									Scientific and Engineering Practices (SP / EP)							
Inv	**Inv Title**	**Part**	**Part Summary**	**Sessions**	**Content**	**NGSS Standards Addressed**	**Disciplinary Core Ideas (Framework)**	**Crosscutting Concepts**	**Asking questions (SP) / Defining problems (EP)**	**Developing and using models**	**Planning and carrying out investigations**	**Analyzing and interpreting data**	**Using mathematics and comp. thinking**	**Constructing explanations (SP) / Designing solutions (EP)**	**Engaging in argument from evidence**	**Obtaining, evaluating, and communicating information**
1	**Substances**	**1**	**Mystery Mixture** Students begin their study of chemistry by observing a mystery mixture of two white, solid substances (citric acid and sodium bicarbonate). After recording the physical characteristics of the dry mixture, they add water and record their observations of the results.	1	• A substance is a form of matter with a unique composition and distinct physical and chemical properties that can be used to identify it.	**MS-PS1-2.** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	**PS1.A: Structure and Properties of Matter** • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3) **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5)	**Patterns** • Patterns can be used to identify cause and effect relationships.			**SP**	**SP**				
1		**2**	**Mixing Substances** Students observe a set of nine white solids, two of which are the substances in the mystery mixture. They develop a plan for testing pairs of substances to discover which two are in the mystery mixture. The fizzing that results from the mixing of seven different two-substance combinations is introduced as evidence of a chemical reaction.	4	• A substance is a form of matter with a unique composition and distinct physical and chemical properties that can be used to identify it. • Substances can be represented with common names, chemical names, and chemical formulas. • A chemical reaction occurs when substances interact to form new substances (products).	**MS-PS1-2.** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	**PS1.A: Structure and Properties of Matter** • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3) **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5)	**Patterns** • Patterns can be used to identify cause and effect relationships.	**SP**		**SP**	**SP**		**SP**	**SP**	
2	**Elements**	**1**	**Periodic Table** Students learn that an element is a basic substance that cannot be reduced to simpler substances in chemical interactions. They become familiar with the names and symbols of the 90 naturally occurring elements by studying the periodic table of the elements.	2	• An element is a basic substance that cannot be broken into simpler substances during chemical interactions. • There are 90 naturally occurring elements on Earth. • Elements combine to make all the substances on Earth. • The periodic table of the elements displays all the naturally occurring and synthesized elements. • The relative abundance of elements varies with location in the universe.	**MS-PS1-1.** Develop models to describe the atomic composition of simple molecules and extended structures.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.		**SP**						**SP**
2		**2**	**Elements in the World** Students study the lists of ingredients in consumer products to discover what elements are present. They determine the total number of elements, the most common elements, and the number of metallic elements in the products.	3	• Elements combine to make all the substances on Earth.	**MS-PS1-1.** Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-3**. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.		**SP**						**SP**

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
3	Particles	1	**Capture the Gas** After observing the inflation of a balloon placed over a sodium bicarbonate and citric acid reaction, students conduct controlled experiments to determine the volume of gas produced. The experiment includes making a stock solution of acid, measuring solids carefully, and measuring the volume of gas produced during the reaction.	2	• Gas is matter—it has mass and occupies space.	**MS-PS1-2**. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **Foundational for MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3) • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems			SP	SP				
3		2	**Air Is Matter** Students learn that the gas produced in a reaction is carbon dioxide, one of many gases in air. Students investigate air to confirm that it qualifies as matter—it has mass and occupies space. They use syringes to discover that air can be compressed and expanded. Students develop explanations for their observations, starting to develop a particulate model for matter.	3	• Matter is made of particles. • Every substance is defined by a unique particle. • Gas is matter—it has mass and occupies space. • Gas compresses when force is applied; gas expands when force is withdrawn. • During compression and expansion, the number and character of particles in a sample of gas do not change; the space between the particles does change.	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems	SP	SP	SP	SP	SP	SP		SP
		3	**Air as Particles** Students refine their model of air (gas) as independent particles with significantly large distances between them. They use representations to show the changes in particle density during compression and expansion.	3	• During compression and expansion, the number and character of particles in a sample of gas do not change; space between particles does change. • Gases are composed of widely spaced individual particles in constant motion. • There is nothing between gas particles except space.	**MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		SP				SP		SP
4	Kinetic Energy	1	**Gas Expansion/Contraction** After reviewing the properties and composition of gas, students work with "empty" plastic bottles to find out what happens to air when it is heated and cooled. Students observe that air expands when heated and contracts when cooled. They use the kinetic particulate model to explain expansion and contraction.	2	• Solids, liquids, and gases vary in how their particles are arranged in relationship to one another, but the particles are always in motion. • Kinetic energy is energy of motion. • The particles in substances gain kinetic energy as they warm, and lose kinetic energy as they cool. • Matter expands when the kinetic energy of its particles increases; matter contracts when the kinetic energy of its particles decreases.	**MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 • The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		SP	SP	SP		SP		

