GRADE	STRAND	SUBSTRAND	STANDARD	CODE	BENCHMARK
K	1. History and Nature of Science	2. The Nature of Engineering	2. Engineers create products or processes based on the needs and wants of society.	0.1.2.2.1	Identify items from everyday life that are engineered or designed. (Examples: cars, playgrounds, buildings and building heating/cooling systems)
K	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There is no one prescribed sequence for the process of inquiry.	0.1.3.2.1	Use tools to observe, measure and make things.
				0.1.3.2.2	Explain how tools can be used to improve observations.
K	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	3. Men and women of all cultures, and across all ages have been involved in engineering design and scientific inquiry.	0.1.4.3.1	Understand that everybody can use science to learn about the natural world, invent things and create ideas.
K	2. Physical Science	2. Motion	1. Motion of an object is described by a change in its position.	0.2.2.1.1	Describe how things near Earth fall to the ground unless something holds them up.
				0.2.2.1.2	Recognize that objects move in a variety of ways, including a straight line, a curve, a circle, back and forth and at different speeds.
				0.2.2.1.3	Demonstrate how push and pull forces can make objects move.
K	2. Physical Science	3. Energy	1. The sun and burning some materials can provide heat.	0.2.3.1.1	Identify the sun as a source of heat and light.
				0.2.3.1.2	Recognize that different kinds of materials can be burned to make heat.
K	2. Physical Science	4. Human Interaction with Physical Systems	1. Some of the things in the world are found in nature and others are made by humans.	0.2.4.1.1	Construct simple structures through the safe and appropriate use of tools and materials. (Examples of tools and materials: glue, scissors, tape, ruler, paper, toothpicks, straws, spools)
K	3. Earth Science	2. Interdependence within the Earth system	2. Weather changes from day to day and over the seasons. Weather can be described by measurable quantities.	0.3.2.2.1.	Monitor daily and seasonal changes in weather and summarize the changes.

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K	4. Life Science	1. Structure and Function of Living Systems	1. Living things are very diverse with many different characteristics that enable them to grow, reproduce and survive.	0.4.1.1.1	Describe how people can use their five senses to learn about living and nonliving things.
				0.4.1.1.2	Compare and contrast living and nonliving things.
K	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many components that interact to maintain success.	0.4.2.1.1	Observe and describe a natural system. (Examples: garden, terrarium, aquarium).
				0.4.2.1.2	Identify living and non living components of a natural system.
K	4. Life Science	4. Human Interactions with Living Systems	1. Humans change environments in ways that can be either good or bad for themselves and other organisms.	0.4.4.1.1	Recognize that people and other animals interact with the environment through their senses of sight, hearing, touch, smell, and taste.
				0.4.4.1.2	Compare and contrast the effects of human actions, including recycling and polluting, on the enviroment.
K	4. Life Science	4. Human Interactions with Living Systems	2. Diseases caused by germs may be spread by people who have them.	0.4.4.2.1	Explain how washing one's hands with soap and water reduces the number of germs that can get into the body or that can be passed on to other people.
1	1. History and Nature of Science	1. The Nature of Science	1. Science involves group interactions, emphasizing evidence and communication.	1.1.1.1.1	Ask, "How do you know?" in situations where others present unsupported information, and attempt to respond with reasonable answers when likewised questioned.
				1.1.1.1.2	Know that describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.
1	1. History and Nature of Science	2. The Nature of Engineering	2. Engineers create products or processes based on the needs and wants of society.	1.1.2.2.1	Understand that tools are simple objects that help humans complete tasks.

