth, Sun, and Moon		Solar System		Objects and Their Motion in the Solar System		Objects in the Universe and Their Motion
Strand 7 Scientific Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry
Strand 8 Science, Technology, & Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity

Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **Objects, and the materials they are made of, have properties that can be used to describe and classify them**	a. Compare the densities of regular and irregular objects using their respective measures of volume and mass	a. Compare the densities of regular and irregular objects using their respective measures of volume and mass	a. Compare the densities of regular and irregular objects using their respective measures of volume and mass	a. Compare the densities of regular and irregular objects using their respective measures of volume and mass
	b. Identify pure substances by their physical and chemical properties (i.e., color, luster/reflectivity, hardness, conductivity, density, pH, melting point, boiling point, specific heat, solubility, phase at room temperature, chemical reactivity)	b. **Physics II Content** Identify pure substances by their physical and chemical properties (i.e., color, luster/reflectivity, hardness, conductivity, density, pH, melting point, boiling point, specific heat, solubility, phase at room temperature, chemical reactivity)	b. Identify pure substances by their physical and chemical properties (i.e., color, luster/reflectivity, hardness, conductivity, density, pH, melting point, boiling point, specific heat, solubility, phase at room temperature, chemical reactivity)	b. Identify pure substances (e.g., minerals, water, atmospheric gases) by their physical and chemical properties (i.e., color, luster/reflectivity, hardness, cleavage, fracture, conductivity, density, pH, melting point, boiling point, specific heat, solubility, phase at room temperature, chemical reactivity)
	c. Classify a substance as being made up of one kind of atom (element) or a compound when given the molecular formula or structural formula (introduce electron dot diagram) for the substance	c. **Physics II Content** Classify a substance as being made up of one kind of atom (element) or a compound when given the molecular formula or structural formula (introduce electron dot diagram) for the substance	c. Classify a substance as being made up of one kind of atom (element) or a compound when given the molecular formula or structural formula (or electron dot diagram) for the substance	
	d. Compare and contrast the common properties of metals, nonmetals, metalloids (semi-conductors) and noble gases	d. **Physics II Content** Compare and contrast the common properties of metals, nonmetals, metalloids (semi-conductors) and noble gases	b. Compare and contrast the common properties of metals, nonmetals, metalloids (semi-conductors), and noble gases	
DOK				
B **Properties of mixtures depend upon the concentrations, properties, and interactions of particles**	a. Compare and contrast the properties of acidic, basic, and neutral solutions		a. Classify solutions as either dilute or concentrated; as either saturated, unsaturated, or supersaturated	a. Compare and contrast the properties of acidic, basic, and neutral solutions
			b. Compare and contrast the properties of acidic, basic, and neutral solutions	b. Predict the effects of solvent and solute polarity on solubility ("like dissolves like"); and predict the effects of temperature, surface area, particle size, and agitation on rates of solubility
			c. Predict the effects of solvent and solute polarity on solubility ("like dissolves like"); and predict the effects of temperature, surface area, particle size, and agitation on rates of solubility	
DOK				

Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
C **Properties of matter can be explained in terms of moving particles too small to be seen without tremendous magnification**	Not assessed at this level			
DOK				
D **Physical changes in states of matter due to thermal changes in materials can be explained by the Kinetic Theory of Matter**	a. Using the Kinetic Theory model, explain the changes that occur in the distance between atoms/molecules and temperature of a substance as energy is absorbed or released during a phase change	a. **Physics II Content** Using the Kinetic Theory model, explain the changes that occur in the distance between atoms/molecules and temperature of a substance as energy is absorbed or released during a phase change	a. Using the Kinetic Theory model, explain the changes that occur in the distance between atoms/molecules and temperature of a substance as energy is absorbed or released during a phase change	a. Using the Kinetic Theory model, explain the changes that occur in the distance between atoms/molecules and temperature of a substance as energy is absorbed or released during a phase change
	b. Predict the effect of a temperature change on the properties (i.e., pressure, density, volume) of a material (solids, liquids, gases)	b. **Physics II Content** Predict the effect of a temperature change on the properties (e.g., pressure, density) of a material (solids, liquids, gases)	b. Predict the effect of a temperature change on the properties (e.g., pressure, density) of a material (solids, liquids, gases)	b. Predict the effect of a temperature change on the properties (e.g., pressure, density) of earth materials (i.e., rock, water, air)
	c. Predict the effect of pressure changes on the properties (i.e., temperature, volume, density) of a material (solids, liquids, gases)	c. **Physics II Content** Predict the effect of pressure changes on the properties (e.g., temperature, density) of a material (solids, liquids, gases)	c. Predict the effect of pressure changes on the properties (e.g., temperature, density) of a material (solids, liquids, gases)	c. Predict the effect of pressure changes on the properties (e.g., temperature, density) of earth materials (i.e., rock, water, air)
DOK				
E **The atomic model describes the electrically neutral atom**	a. Describe the atom as having a dense, positive nucleus surrounded by a cloud of negative electrons	a. **Physics II Content** Describe the atom as having a dense, positive nucleus surrounded by a cloud of negative electrons	a. Describe the atom as having a dense, positive nucleus surrounded by a cloud of negative electrons	
	b. Calculate the number of protons, neutrons, and electrons of an element/isotopes given its mass number and atomic number	b. **Physics II Content** Calculate the number of protons, neutrons, and electrons of an element (or isotopes) given its atomic mass (or mass number) and atomic number	b. Calculate the number of protons, neutrons, and electrons of an isotope, given its mass number and atomic number	
	c. Describe the information provided by the atomic number and the mass number (i.e., electrical charge, chemical stability)	c. **Physics II Content** Describe the information provided by the atomic number and the mass number (i.e., electrical charge, chemical stability)	c. Describe the information provided by the atomic number and the mass number (i.e., electrical charge, chemical stability)	
DOK				

Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
F **The periodic table organizes the elements according to their atomic structure and chemical reactivity**	a. Explain the structure of the periodic table in terms of the elements with common properties (groups/families) and repeating properties (periods) b. Classify elements as metals, nonmetals, metalloids (semi-conductors), and noble gases according to their location on the Periodic Table c. Predict the chemical reactivity of elements, and the type of bonds that may result between them, using the Periodic Table		a. Explain the structure of the periodic table in terms of the elements with common properties (groups/families) and repeating properties (periods) b. Classify elements as metals, nonmetals, metalloids (semi-conductors), and noble gases according to their location on the Periodic Table c. Predict the chemical reactivity of elements, and the type of bonds that may result between them, using the Periodic Table	
DOK				
G **Properties of objects and states of matter can change chemically and/or physically**	a. Distinguish between physical and chemical changes in matter		a. Distinguish between physical and chemical changes in matter	
DOK				
H **Chemical bonding is the combining of different pure substances (elements, compounds) to form new substances with different properties**	a. Describe how the valence electron configuration determines how atoms interact and may bond b. Compare and contrast the types of chemical bonds (i.e., ionic, covalent)		a. Describe how the valence electron configuration determines how atoms interact and may bond b. **Chemistry II Content** Predict the reaction rates of different substances based on their properties (i.e., concentrations of reactants, pressure, temperature, state of matter, surface area, type of reactant material) c. Compare and contrast the types of chemical bonds (i.e., ionic, covalent) d. Predict the products of an acid/base (neutralization), oxidation (rusting), and combustion (burning) reaction	a. Compare and contrast the types of chemical bonds (i.e., ionic, covalent) as they relate to mineralization, changes in rock type within the rock cycle, formation of pollutant molecules (e.g., acid rain, ozone) b. Predict the products of an acid/base (neutralization), oxidation (rusting), and combustion (burning) reaction as it may occur in the geosphere, hydrosphere, or atmosphere
DOK				

Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
I **Mass is conserved during any physical or chemical change**	a. Compare the mass of the reactants to the mass of the products in a chemical reaction or physical change as support for the Law of Conservation of Mass		a. Compare the mass of the reactants to the mass of the products in a chemical reaction or physical change as support for the Law of Conservation of Mass b. Recognize whether the number of atoms of the reactants and products in a chemical equation are balanced	a. Compare the mass of the reactants to the mass of the products in a chemical reaction or physical change (e.g., cycling of minerals within rock cycle, process of erosion/weathering, carbon dioxide-oxygen cycle, nitrogen cycle, water cycle, nuclear reaction) as support for the Law of Conservation of Mass
DOK				

Strand 1: Properties and Principles of Matter and Energy

2. Energy has a source, can be stored, and can be transferred but is conserved within a system				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **Forms of energy have a source, a means of transfer (work and heat), and a receiver**	a. Differentiate between thermal energy (the total internal energy of a substance which is dependent upon mass), heat (thermal energy that transfers from one object or system to another due to a difference in temperature), and temperature (the measure of average kinetic energy of molecules or atoms in a substance)	a. **Physics II Content** Differentiate between thermal energy (the total internal energy of a substance which is dependent upon mass), heat (thermal energy that transfers from one object or system to another due to a difference in temperature), and temperature (the measure of average kinetic energy of molecules or atoms in a substance)	a. Differentiate between thermal energy (the total internal energy of a substance which is dependent upon mass), heat (thermal energy that transfers from one object or system to another due to a difference in temperature), and temperature (the measure of average kinetic energy of molecules or atoms in a substance)	a. Describe the relationship among wavelength, energy, and frequency as illustrated by the electromagnetic spectrum
	b. Differentiate between the properties and examples of conductors and insulators	b. **Physics II Content** Describe the relationship among wavelength, energy, and frequency as illustrated by the electromagnetic spectrum	b. Describe the relationship among wavelength, energy, and frequency as illustrated by the electromagnetic spectrum	b. Describe sources and common uses of different forms of energy: chemical, nuclear, thermal, electromagnetic , mechanical (as transferred by moving objects, including rock, water, wind, waves)
	c. Describe sources and common uses of different forms of energy: chemical, nuclear, thermal, mechanical, electromagnetic	c. **Physics II Content** Differentiate between the properties and examples of conductors and insulators of different forms of energy (i.e., thermal, mechanical, electromagnetic)	c. **Chemistry II Content** Describe sources and common uses of different forms of energy: chemical (the energy stored in the electrical fields between atoms in a compound), nuclear, thermal, mechanical, electromagnetic	c. Identify and evaluate advantages/disadvantages of using various sources of energy (e.g., wind, solar, geothermal, hydroelectric, biomass, fossil fuel, electromagnetic radiation) for human activity
	d. Identify and evaluate advantages/disadvantages of using various sources of energy (e.g., wind, solar, geothermal, hydroelectric, biomass, fossil fuel) for human activity	d. Describe sources and common uses of different forms of energy: chemical, nuclear, thermal, mechanical, electromagnetic	d. Describe the effect of different frequencies of electromagnetic waves on the Earth and living organisms (e.g., radio, infrared, visible, ultraviolet, gamma, cosmic rays)	d. Describe the effect of different frequencies of electromagnetic waves on the Earth and living organisms (e.g., radio, infrared, visible, ultraviolet, gamma, cosmic rays)
	e. Describe the effect of different frequencies of electromagnetic waves on the Earth and living organisms (e.g., radio, infrared, visible, ultraviolet, gamma, cosmic rays)	e. Identify and evaluate advantages/disadvantages of using various sources of energy (e.g., wind, solar, geothermal, hydroelectric, biomass, fossil fuel) for human activity		e. Interpret examples (e.g., land and sea breezes, plate tectonics) of heat transfer as convection, conduction, or radiation
	f. Interpret examples of heat transfer (e.g., home heating, solar panels) as convection, conduction, or radiation	f. Describe the effect of different frequencies of electromagnetic waves on the Earth and living organisms (e.g., radio, infrared, visible, ultraviolet, gamma, cosmic rays)		
		g. **Physics II Content** Interpret examples (e.g., land and sea breezes, home heating, plate tectonics) of heat transfer as convection, conduction, or radiation		
DOK				