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
4		**2**	**Liquid Expansion/Contraction** Students make a water thermometer with a glass bottle, plastic tube, and rubber stopper. They place the water-filled system in cold water, then hot water. They observe the contraction and expansion of liquid water in response to cooling and heating. Students apply their understanding of kinetic theory to explain liquid expansion, including how a thermometer works.	3	• Solids, liquids, and gases vary in how their particles are arranged in relationship to one another, but the particles are always in motion. • Kinetic energy is energy of motion. • The particles in substances gain kinetic energy as they warm, and lose kinetic energy as they cool. • Matter expands when the kinetic energy of its particles increases; matter contracts whe	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 • The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		**SP**	**SP**	**SP**		**SP**		**SP**
4		**3**	**Solid Expansion/Contraction** Students observe the brass sphere-and-ring demonstration. At room temperature, the sphere passes easily through the ring. When the ring is cooled in ice water and the sphere is heated on a burner, the sphere does not pass easily through the ring. Students observe that solids expand and contract**.**	4	• Solids, liquids, and gases vary in how their particles are arranged in relationship to one another, but the particles are always in motion. • Kinetic energy is energy of motion. • The particles in substances gain kinetic energy as they warm, and lose kinetic energy as they cool. • Matter expands when the kinetic energy of its particles increases; matter contracts when	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 • The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		**SP**		**SP**				**SP**

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
5	**Energy Transfer**	1	**Mixing Hot and Cold** Students call on their knowledge of mixing hot and cold liquids to predict the final temperature of a mixture of equal masses of hot and cold water. They conduct the activity and use their results to determine an algorithm for calculating final temperatures.	2	• Substances "heat up" or "cool down" as a result of energy transfer. • Temperature is a measure of the average kinetic energy of the particles of a substance.	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. **MS-PS3-4:** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	**PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (secondary to MS-PS1-4) • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). • The transfer of energy can be tracked as energy flows through a designed or natural system.			SP	SP	SP			
5		2	**Particle Collisiions** Students explore the concept of energy transfer as a consequence of collisions between particles. They engage in group discussions, listen to minilectures, watch interactive animations, and participate in a structured classroom reading. They are introduced to temperature as the average kinetic energy of particles in a substance, and they study how a thermometer works.	2	• Substances "heat up" or "cool down" as a result of energy transfer. • Energy transfers between particles when they collide. Energy transfer by contact is conduction. • Energy always transfers from particles with more kinetic energy to particles with less kinetic energy. • Temperature is a measure of the average kinetic energy of the particles of a substance.	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. **Foundational for MS-PS3-3**. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. **MS-PS3-4.** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. **MS-PS3-5.** Construct, use and present arguments to support the claim that when the motion energy of an object changes, energy is transferred to or from the object	**PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (secondary to MS-PS1-4) • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** • When the kinetic energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). • The transfer of energy can be tracked as energy flows through a designed or natural system. **Stability and Change** •Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.		SP				SP		SP
5		3	**Heat** Students are introduced to the calorie as a unit of heat. They conduct a water-mixing investigation and use the results to calculate the number of calories transferred from hot water and to cold water during the interaction. The numbers are equal, supporting the notion of conservation of energy.	4	• Energy always transfers from particles with more kinetic energy to particles with less kinetic energy. • Energy is conserved. The amount of energy in a system does not change—no energy is ever created, and no energy is ever destroyed. • Temperature is a measure of the average kinetic energy of the particles of a substance. • Heat (energy transfer) is measured in calories. One calorie is the amount of heat needed to raise the temperature of 1 mL of water 1 degree Celcius.	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. **Foundational for MS-PS3-3**. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. **MS-PS3-4.** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. **MS-PS3-5**. Construct, use and present arguments to support the claim that when the motion energy of an object changes, energy is transferred to or from the object.	**PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** • When the kinetic energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). • The transfer of energy can be tracked as energy flows through a designed or natural system. **Stability and Change** •Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.			SP	SP	SP	SP		