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1	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There is no one prescribed sequence for the process of inquiry.	1.1.3.1.1	Raise questions about the natural world and seek answers to some of them by making careful observations and doing something to an object and noting what happens.
				1.1.3.1.2	Describe and compare things in terms of number, shape, texture, size, weight, color and motion.
				1.1.3.1.3	Correctly portray the major features of an object or phenomenon with words or pictures.
1	2. Physical Science	1. Matter	1. Objects can be described in terms of the materials they are made of and their physical properties (attributes).	1.2.1.1.1	Describe objects in terms of color, size, shape, weight, texture, flexibility, strength, and hardness.
				1.2.1.1.2	Sort and classify objects in terms of color, size, and shape.
1	2. Physical Science	4. Human Interaction with Physical Systems	1. Some of the things in the world are found in nature and others are made by humans.	1.2.4.1.1	Distinguish between things found in nature and things made by people.
				1.2.4.1.2	Describe things that can be used over and over again, and some that can only be used once.
1	3. Earth Science	3. The Universe	2. The sun, moon, and stars all have locations and movements that can be observed and described.	1.3.3.2.1.	Observe and describe the changes in the position of the sun.
				1.3.3.2.2	Recognize that there is a repeating pattern in the apparent changes in the shape of the moon over time.
				1.3.3.2.3	Observe the night sky and recognize that there are more stars than anyone can easily count, they are unevenly scattered and are different in brightness and color.
1	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many components that interact to maintain success.	1.4.2.1.1	Recognize that living things need space, water, food and air.
				1.4.2.1.2	Determine ways in which an organism's habitat provides for its basic needs. (Examples: Plants require air, water, nutrients, and light. Animals require food, water, air, and shelter.)

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1	4. Life Science	3. Variation and Change in Living Systems	1. Plants and animals do not look the same throughout their life. An organism's life cycle can be described.	1.4.3.1.1	Understand that plants and animals have life cycles that include a beginning, developing into adults, reproducing, and eventually dying.
				1.4.3.1.2	Recognize that in all stages of their life cycles, plants and animals closely resemble their parents.
2	1. History and Nature of Science	1. The Nature of Science	2. Scientific knowledge is based on systematic observation and investigation of the natural world.	2.1.1.2.1	Understand that when a science investigation is done the way it was done before, a very similar result is expected.
				2.1.1.2.2	Understand that when a science investigation is done again in a different place, we expect to get a very similar result.
2	1. History and Nature of Science	2. The Nature of Engineering	1. Engineering involves group interactions to address problems in light of design constraints.	2.1.2.1.1	Describe why some materials are better than others for making a particular object and how materials that are better in some ways may be worse in other ways.
2	1. History and Nature of Science	2. The Nature of Engineering	2. Engineers create products or processes based on the needs and wants of society.	2.1.2.2.1	Explain how engineered or designed items from everyday life benefit people.
2	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There is no one prescribed sequence for the process of inquiry.	2.1.3.1.1	Use observations to develop an accurate description of a natural phenomenon and compare one's observations and descriptions with those of others.
2	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	2. Engineering design is the process of identifying problems and devising a product or solution.	2.1.3.2.1	Brainstorm everyday needs and wants and identify problems that can be solved through design.
				2.1.3.2.2	Based on an identified need, build or construct an object that helps accomplish a task.
				2.1.3.2.3	Investigate how an object is constructed by taking it apart and suggest how it can be improved.

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2	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	1. People invent solutions to solve problems.	2.1.4.1.1	Understand that people alone or in groups are always inventing new ways to solve problems and accomplish work.
2	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	2. Designed, and natural systems exist in the world. These systems are made up of components that act within a system and interact with other systems.	2.1.4.2.1	Describe a system in terms of its parts.
				2.1.4.2.2	Recognize that systems may not continue to function if some of the parts are broken or missing.
				2.1.4.2.3	Recognize that when the parts of a system are put together, they can do things that they couldn't do by themselves.
2	2. Physical Science	1. Matter	1. Objects can be described in terms of the materials they are made of and their physical properties (attributes).	2.2.1.1.1	Describe how parts are used to make up a whole object.
				2.2.1.1.1	Justify the value of certain materials and tools as better than others depending on their use.
2	2. Physical Science	1. Matter	2. Things can be done to materials to change some of their properties, but not all materials respond the same way to what is done to them.	2.2.1.2.1	Distinguish between solids that have a definite shape and liquids that take the shape of their container.
				2.2.1.2.2	Observe that water can be a solid or liquid and can change from one state to the other.
				2.2.1.2.3	Describe how some substances can dissolve in water and some cannot.
2	4. Life Science	1. Structure and Function of Living Systems	1. Living things are very diverse with many different characteristics that enable them to grow, reproduce and survive.	2.4.1.1.1	Describe the behaviors and characteristics of plants and animals at different stages of their life cycle.
				2.4.1.1.2	Describe and sort plants and animals into groups in many ways according to their physical characteristics and behaviors.