Strand 1: Properties and Principles of Matter and Energy

2. Energy has a source, can be stored, and can be transferred but is conserved within a system				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
B **Mechanical energy comes from the motion (kinetic energy) and/or relative position (potential energy) of an object**	a. Relate kinetic energy to an object's mass and its velocity	a. Relate kinetic energy to an object's mass and its velocity	a. **Chemistry II Content** Relate kinetic energy to an object's mass and its velocity	
	b. Relate an object's gravitational potential energy to its weight and height relative to the surface of the Earth	b. Relate an object's gravitational potential energy to its weight and height relative to the surface of the Earth		
	c. Distinguish between examples of kinetic and potential energy (i.e., gravitational) within a system	c. Distinguish between examples of kinetic and potential energy (i.e., gravitational, elastic) within a system		
	d. Describe the effect of work on an object's kinetic and potential energy	d. Describe the effect of work on an object's kinetic and potential energy		
DOK				
C **Electromagnetic energy from the Sun (solar radiation) is a major source of energy on Earth**	a. Identify stars as producers of electromagnetic energy	a. Identify stars as producers of electromagnetic energy	a. **Chemistry II Content** Describe how electromagnetic energy is transferred through space as electromagnetic waves of varying wavelength and frequency	a. Identify stars as producers of electromagnetic energy
	b. Describe how electromagnetic energy is transferred through space as electromagnetic waves of varying wavelength and frequency	b. Describe how electromagnetic energy is transferred through space as electromagnetic waves of varying wavelength and frequency		b. Describe how electromagnetic energy is transferred through space as electromagnetic waves of varying wavelength and frequency
DOK				
D **Chemical reactions involve changes in the bonding of atoms with the release or absorption of energy**			a. Describe evidence of energy transfer and transformations that occur during exothermic and endothermic chemical reactions	
DOK				
E **Nuclear energy is a major source of energy throughout the universe**	a. Describe how changes in the nucleus of an atom during a nuclear reaction (i.e., nuclear decay, fusion, fission) result in emission of radiation	a. **Physics II Content** Describe how changes in the nucleus of an atom during a nuclear reaction (i.e., nuclear decay, fusion, fission) result in emission of radiation)	a. Describe how changes in the nucleus of an atom during a nuclear reaction (i.e., nuclear decay, fusion, fission) result in emission of radiation	a. Describe how changes in the nucleus of an atom during a nuclear reaction (i.e., nuclear decay, fusion, fission) result in emission of radiation
	b. Identify the role of nuclear energy as it serves as a source of energy for the Earth, stars, and human activity (e.g., source of electromagnetic radiation, nuclear power plants, fuel for stars)	b. Identify the role of nuclear energy as it serves as a source of energy for the Earth, stars, and human activity (e.g., source of electromagnetic radiation, thermal energy within mantle, nuclear power plants, fuel for stars)		b. Identify the role of nuclear energy as it serves as a source of energy for the Earth, stars, and human activity (e.g., source of electromagnetic radiation, thermal energy within mantle, nuclear power plants, fuel for stars)
DOK				

Strand 1: Properties and Principles of Matter and Energy

2. Energy has a source, can be stored, and can be transferred but is conserved within a system				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
F **Energy can be transferred within a system as the total amount of energy remains constant (i.e., Law of Conservation of Energy)**	a. Describe the transfer of energy that occurs as energy changes from kinetic to potential within a system (e.g., car moving on rollercoaster track, child swinging, diver jumping off a board) (Do NOT assess calculations)	a. Describe the transfer of energy that occurs as energy changes from kinetic to potential within a system (e.g., car moving on rollercoaster track, child swinging, diver jumping off a board)	a. Classify the different ways to store energy (i.e., chemical, nuclear, thermal, mechanical, electromagnetic) and describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant, within a system (e.g., using gasoline to move a car, photocell generating electricity, electromagnetic motor doing work, energy generated by nuclear reactor)	a. Classify the different ways to store energy (i.e., chemical, nuclear, thermal, mechanical, electromagnetic) and describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant, within a system (e.g., using gasoline to move a car, photocell generating electricity, electromagnetic motor doing work, energy generated by nuclear reactor)
	b. Compare the efficiency of systems (recognizing that, as work is done, the amount of usable energy decreases)	b. Compare the efficiency of systems (recognizing that, as work is done, the amount of usable energy decreases)		
	c. Classify the different ways to store energy (i.e., chemical, nuclear, thermal, mechanical, electromagnetic) and describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant, within a system (e.g., using gasoline to move a car, photocell generating electricity, electromagnetic motor doing work, energy generated by nuclear reactor)	c. Classify the different ways to store energy (i.e., chemical, nuclear, thermal, mechanical, electromagnetic) and describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant, within a system (e.g., using gasoline to move a car, photocell generating electricity, electromagnetic motor doing work, energy generated by nuclear reactor)		
DOK				

Strand 2: Properties and Principles of Force and Motion

1. The motion of an object is described by its change in position relative to another object or point				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **The motion of an object is described as a change in position, direction, and speed relative to another object (frame of reference)**	a. Represent and analyze the motion of an object graphically b. Analyze the velocity of two objects in terms of distance and time (i.e., verbally, diagrammatically, graphically, mathematically)	a. Represent and analyze the motion of an object graphically b. Analyze the velocity of two objects in terms of distance and time (i.e., verbally, diagrammatically, graphically, mathematically)		
DOK				
B **An object that is accelerating is speeding up, slowing down, or changing direction**	a. Measure and analyze an object's motion in terms of speed, velocity, and acceleration (i.e., verbally, diagrammatically, graphically)	a. Measure and analyze an object's motion in terms of speed, velocity, and acceleration (i.e., verbally, diagrammatically, graphically, mathematically)		
DOK				
C **Momentum depends on the mass of the object and the velocity with which it is traveling**	a. Compare the momentum of two objects in terms of mass and velocity (Do NOT assess calculations) b. Explain that the total momentum remains constant within a system	a. Compare the momentum of two objects in terms of mass and velocity (Do NOT assess calculations) b. Explain that the total momentum remains constant within a system		
DOK				

Strand 2: Properties and Principles of Force and Motion

2. Forces affect motion				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **Forces are classified as either contact forces (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism), that can be described in terms of direction and magnitude**	Identify and describe the forces acting on an object (i.e., type of force, direction, magnitude in Newtons) using a force diagram (do not assess calculations)	Identify and describe the forces acting on an object (i.e., type of force, direction, magnitude in Newtons) using a force diagram and calculating net force		
DOK				
B **Every object exerts a gravitational force on every other object**	a. Describe gravity as an attractive force among all objects	a. Describe gravity as an attractive force among all objects		a. Compare and describe the gravitational forces between two objects in terms of their masses and the distances between them
	b. Compare and describe the gravitational forces between two objects in terms of their masses and the distances between them	b. **Physics II Content** Compare and describe the gravitational forces between two objects in terms of their masses and the distances between them		
	c. Describe weight in terms of the force of a planet's or moon's gravity acting on a given mass	c. Describe weight in terms of the force of a planet's or moon's gravity acting on a given mass		
	d. Recognize all free falling bodies accelerate at the same rate due to gravity regardless of their mass	d. Recognize all free falling bodies accelerate at the same rate due to gravity regardless of their mass		
DOK				
C **Magnetic forces are related to electrical forces as different aspects of a single electromagnetic force**		a. **Physics II Content** Recognize changing magnetic fields can produce electrical current and electric currents can produce magnetic forces		
		b. **Physics II Content** Predict the effects of an electromagnetic force on the motion of objects (attract or repel)		
DOK				