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
6	**Thermos Engineering**	1	**Insulation** Students use their understanding of energy transfer to face an engineering problem: how to build a container that keeps hot liquids hot and cold liquids cold. They test materials for their insulating properties in preparation for the design challenge.	2	• Insulating materials reduce energy transfer via conduction. • Materials with more widely spaced particles serve as better insulators. • Engineers try to solve problems that meet a set of criteria and that work within the constraints of the problem.	**MS-PS3-3**. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. **MS-ETS1-1**. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2**. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and difference among several design solutions to identify the best characteristics of each that can be combined into a new solutions to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. **Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	SP/EP		SP/EP	SP/EP	SP/EP	SP/EP	SP/EP	
6		2	**Thermos Design** Students design a thermos, using the materials and data from Part 1. They determine criteria and constraints in the engineering design process and test their designs.	2	• Insulating materials reduce energy transfer via conduction. • Materials with more widely spaced particles serve as better insulators. • Engineers try to solve problems that meet a set of criteria and that work within the constraints of the problem.	**MS-PS3-3**. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. **MS-ETS1-1**. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2**. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3**. Analyze data from tests to determine similarities and difference among several design solutions to identify the best characteristics of each that can be combined into a new solutions to better meet the criteria for success. **MS-ETS1-4**. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6)	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. **Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.		SP/EP	SP/EP	SP/EP	SP/EP	SP/EP		SP/EP

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
7	Solutions	1	**Dissolve and Melt** In a quick write, students express their understanding of the processes of melting and dissolving. They observe what happens to four candy-coated chocolate pieces in four different environments: hot and dry, cold and dry, hot water, and cold water. They describe the different outcomes for the candy coating and the chocolate center. Students generate definitions for melting and dissolving, based on their observations.	1	• Dissolving is an interaction between two substances in which one substance breaks apart and goes into another substance. • A mixture is a combination of two or more substances. • Dissolving occurs when one substance (solute) is reduced to particles and is distributed uniformly throughout the particles of a second substance (solvent). • Dissolving involves both kinetic interactions (collisions) and attractive forces (bonds).	**MS-PS1-1**. Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-2**. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3) • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) **PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.			SP	SP		SP		
7		2	**Solubility** Students make two aqueous mixtures, one with soluble sodium chloride and one with insoluble calcium carbonate. They compare the two mixtures and attempt to separate them with filters. The salt mixture cannot be separated with the filter. It is identified as a solution. Students separate the salt solution into its original components, using evaporation.	2	• Dissolving is an interaction between two substances in which one substance breaks apart and goes into another substance. • Dissolving occurs when one substance (solute) is reduced to particles and is distributed uniformly throughout the particles of a second substance (solvent). • Dissolving involves both kinetic interactions (collisions) and attractive forces (bonds). • Not all substances are soluble in water. • Solutions can be separated back into their original components, which are not chemically changed.	**MS-PS1-1**. Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-2**. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3) • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.		SP	SP	SP		SP		SP
8	Phase Change	1	**Melting Temperature** Students heat three materials and observe the results. Students observe change of state from liquid to solid and discover that the materials melt at different temperatures. Students work on a mental model to explain what happens at a particle level when a substance changes state from solid to liquid. The model includes kinetic energy, energy transfer, and the relationship of particles.	1	• Matter exists on Earth in three common states—solid, liquid, and gas. • In solids, particles are held in place and move only by vibrating. • In liquids, particles are held close, but are able to move around and over one another. • Change of state is the result of change of energy in the particles in a sample of matter. • The temperatures at which phase changes occur are different for different substances.	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (secondary to MS-PS1-4)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system.		SP	SP	SP		SP		

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
8		**2**	**Adding Thermal Energy** Students use candles to increase the energy transferred to wax and sugar. They observe that both wax and sugar change from solid to liquid when heated with a candle, and change back to solid when the flame is removed. Students use this experience to extend their understanding of melting and to reinforce the idea that different substances melt and freeze at different temperatures.	2	• Matter exists on Earth in three common states—solid, liquid, and gas. • Change of state is the result of change of energy in the particles in a sample of matter. • During phase change, particles do not change; relationships between particles do change. • The temperatures at which phase changes occur are different for different substances.	**MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4) • Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (secondary to MS-PS1-4)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system.		SP	SP					SP
8		**3**	**Freeze Water** Students think about freezing water. When they discover ice is not cold enough to freeze water, they add different substances to the ice to see how they affect its temperature. Students use this data and their experience designing a thermos to design a "freezer" that will freeze water in the classroom.	3	• Change of state is the result of change of energy in the particles in a sample of matter. • During phase change, particles do not change; relationships between particles do change.	**MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. **MS-PS1-6.** Undertake a design project to consruct, test, and modify a device that either release or absorbs thermal energy by chemical processes. **MS-PS3-4**. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. **MS-ETS1-1**. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2**. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and difference among several design solutions to identify the best characteristics of each that can be combined into a new solutions to better meet the criteria for success. **MS-ETS1-4**. Develop a model to generate data for iterative	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 • The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **ETS1.C: Optimizing the Design Solution (ETS1.B?? too)** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. **Stability and Change** •Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.	SP/EP	SP/EP	SP/EP	SP/EP		SP/EP		