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2	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many components that interact to maintain success.	2.4.2.1.1	Predict what would happen to a natural system (such as a garden, terrarium or an aquarium) if any of the components were broken or missing.
3	1. History and Nature of Science	1. The Nature of Science	1. Scientists work as individuals and in groups; emphasizing evidence, open communication and skepticism.	3.1.1.1.1	Understand that one's prior knowledge and experience sometimes influences observations that are made.
				3.1.1.1.2	Provide better reasons for believing something other than "Everyone knows that," or "I just know," and discount such reasons when given by others.
3	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There is no one prescribed sequence for the process of inquiry	3.1.3.1.1	Ask a question that can be answered with scientific knowledge combined with one's own observations or experiments.
				3.1.3.1.2	Use tools to improve observations, and keep a record that describes the observations made. (Examples of tools: scales, thermometers, microscopes, balances, spring scales)
3	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	3. Men and women of all cultures, including Minnesota American Indian tribes and communities, and across all ages have been involved in engineering design and scientific inquiry.	3.1.4.3.1	Identify people who are engineers and scientists.
3	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	2. Designed and natural systems exist in the world. These systems are made up of components that act within a system and interact with other systems.	3.1.4.2.1	Distinguish between systems found in nature and those made by humans.

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3	2. Physical Science	1. Matter	1. Objects have many observable properties that can be measured and these properties can be used to identify them, sort them or select them for different uses.	3.2.1.1.1	Sort and classify objects using properties of matter, including weight, volume, temperature, color, shape, flexibility, durability, resistance to water or fire, and ease of conducting heat.
				3.2.1.1.2	Use appropriate tools to measure temperature, volume, weight and length.
				3.2.1.1.3	Describe how properties of matter make materials more or less suitable for certain applications.
3	2. Physical Science	1. Matter	2. Heating and cooling cause changes in the properties of materials.	3.2.1.2.1	Describe how materials can exist in different states, solid, liquid or vapor (gas).
				3.2.1.2.2	Observe that heating and cooling can cause changes in state.
3	2. Physical Science	1. Matter	3. Many objects are made of more than one material. The materials are selected and combined to work together for a purpose.	3.2.1.3.1	Recognize that no matter how parts of an object are assembled, the weight of the whole object made is always the same as the sum of the parts.
				3.2.1.3.2	Analyze objects in terms of the types of materials in the object (for example metals, wood, plastics) and explain how the combination helps the object to be useful.
3	2. Physical Science	2. Motion	2. Sound is produced by vibrating objects.	3.2.2.2.1	Describe that sound travels away from a source in waves.
				3.2.2.2.2	Explain the relationship between the pitch of a sound and the rate of vibration of the source.
				3.2.2.2.3	Explain how different factors in the source affect the loudness of a sound.
3	2. Physical Science	3. Energy	3. Heat, light and electricity are forms of energy.	3.2.3.3.1	Demonstrate how light energy travels in a straight line until it is absorbed, bent or reflected by an object.
3	3. Earth Science	2. Interdependence within the Earth system	2. Weather changes from day to day and over the seasons, and can be described by measurable quantities, including temperature, wind direction and speed, and precipitation.	3.3.2.2.1.	Measure, record, and describe weather conditions using common instruments, including thermometer and rain gauge.