Strand 2: Properties and Principles of Force and Motion

2. Forces affect motion				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
D **Newton's Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion**	a. Recognize that inertia is a property of matter that can be described as an object's tendency to resist a change in motion, and is dependent upon the object's mass (Newton's First Law of Motion)	a. Recognize that inertia is a property of matter that can be described as an object's tendency to resist a change in motion, and is dependent upon the object's mass (Newton's First Law of Motion)		
	b. Determine the effect (i.e., direction and magnitude) of the sum of the forces acting on an object (i.e., net force)	b. Determine the effect (i.e., direction and magnitude) of the sum of the forces acting on an object (i.e., net force)		
	c. Using information about net force and mass determine the effect on acceleration (Newton's Second Law of Motion)	c. Using information about net force and mass determine the effect on acceleration (Newton's Second Law of Motion)		
	d. Identify forces acting on a falling object (i.e., weight, air resistance) and how those forces affect the rate of acceleration	d. Identify forces acting on a falling object (i.e., weight, air resistance) and how those forces affect the rate of acceleration		
	e. Analyze force pairs (i.e., action/reaction forces) when given a scenario (e.g., handball hits concrete wall, shotgun firing) and describe their magnitudes and directions. (Newton's Third Law of Motion)	e. Analyze force pairs (i.e., action/reaction forces) when given a scenario (e.g., handball hits concrete wall, shotgun firing) and describe their magnitudes and directions. (Newton's Third Law of Motion)		
DOK				
E **Perpendicular forces act independently of each other**	a. Predict the path of an object when the net force changes	a. Describe the force(s) that keep an object traveling in a circular path		
		b. Describe the force(s) acting on a projectile on the Earth		
		c. Predict the path of an object when the net force changes		
DOK				
F **Work transfers energy into and out of a mechanical system**	a. Describe the relationships among work, applied net force, and the distance an object moves	a. Describe the relationships among work, applied net force, and the distance an object moves		
	b. Explain how the efficiency of a mechanical system can be expressed as a ratio of work output to work input	b. Explain how the efficiency of a mechanical system can be expressed as a ratio of work output to work input		
	c. Describe power in terms of work and time	c. Describe power in terms of work and time		
	d. Describe and analyze the relationships among force, distance, work, efficiency, and power	d. Describe and analyze the relationships among force, distance, work, efficiency, and power		
DOK				

Strand 3: Characteristic and Interactions of Living Organisms

1. There is a fundamental unity underlying the diversity of all living organisms				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A				
Organisms have basic needs for survival				
DOK				
B				
Organisms progress through life cycles unique to different types of organisms				
DOK				
C				
Cells are the fundamental units of structure and function of all living things				
DOK				
D				
Plants and animals have different structures that serve similar functions necessary for the survival of the organism				
DOK				
E				
Biological classifications are based on how organisms are related				
DOK				

Strand 3: Characteristic and Interactions of Living Organisms

2. Living organisms carry out life processes in order to survive				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A				
The cell contains a set of structures called organelles that interact to carry out life processes through physical and chemical means				
DOK				
B				
Photosynthesis and cellular respiration are complementary processes necessary to the survival of most organisms on Earth				
DOK				
C				
Complex multicellular organisms have systems that interact to carry out life processes through physical and chemical means				
DOK				
D				
Cells carry out chemical transformations that use energy for the synthesis or breakdown of organic compounds				
DOK				

Strand 3: Characteristic and Interactions of Living Organisms

2. Living organisms carry out life processes in order to survive				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
E				
Protein structure and function are coded by the DNA (Deoxyribonucleic acid) molecule				
DOK				
F				
Cellular activities and responses can maintain stability internally while external conditions are changing (homeostasis)				
DOK				
G				
Life processes can be disrupted by disease (intrinsic failures of the organ systems or by infection due to other organisms)				
DOK				

Strand 3: Characteristic and Interactions of Living Organisms

3. There is a genetic basis for the transfer of biological characteristics from one generation to the next through reproductive processes				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **Reproduction can occur asexually or sexually**				
DOK				
B **All living organisms have genetic material (DNA) that carries hereditary information**				
DOK				
C **Chromosomes are components of cells that occur in pairs and carry hereditary information from one cell to daughter cells and from parent to offspring during reproduction**				
DOK				
D **There is heritable variation within every species of organism**				
DOK				
E **The pattern of inheritance for many traits can be predicted by using the principles of Mendelian genetics**				
DOK				

Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

1. Organisms are interdependent with one another and with their environment				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem**				
DOK				
B **Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite**				
DOK				
C **All organisms, including humans, and their activities cause changes in their environment that affect the ecosystem**				a. Predict and explain how natural or human caused changes (biological, chemical and/or physical) in one ecosystem may affect other ecosystems due to natural mechanisms (e.g., global wind patterns, water cycle, ocean currents)
DOK				
D **The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes**				
DOK				

Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

2. Matter and energy flow through the ecosystem				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A				
As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form they can use				
DOK				
B				a. Explain the processes involved in the recycling of nitrogen, oxygen, and carbon through an ecosystem
Matter is recycled through an ecosystem				b. Explain the importance of the recycling of nitrogen, oxygen, and carbon within an ecosystem
DOK				

Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

3. Genetic variation sorted by the natural selection process explains evidence of biological evolution				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A				
Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record				
DOK				
B				
Reproduction is essential to the continuation of every species				
DOK				
C				
Natural selection is the process of sorting individuals based on their ability to survive and reproduce within their ecosystem				
DOK				

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

1. Earth's Systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **The Earth's crust is composed of various materials, including soil, minerals, and rocks, with characteristic properties**				a. Classify minerals (rock-forming and ore) based on physical and chemical properties (e.g., color, streak, luster/reflectivity, hardness, cleavage, fracture, conductivity, density, melting point, boiling point, solubility, pH, chemical reactivity) b. Classify common igneous, metamorphic, and/or sedimentary rocks based on physical and chemical properties (e.g., mineral composition, texture, density, and other unique properties) c. Classify earth materials as minerals, rocks, and soils by comparing and contrasting their components, unique properties, and the processes which formed them
DOK				
B **The hydrosphere is composed of water (a material with unique properties) and other materials**			a. Recognize the importance of water as a solvent in the environment as it relates to acid rain and water pollution	a. Recognize the importance of water as a solvent in the environment as it relates to karst geology (dissolution and mineralization), acid rain, water pollution, erosion and deposition of rock and soil materials
DOK				
C **The atmosphere (air) is composed of a mixture of gases, including water vapor, and minute particles**			a. Relate the composition of gases and temperature of the layers of the atmosphere (i.e., troposphere, stratosphere, ionosphere) to cloud formation and transmission of radiation (e.g., ultraviolet, infrared) b. Describe the causes and consequences of observed and predicted changes in the ozone layer	a. Relate the composition of gases and temperature of the layers of the atmosphere (i.e., troposphere, stratosphere, ionosphere) to cloud formation and transmission of radiation (e.g., ultraviolet, infrared) b. Describe the causes and consequences of observed and predicted changes in the ozone layer
DOK				

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

2. Earth's Systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **The Earth's materials and surface features are changed through a variety of external processes**				a. Explain the external processes (i.e., weathering, erosion, deposition of sediment) that result in the formation and modification of landforms b. Describe the factors that affect rates of weathering and erosion of landforms (e.g., soil/rock type, amount and force of run-off, slope)
DOK				