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
8		4	**Changing Phase** Students investigate all three ordinary states of matter, using a condensation apparatus. Hot water releases water vapor, which condenses on the icy cup, and then freezes to solid water. Students develop an explanation of the system, using their particle model.	3	• The Matter exists on Earth in three common states—solid, liquid, and gas. • In gases, particles move independently through space. • Change of state is the result of change of energy in the particles in a sample of matter. • The processes of phase change are evaporation, condensation, melting, freezing, sublimation, and deposition.	**MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. **MS-PS3-4.** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	**PS1.A: Structure and Properties of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4 The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)	**Patterns** • Patterns can be used to identify cause and effect relationships. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system.		SP		SP		SP		
9	Reaction	1	**Substance Models** Students review chemical formulas as symbolic representations for substances and learn that the fundamental building blocks of substances are atoms. Colored adhesive dots, introduced as representations of atoms, are used to construct two-dimensional representations of compounds—molecules and ionic compounds. Chemical bonds are introduced as the attractive forces holding particles together. Students make and analyze representations of particles of familiar substances.	2	• All substances are made from some 100 different types of atoms (elements), which combine with one another in various ways. • A compound is a substance composed of two or more different kinds of elements (kinds of atoms). • Atoms combine to make particles of substances: molecules and ionic compounds. • Molecules and ionic compounds are held together by attractive forces called bonds.	**MS-PS1-1**. Develop models to describe the atomic composition of simple molecules and extended structures.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		SP			SP	SP		SP
9		2	**Limewater Reaction** Students observe no change when atmospheric air is pumped through a sample of limewater. They blow exhaled breath through limewater and observe a milky precipitate. Students use atom tiles to represent of the reactant molecules and rearrange them to make product molecules. They write a balanced chemical equation for the reaction, using standard conventions.	2	• All substances are made from some 100 different types of atoms (elements), which combine with one another in various ways. • A chemical reaction is a process in which the atoms of substances (reactants) rearrange to form new substances (products). • Atoms are neither created nor destroyed during chemical reactions, only rearranged.	**MS-PS1-1**. Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-2**. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-5**. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5) • The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5). Some chemical reactions release energy, others store energy. (MS-PS1-6)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Scale, proportion, and quantity** • Systems and System Models Scientific relationships can be represented through the use of algebraic expressions and equations. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		SP		SP	SP			SP

Inv	Inv Title	Part	Part Summary	Sessions	Content	NGSS Standards Addressed	Disciplinary Core Ideas (Framework)	Crosscutting Concepts	Asking questions (SP) / Defining problems (EP)	Developing and using models	Planning and carrying out investigations	Analyzing and interpreting data	Using mathematics and comp. thinking	Constructing explanations (SP) / Designing solutions (EP)	Engaging in argument from evidence	Obtaining, evaluating, and communicating information
9		3	**Baking Soda and Acid** Students are introduced to hydrochloric acid and think about what might happen if it were mixed with sodium bicarbonate. They observe a demonstration of the reaction and work with atom tiles to determine the products of the reaction. They conduct the reaction, bubbling the gas produced through limewater and evaporating the liquid, to confirm that the gas was carbon dioxide and that sodium chloride was dissolved in the liquid.	4	• All substances are made from some 100 different types of atoms (elements), which combine with one another in various ways. • A chemical reaction is a process in which the atoms of substances (reactants) rearrange to form new substances (products). • Atoms are neither created nor destroyed during chemical reactions, only rearranged.	**MS-PS1-1**. Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-2**. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-5**. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5) • The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5). Some chemical reactions release energy, others store energy. (MS-PS1-6)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		**SP**	**SP**	**SP**	**SP**	**SP**	**SP**	**SP**
10	**Limiting Factors**	1	**Citric Acid and Baking Soda** Students work with baking soda and two citric acid solutions, one twice as concentrated as the other. Using the syringe-and-bottle system, they compare the volumes of gas produced with equal volumes of the two solutions. They discover that the quantity of product is directly related to the reactant that is present in the least quantity, the limiting factor.	2	• The quantities of reactants available at the start of a reaction determine the quantities of products. • The limiting factor is the reactant present in the lowest concentration. • Reactants that remain in their original form after a reaction has run to completion were present in excess. • Atoms are neither created nor destroyed during chemical reactions, only rearranged; matter is conserved.	**MS-PS1-1**. Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-2**. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-5**. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5) • The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5). • Some chemical reactions release energy, others store energy. (MS-PS1-6)	**Scale, proportion, and quantity** • Systems and System Models Scientific relationships can be represented through the use of algebraic expressions and equations. **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems **Stability and Change** •Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.		**SP**	**SP**	**SP**	**SP**	**SP**		
10		2	**Identify Key Ideas** Students look back on the entire Chemical Interactions Course and work individually and in groups to review the big concepts.	2	• Atoms are neither created nor destroyed during chemical reactions, only rearranged; matter is conserved.	**MS-PS1-1**. Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1-2**. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-5**. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.	This is summary so involves all of the DCIs	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems		**SP**				**SP**		**SP**