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				3.3.2.2.2.	Correlate various cloud types, including cumulus, cirrus and stratus with different weather conditions.
3	3. Earth Science	4. Human Interaction with Earth Systems	4. Scientists use models represent and communicate to others information about the Eath System .	3.3.4.4.1.	Use a map key to interpret symbols for different kinds of weather maps used by meteorologists.
3	4. Life Science	4. Human Interactions with Living Systems	2. If germs are able to get inside one's body, they may keep if from working properly.	3.4.4.2.1	Recognize that for defense against germs, the human body has tears, saliva, skin, some blood cells, and stomach secretions.
				3.4.4.2.2	Recognize that there are many diseases that can be prevented by vaccination, so that people don't ever catch them.
4	1. History and Nature of Science	1. The Nature of Science	1. Scientists work as individuals and in groups; emphasizing evidence, open communication and skepticism.	4.1.1.1.1	Understand that clear communication is an essential part of doing science.
4	1. History and Nature of Science	1. The Nature of Science	2. Scientific knowledge describes and explains the natural world based on careful observation and analysis.	4.1.1.2.1	Understand that sometimes similar investigations give different results because of differences in the things being investigated, the methods used, or the circumstances in which the investigation is carried out, and sometimes just because of uncertainties in observations. It is not always easy to tell which.
				4.1.1.2.2	Understand that because we expect science investigations that are done the same way to produce the same results, when they do not, it is important to try to figure out why.
4	1. History and Nature of Science	2. The Nature of Engineering	2. Engineers create, develop, and manufacture machines, structures, processes, and systems, (e.g., technologies) that improve society and may make humans more productive.	4.1.2.2.1	Describe the impact that the designed world has on the natural world as more and more engineered products and services are implemented.

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				4.1.2.2.2	Understand that a technology that helps some people or organisms may hurt others or a solution to one problem may create others.
4	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Inquiry is a set of interrelated processes used to investigate phenomena and pose questions about the natural and engineered world. There is no one prescribed sequence for the process of inquiry.	4.1.3.1.1	Design a fair test (simple investigation with controls).
				4.1.3.1.2	Make detailed notes in order to maintain a complete record of observations.
				4.1.3.1.3	Distinguish actual observations from ideas and speculations about what was observed.
4	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	2. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	4.1.3.2.1	Use data to construct reasonable explanations.
4	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	3. Engineering design is the process of identifying problems, developing multiple solutions and selecting the best possible solution, and building the product.	4.1.3.3.1	Identify and collect information about everyday problems that can be solved by engineering, and generate ideas and requirements for solving a problem.
				4.1.3.3.2	Present some possible solutions in visual form and then select the best solution.
				4.1.3.3.3	Test and evaluate solutions for the designed problem.
				4.1.3.3.4	Improve the designed solutions.
4	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	1. Technology shapes society and is shaped by it.	4.1.4.1.1	Understand that technology is an intrinsic part of human cultures and that the technology that is available to people greatly influences their lives.
				4.1.4.1.2	Recognize that invention is likely to lead to other inventions. Once an invention exists, people are likely to think of ways to use it that were never imagined at first.