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

2. Earth's Systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
B **There are internal processes and sources of energy within the geosphere that cause changes in Earth's crustal plates**		**Physics II Content** a. Describe the internal source of energy on Earth that results in uneven heating of the mantle (i.e., decay of radioactive isotopes)		a. Describe the internal source of energy on Earth that results in uneven heating of the mantle (i.e., decay of radioactive isotopes)
		Physics II Content b. Illustrate and explain the convection currents that result from the uneven heating inside the mantle and cause movement of crustal plates		b. Illustrate and explain the convection currents that result from the uneven heating inside the mantle and cause movement of crustal plates
		Physics II Content c. Illustrate and explain the convection currents that result from the uneven heating inside the mantle and cause movement of crustal plates		c. Describe how the energy of an earthquake travels as seismic waves and provides evidence for the layers of the geosphere
		Physics II Content d. Relate the densities of the materials found in continental and oceanic plates to the processes that result in each type of plate boundary (i.e., diverging, converging, transform)		d. Relate the densities of the materials found in continental and oceanic plates to the processes that result in each type of plate boundary (i.e., diverging, converging, transform)
		Physics II Content e. Describe the effects of the movement of crustal plates (i.e., earthquakes, sea floor spreading, mountain building, volcanic eruptions) at a given location on the planet		e. Describe the effects of the movement of crustal plates (i.e., earthquakes, sea floor spreading, mountain building, volcanic eruptions) at a given location on the planet
		Physics II Content f. Articulate the processes involved in the Theory of Plate Tectonics (i.e., uneven heating of the mantle due to the decay of radioactive isotopes, movement of materials via convection currents, movement of continental and oceanic plates along diverging, converging, or transform plate boundaries) and describe evidence that supports that theory (e.g., correlation of rock sequences, landforms, and fossils; presence of intrusions and faults; evidence of sea-floor spreading)		f. Articulate the processes involved in the Theory of Plate Tectonics (i.e., uneven heating of the mantle due to the decay of radioactive isotopes, movement of materials via convection currents, movement of continental and oceanic plates along diverging, converging, or transform plate boundaries) and describe evidence that supports that theory (e.g., correlation of rock sequences, landforms, and fossils; presence of intrusions and faults; evidence of sea-floor spreading)
DOK				

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

2. Earth's Systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
C **Continual changes in Earth's materials and surface that result from internal and external processes is described by the rock cycle**				a. Describe the rock cycle as it relates to the origin and transformation of rock types (i.e., igneous, metamorphic, and sedimentary)
DOK				
D **Changes in the Earth over time can be inferred through rock and fossil evidence**		**Physics II Content** a. Use evidence from relative and real dating techniques (e.g., correlation of trace fossils, landforms, and rock sequences; evidence of climate changes; presence of intrusions and faults; magnetic orientation; relative age of drill samples) to infer geologic history		a. Use evidence from relative and real dating techniques (e.g., correlation of trace fossils, landforms, and rock sequences; evidence of climate changes; presence of intrusions and faults; magnetic orientation; relative age of drill samples) to infer geologic history
DOK				
E **Changes in the form of water as it moves through Earth's systems are described as the water cycle**				
DOK				

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

2. Earth's Systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
F **Climate is a description of average weather conditions in a given area due to the transfer of energy and matter through Earth's systems.**		**Physics II Content** a. Explain how global wind and ocean currents are produced on the Earth's surface (e.g., effects of unequal heating of the Earth's land masses, oceans, and air by the Sun due to latitude and surface material type; effects of gravitational forces acting on layers of air of different densities due to temperature differences; effects of the rotation of the Earth; effects of surface topography)	a. Provide evidence (e.g., variations in sea level, glaciation, and permafrost layers, fossils, desertification) that supports theories of climate change due to natural phenomena and/or human interactions	a. Predict the weather (patterns of change in the atmosphere) at a designated location using weather maps (including map legends) and/or weather data (e.g., temperature, barometric pressure, cloud cover and type, wind speed and direction, precipitation) b. Explain how global wind and ocean currents are produced on the Earth's surface (e.g., effects of unequal heating of the Earth's land masses, oceans, and air by the Sun due to latitude and surface material type; effects of gravitational forces acting on layers of air of different densities due to temperature differences; effects of the rotation of the Earth; effects of surface topography) c. Describe the effects of natural phenomena (e.g., burning organic material, volcanic eruptions, lightning, changes in global wind and ocean currents) on the properties of the atmosphere d. Explain how climate and weather patterns in a particular region are affected by factors such as proximity to large bodies of water or ice/ocean currents, latitude, altitude, wind and ocean currents, amount of solar radiation, changes in the atmosphere due to natural phenomena (e.g., burning organic material, volcanic eruptions) e. Provide evidence (e.g., fossils, desertification, variation in sea level, glaciations, and permafrost layers) that supports theories of climate change due to natural phenomena and/or human interactions with the environment
DOK				

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

3. Human activity is dependent upon and affects Earth's resources and systems				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **Earth's materials are limited natural resources affected by human activity**		a. Distinguish between renewable and nonrenewable energy resources		a. Recognize the limited availability of some energy resources (i.e., solar radiation, wind, fossil fuels) and major mineral deposits in the United States (e.g., lead, petroleum, coal, copper, zinc, iron, gravel, aluminum) and the factors that affect their availability
		b. Identify human activities that may adversely affect the composition of the atmosphere, hydrosphere, or geosphere		b. Identify human activities that may adversely affect the composition of the atmosphere, hydrosphere, or geosphere
				c. Predict local and/or global effects of environmental changes when given a scenario describing how the composition of the geosphere, hydrosphere, or atmosphere is altered by natural phenomena or human activities
				d. Recognize how the geomorphology of Missouri (i.e., different types of Missouri soil and rock materials such as limestone, granite, clay, loam; land formations such as karst (cave) formations, glaciated plains, river channels) affects the survival of organisms and the development of land use by humans (e.g., agriculture, recreation, planning and zoning, waste management)
				e. Recognize the economic, political, social, and ethical constraints associated with obtaining and using natural resources (e.g., mining and use of different types of Missouri mineral resources such as lead mining, gravel dredging, strip mining, coal burning, production of fertilizers and explosives; use of fossil fuels versus renewable resources)
DOK				

Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

1. The universe has observable properties and structure				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **The Earth, Sun, and moon are part of a larger system that includes other planets and smaller celestial bodies**		a. Describe and relate the positions and motions of the Sun-Earth solar system, the Milky-Way galaxy, and other galaxies within the universe (i.e., it is just one of several solar systems orbiting the center of a rotating spiral galaxy; that spiral galaxy is just one of many galaxies which orbit a common center of gravity; the expanding universe causes the distance between galaxies to increase)		a. Describe and relate the positions and motions of the Sun-Earth solar system, the Milky-Way galaxy, and other galaxies within the universe (i.e., it is just one of several solar systems orbiting the center of a rotating spiral galaxy; that spiral galaxy is just one of many galaxies which orbit a common center of gravity; the expanding universe causes the distance between galaxies to increase)
DOK				
B **The Earth has a composition and location suitable to sustain life**	a. Explain how Earth's environmental characteristics and location in the universe (e.g., atmosphere, temperature, orbital path, magnetic field, mass-gravity, location in solar system) provide a life-supporting environment	a. Explain how Earth's environmental characteristics and location in the universe (e.g., atmosphere, temperature, orbital path, magnetic field, mass-gravity, location in solar system) provide a life-supporting environment b. Compare the environmental characteristics and location in the universe of Earth and other celestial bodies (e.g., planets, moons) to determine ability to support life		a. Explain how Earth's environmental characteristics and location in the universe (e.g., atmosphere, temperature, orbital path, magnetic field, mass-gravity, location in solar system) provide a life-supporting environment b. Compare the environmental characteristics and location in the universe of Earth and other celestial bodies (e.g., planets, moons) to determine ability to support life
DOK				
C **Most of the information we know about the universe comes from the electromagnetic spectrum**	a. Identify information that the electromagnetic spectrum provides about the stars and the universe (e.g., chemical composition, temperature, age of stars, location of black holes, motion of celestial bodies)	a. Identify information that the electromagnetic spectrum provides about the stars and the universe (e.g., chemical composition, temperature, age of stars, location of black holes, motion of celestial bodies) b. Evaluate the advantages/ disadvantages of using different tools (e.g., spectroscope, different types of telescopes, probes) to gather information about the universe (e.g., background radiation, magnetic fields, discovery of previously unknown celestial bodies)		a. Identify information that the electromagnetic spectrum provides about the stars and the universe (e.g., chemical composition, temperature, age of stars, location of black holes, motion of celestial bodies) b. Evaluate the advantages/ disadvantages of using different tools (e.g., spectroscope, different types of telescopes, probes) to gather information about the universe (e.g., background radiation, magnetic fields, discovery of previously unknown celestial bodies)
DOK				

Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

2. Regular and predictable motions of objects in the universe can be described and explained as the result of gravitational forces				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **The apparent position of the Sun and other stars, as seen from Earth, changes in observable patterns**				
DOK				
B **The apparent position of the moon, as seen from Earth, and its actual position relative to Earth changes in observable patterns**				
DOK				
C **The regular and predictable motions of a planet and moon relative to the Sun explain natural phenomena, such as day, month, year, shadows, moon phases, eclipses, tides, and seasons**	a. Predict the moon rise/set times, phases of the moon, and/or eclipses when given the relative positions of the moon, planet, and Sun	a. Relate units of time (i.e., day, month, year) to the regular and predictable motion of the planets and moons and their positions in the Solar system		a. Relate units of time (i.e., day, month, year) to the regular and predictable motion of the planets and moons and their positions in the Solar system
	b. Explain how the gravitational forces, due to the relative positions of a planet, moon, and Sun, determine the height and frequency of tides	b. Explain seasonal phenomena (i.e., weather, length of day, temperature, intensity of sunlight) as a consequence of a planet's axial tilt as it rotates and a planet's orbital position as it revolves around the Sun		b. Explain seasonal phenomena (i.e., weather, length of day, temperature, intensity of sunlight) as a consequence of a planet's axial tilt as it rotates and a planet's orbital position as it revolves around the Sun
		c. Provide evidence that can be observed from Earth that supports the fact Earth rotates on its axis and revolves around the Sun		c. Provide evidence that can be observed from Earth that supports the fact Earth rotates on its axis and revolves around the Sun
		d. Predict the moon rise/set times, phases of the moon, and/or eclipses when given the relative positions of the moon, planet, and Sun		d. Predict the moon rise/set times, phases of the moon, and/or eclipses when given the relative positions of the moon, planet, and Sun
		e. Explain how the gravitational forces, due to the relative positions of a planet, moon, and Sun, determine the height and frequency of tides		e. Explain how the gravitational forces, due to the relative positions of a planet, moon, and Sun, determine the height and frequency of tides
DOK				

Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

2. Regular and predictable motions of objects in the universe can be described and explained as the result of gravitational forces				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
D **Gravity is a force of attraction between objects in the solar system that governs their motion**	a. Explain orbital motions of moons around planets, and planets around the Sun, as the result of gravitational forces between those objects	a. Explain orbital motions of moons around planets, and planets around the Sun, as the result of gravitational forces between those objects		a. Explain orbital motions of moons around planets, and planets around the Sun, as the result of gravitational forces between those objects
DOK				

Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A	a. Formulate testable questions and hypotheses	a. Formulate testable questions and hypotheses	a. Formulate testable questions and hypotheses	a. Formulate testable questions and hypotheses
Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation	b. Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment	b. Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment	b. Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment	b. Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment
	c. Design and conduct a valid experiment	c. Design and conduct a valid experiment	c. Design and conduct a valid experiment	c. Design and conduct a valid experiment
	d. Recognize it is not always possible, for practical or ethical reasons, to control some conditions (e.g., when sampling or testing humans, when observing animal behaviors in nature)	d. Recognize it is not always possible, for practical or ethical reasons, to control some conditions (e.g., when sampling or testing humans, when observing animal behaviors in nature)	d. Recognize it is not always possible, for practical or ethical reasons, to control some conditions (e.g., when sampling or testing humans, when observing animal behaviors in nature)	d. Recognize it is not always possible, for practical or ethical reasons, to control some conditions (e.g., when sampling or testing humans, when observing animal behaviors in nature)
	e. Acknowledge some scientific explanations (e.g., explanations of astronomical or meteorological phenomena) cannot be tested using a controlled laboratory experiment, but instead by using a model, due to the limits of the laboratory environment, resources, and/or technologies	e. Acknowledge some scientific explanations (e.g., explanations of astronomical or meteorological phenomena) cannot be tested using a controlled laboratory experiment, but instead by using a model, due to the limits of the laboratory environment, resources, and/or technologies	e. Acknowledge some scientific explanations (e.g., explanations of astronomical or meteorological phenomena) cannot be tested using a controlled laboratory experiment, but instead by using a model, due to the limits of the laboratory environment, resources, and/or technologies	e. Acknowledge some scientific explanations (e.g., explanations of astronomical or meteorological phenomena) cannot be tested using a controlled laboratory experiment, but instead by using a model, due to the limits of the laboratory environment, resources, and/or technologies
	f. Acknowledge there is no fixed procedure called "the scientific method", but that some investigations involve systematic observations, carefully collected and relevant evidence, logical reasoning, and some imagination in developing hypotheses and other explanations	f. Acknowledge there is no fixed procedure called "the scientific method", but that some investigations involve systematic observations, carefully collected and relevant evidence, logical reasoning, and some imagination in developing hypotheses and other explanations	f. Acknowledge there is no fixed procedure called "the scientific method", but that some investigations involve systematic observations, carefully collected and relevant evidence, logical reasoning, and some imagination in developing hypotheses and other explanations	f. Acknowledge there is no fixed procedure called "the scientific method", but that some investigations involve systematic observations, carefully collected and relevant evidence, logical reasoning, and some imagination in developing hypotheses and other explanations
	g. Evaluate the design of an experiment and make suggestions for reasonable improvements	g. Evaluate the design of an experiment and make suggestions for reasonable improvements	g. Evaluate the design of an experiment and make suggestions for reasonable improvements	g. Evaluate the design of an experiment and make suggestions for reasonable improvements
DOK				

Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
B Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations	a. Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders)	a. Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders)	a. Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders)	a. Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders)
	b. Measure length to the nearest millimeter, mass to the nearest gram, volume to the nearest milliliter, force (weight) to the nearest Newton, temperature to the nearest degree Celsius, time to the nearest second	b. Measure length to the nearest millimeter, mass to the nearest gram, volume to the nearest milliliter, force (weight) to the nearest Newton, temperature to the nearest degree Celsius, time to the nearest second	b. Measure length to the nearest millimeter, mass to the nearest gram, volume to the nearest milliliter, force (weight) to the nearest Newton, temperature to the nearest degree Celsius, time to the nearest second	b. Measure length to the nearest millimeter, mass to the nearest gram, volume to the nearest milliliter, force (weight) to the nearest Newton, temperature to the nearest degree Celsius, time to the nearest second
	c. Determine the appropriate tools and techniques to collect, analyze, and interpret data	c. Determine the appropriate tools and techniques to collect, analyze, and interpret data	c. Determine the appropriate tools and techniques to collect, analyze, and interpret data	c. Determine the appropriate tools and techniques to collect, analyze, and interpret data
	d. Judge whether measurements and computation of quantities are reasonable	d. Judge whether measurements and computation of quantities are reasonable	d. Judge whether measurements and computation of quantities are reasonable	d. Judge whether measurements and computation of quantities are reasonable
	e. Calculate the range, average/mean, percent, and ratios for sets of data	e. Calculate the range, average/mean, percent, and ratios for sets of data	e. Calculate the range, average/mean, percent, and ratios for sets of data	e. Calculate the range, average/mean, percent, and ratios for sets of data
	f. Recognize observation is biased by the experiences and knowledge of the observer (e.g., strong beliefs about what should happen in particular circumstances can prevent the detection of other results)	f. Recognize observation is biased by the experiences and knowledge of the observer (e.g., strong beliefs about what should happen in particular circumstances can prevent the detection of other results)	f. Recognize observation is biased by the experiences and knowledge of the observer (e.g., strong beliefs about what should happen in particular circumstances can prevent the detection of other results)	f. Recognize observation is biased by the experiences and knowledge of the observer (e.g., strong beliefs about what should happen in particular circumstances can prevent the detection of other results)
DOK				

Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
C **Scientific inquiry includes evaluation of explanations (laws/principles, theories/models) in light of evidence (data) and scientific principles (understandings)**	a. Use quantitative and qualitative data as support for reasonable explanations (conclusions)	a. Use quantitative and qualitative data as support for reasonable explanations (conclusions)	a. Use quantitative and qualitative data as support for reasonable explanations (conclusions)	a. Use quantitative and qualitative data as support for reasonable explanations (conclusions)
	b. Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable)	b. Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable)	b. Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable)	b. Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable)
	c. Identify the possible effects of errors in observations, measurements, and calculations, on the validity and reliability of data and resultant explanations (conclusions)	c. Identify the possible effects of errors in observations, measurements, and calculations, on the validity and reliability of data and resultant explanations (conclusions)	c. Identify the possible effects of errors in observations, measurements, and calculations, on the validity and reliability of data and resultant explanations (conclusions)	c. Identify the possible effects of errors in observations, measurements, and calculations, on the validity and reliability of data and resultant explanations (conclusions)
	d. Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models)	d. Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models)	d. Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models)	d. Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models)
DOK				

Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
D **The nature of science relies upon communication of results and justification of explanations**	a. Communicate the procedures and results of investigations and explanations through: • oral presentations • drawings and maps • data tables (allowing for the recording and analysis of data relevant to the experiment such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities) • graphs (bar, single, and multiple line) • equations and writings	a. Communicate the procedures and results of investigations and explanations through: • oral presentations • drawings and maps • data tables (allowing for the recording and analysis of data relevant to the experiment such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities) • graphs (bar, single, and multiple line) • equations and writings	a. Communicate the procedures and results of investigations and explanations through: • oral presentations • drawings and maps • data tables (allowing for the recording and analysis of data relevant to the experiment such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities) • graphs (bar, single, and multiple line) • equations and writings	a. Communicate the procedures and results of investigations and explanations through: • oral presentations • drawings and maps • data tables (allowing for the recording and analysis of data relevant to the experiment such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities) • graphs (bar, single, and multiple line) • equations and writings
	b. Communicate and defend a scientific argument	b. Communicate and defend a scientific argument	b. Communicate and defend a scientific argument	b. Communicate and defend a scientific argument
	c. Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed, and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work)	c. Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed, and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work)	c. Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed, and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work)	c. Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed, and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work)
DOK				

Strand 8: Impact of Science, Technology and Human Activity

1. The nature of technology can advance, and is advanced by, science as it seeks to apply scientific knowledge in ways that meet human needs				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **Designed objects are used to do things better or more easily and to do some things that could not otherwise be done at all**				
DOK				
B **Advances in technology often result in improved data collection and an increase in scientific information**	a. Recognize the relationships linking technology and science (e.g., how technological problems may create a demand for new science knowledge, how new technologies make it possible for scientists to extend research and advance science)	a. Recognize the relationships linking technology and science (e.g., how technological problems may create a demand for new science knowledge, how new technologies make it possible for scientists to extend research and advance science)		a. Recognize the relationships linking technology and science (e.g., how technological problems may create a demand for new science knowledge, how new technologies make it possible for scientists to extend research and advance science)
DOK				

Strand 8: Impact of Science, Technology and Human Activity

2. Historical and cultural perspectives of scientific explanations help to improve understanding of the nature of science and how science knowledge and technology evolve over time				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A **People of different gender and ethnicity have contributed to scientific discoveries and the invention of technological innovations**	a. Recognize contributions to science are not limited to the work of one particular group, but are made by a diverse group of scientists representing various ethnic and gender groups	a. Recognize contributions to science are not limited to the work of one particular group, but are made by a diverse group of scientists representing various ethnic and gender groups	a. Recognize contributions to science are not limited to the work of one particular group, but are made by a diverse group of scientists representing various ethnic and gender groups	a. Recognize contributions to science are not limited to the work of one particular group, but are made by a diverse group of scientists representing various ethnic and gender groups
	b. Recognize gender and ethnicity of scientists often influence the questions asked and/or the methods used in scientific research and may limit or advance science knowledge and/or technology	b. Recognize gender and ethnicity of scientists often influence the questions asked and/or the methods used in scientific research and may limit or advance science knowledge and/or technology		b. Recognize gender and ethnicity of scientists often influence the questions asked and/or the methods used in scientific research and may limit or advance science knowledge and/or technology
DOK				
B **Scientific theories are developed based on the body of knowledge that exists at any particular time and must be rigorously questioned and tested for validity**	a. Identify and describe how explanations (laws/principles, theories/models) of scientific phenomena have changed over time as a result of new evidence (e.g., model of the solar system, basic structure of matter, structure of an atom, Big Bang and nebular theory of the Universe)\	**Physics II Content** a. Identify and describe how explanations (laws/principles, theories/models) of scientific phenomena have changed over time as a result of new evidence (e.g., model of the solar system, basic structure of matter, structure of an atom, Theory of Plate Tectonics, Big Bang and nebular theory of the Universe, explanation of electric current)	a. Identify and describe how explanations (laws/principles, theories/models) of scientific phenomena have changed over time as a result of new evidence (e.g., basic structure of matter, structure of an atom)	a. Identify and describe how explanations (laws/principles, theories/models) of scientific phenomena have changed over time as a result of new evidence (e.g., model of the solar system, Theory of Plate Tectonics, Big Bang and nebular theory of the Universe)
	b. Identify and analyze current theories that are being questioned, and compare them to new theories that have emerged to challenge older ones (e.g., theories of evolution, extinction, global warming)	b. Identify and analyze current theories that are being questioned, and compare them to new theories that have emerged to challenge older ones (e.g., theories of evolution, extinction, global warming)		b. Identify and analyze current theories that are being questioned, and compare them to new theories that have emerged to challenge older ones (e.g., theories of evolution, extinction, global warming)
DOK				

Strand 8: Impact of Science, Technology and Human Activity

3. Science and technology affect, and are affected by, society				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
A People, alone or in groups, are always making discoveries about nature and inventing new ways to solve problems and get work done				
DOK				
B Social, political, economic, ethical and environmental factors strongly influence, and are influenced by, the direction of progress of science and technology	a. Identify and describe major scientific and technological challenges to society and their ramifications for public policy (e.g., global warming, limitations to fossil fuels, genetic engineering of plants, space and/or medical research)	a. Analyze the roles of science and society as they interact to determine the direction of scientific and technological progress (e.g., prioritization of and funding for new scientific research and technological development is determined on the basis of individual, political and social values and needs; understanding basic concepts and principles of science and technology influences debate about the economics, policies, politics, and ethics of various scientific and technological challenges)	a. Analyze the roles of science and society as they interact to determine the direction of scientific and technological progress (e.g., prioritization of and funding for new scientific research and technological development is determined on the basis of individual, political and social values and needs; understanding basic concepts and principles of science and technology influences debate about the economics, policies, politics, and ethics of various scientific and technological challenges)	a. Analyze the roles of science and society as they interact to determine the direction of scientific and technological progress (e.g., prioritization of and funding for new scientific research and technological development is determined on the basis of individual, political and social values and needs; understanding basic concepts and principles of science and technology influences debate about the economics, policies, politics, and ethics of various scientific and technological challenges)
	b. Identify and evaluate the drawbacks (e.g., design constraints, unintended consequences, risks) and benefits of technological solutions to a given problem (e.g., use of alternative energies to reduce the use of carbon fuels, use of satellite communications to gather information)	**<u>Physics II Content</u>** b. Identify and describe major scientific and technological challenges to society and their ramifications for public policy (e.g., global warming, limitations to fossil fuels, genetic engineering of plants, space and/or medical research)	b. Identify and describe major scientific and technological challenges to society and their ramifications for public policy (e.g., global warming, limitations to fossil fuels, genetic engineering of plants, space and/or medical research)	b. Identify and describe major scientific and technological challenges to society and their ramifications for public policy (e.g., global warming, limitations to fossil fuels, space and/or medical research)
		c. Analyze and evaluate the drawbacks (e.g., design constraints, unintended consequences, risks), benefits, and factors (i.e., social, political, economic, ethical, and environmental) affecting progress toward meeting major scientific and technological challenges (e.g., use of alternative energies to reduce the use of carbon fuels, use of satellite communications to gather information, nuclear energy, computer technology)		c. Analyze and evaluate the drawbacks (e.g., design constraints, unintended consequences, risks), benefits, and factors (i.e., social, political, economic, ethical, and environmental) affecting progress toward meeting major scientific and technological challenges (e.g., use of alternative energies to reduce the use of carbon fuels, damming a river for flood control, use of satellite communications to gather information, deforestation, nuclear energy, space technology)
DOK				

Strand 8: Impact of Science, Technology and Human Activity

3. Science and technology affect, and are affected by, society				
Concept	**Physical Science**	**Physics I**	**Chemistry I**	**Earth & Space Science**
C **Scientific ethics require that scientists must not knowingly subject people or the community to health or property risks without their knowledge and consent**		a. Identify and evaluate the need for informed consent in experimentation b. Identify the ethical issues involved in experimentation (i.e., risks to organisms or environment) c. Identify and evaluate the role of models as an ethical alternative to direct experimentation (e.g., using a model for human subjects when safety features of crashed vehicles)		a. Identify and evaluate the need for informed consent in experimentation b. Identify the ethical issues involved in experimentation (i.e., risks to organisms or environment) c. Identify and evaluate the role of models as an ethical alternative to direct experimentation (e.g., using a model for a stream rather than pouring oil in an existing stream when studying the effects of oil pollution)
DOK				
D **Scientific information is presented through a number of credible sources, but is at times influenced in such a way to become non-credible**	a. Evaluate a given source for its scientific credibility (e.g., articles in a new periodical quoting an "eye witness," a scientist speaking within or outside his/her area of expertise) b. Explain why accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society	a. Evaluate a given source for its scientific credibility (e.g., articles in a new periodical quoting an "eye witness," a scientist speaking within or outside his/her area of expertise) b. Explain why accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society	a. Evaluate a given source for its scientific credibility (e.g., articles in a new periodical quoting an "eye witness", a scientist speaking within or outside his/her area of expertise) b. Explain why accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society	a. Evaluate a given source for its scientific credibility (e.g., articles in a new periodical quoting an "eye witness," a scientist speaking within or outside his/her area of expertise) b. Explain why accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society
DOK				