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4	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	2. Designed and natural systems exist in the world. These systems are made up of components that act within a system and interact with other systems.	4.1.4.2.1	Recognize that the parts of a system influence one another.
				4.1.4.2.2	Describe a system in terms of inputs and outputs.
4	2. Physical Science	3. Energy	3. Heat, light and electricity are forms of energy.	4.2.3.3.1	Construct a simple electrical circuit using components such as wires, batteries, and bulbs.
				4.2.3.3.2	Identify objects and materials that conduct electricity and those that are insulators.
				4.2.3.3.3	Demonstrate how an electric current can produce a magnetic force.
				4.2.3.3.4	Demonstrate how electricity produces heat in resistive wires such as light bulbs and heaters.
4	3. Earth Science	2. Interdependence within the Earth system	3. Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle.	4.3.2.3.1.	Describe how water changes state as it cycles through the Earth system through the processes of evaporation, condensation, precipitation.
				4.3.2.3.2.	Identify where water exists on Earth, including atmosphere, ground water and at Earth's surface.
4	3. Earth Science	3. The Universe	1. The universe consists of countless more objects than we can see naturally and appear to be points of light and patterns of motion.	4.3.3.1.1.	Relate the Earth's rotation and revolution to day, night, seasons and the year.
				4.3.3.1.2.	Relate the Earth's rotation to the apparent movement of the stars in the sky from east to west.
				4.3.3.1.3.	Recognize that a large light source at a great distance looks like a small light that is much closer and that the sun is a star which looks big because it is close to the Earth.
				4.3.3.1.4.	Recognize that the Earth is one of several planets that orbit the sun and the moon orbits around the Earth.
				4.3.3.1.5.	Recognize that telescopes help us to see distant objects in the sky and dramatically increase the number of stars we can see.

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4	3. Earth Science	4. Human Interaction with Earth Systems	4. Scientists use models represent and communicate to others information about the Earth System .	4.3.4.4.2.	Use a map key to interpret symbols for different kinds of maps used by earth scientists, including lakes and rivers, elevation, and other Minnesota landforms.
				4.3.4.4.3.	Make a map of where the student lives showing natural and human made features.
4	4. Life Science	3. Variation and Change in Living Systems	1. While offspring are generally similar to their parents, they have variations that can be advantageous or disadvantageous in a particular environment.	4.4.3.1.1	Give examples of likenesses between children and parents that are can be inherited and learned.
				4.4.3.1.2	Give examples of differences between individuals that can sometimes give an individual an advantage in surviving and reproducing.
				4.4.3.1.3	Recognize that offspring are similar to but can have distinct characteristics from their parents.
				4.4.3.1.4	Compare the life cycles of a variety of plants and animals.
5	1. History and Nature of Science	1. The Nature of Science	2. Scientific knowledge describes and explains the natural world based on careful observation and analysis.	5.1.1.2.1	Understand that sometimes scientists have different explanations for the same observations. That usually leads to making more observations to try to resolve the differences**.**
				5.1.1.2.2	Understand that scientific investigations may take many different forms based on the type of question asked, including observing what things are like, or what is happening somewhere, collecting specimens for analysis and doing experiments or examining pre-existing data.
5	1. History and Nature of Science	2. The Nature of Engineering	1. Engineers work as individuals and in groups to develop and recognize alternative solutions.	5.1.2.1.1	Understand that the design process is a purposeful method of planning practical solutions to problems.
				5.1.2.1.2	Understand that requirements for a design include such factors as the desired element and features of a product or system or the constraints that are placed on the design.

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				5.1.2.1.3	Analyze the benefits and drawbacks of alternative solutions.
				5.1.2.1.4	Identify factors such as cost, safety, appearance, culture, environmental impact, and what will happen if the solution fails, that must be considered in technological design.
5	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	2. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	5.1.3.2.1	Support one's statements with facts found in books, articles, and data bases, and identify the sources used.
				5.1.3.2.2	Share, critique and analyze one's own observations and speculations and those of classmates.
5	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	3. Men and women of all cultures, including Minnesota American Indian tribes and communities, and across all ages have been involved in engineering design and scientific inquiry.	5.1.4.3.1	Describe how science and engineering both influence and are affected by local traditions and beliefs.
				5.1.4.3.2	Recognize that science and engineering involve many different kinds of work and engage men and women of all ages and backgrounds.
5	2. Physical Science	1. Matter	2. Heating and cooling cause changes in the properties of materials.	5.2.1.2.1	Compare and contrast the mass, shape, compressibility, and volume of solids, liquids and gases.
5	2. Physical Science	2. Motion	1. Changes in speed or direction are caused by forces.	5.2.2.1.1	Demonstrate that the greater the force applied, the greater the change in motion.
				5.2.2.1.2	Describe how simple machines are used to control forces to accomplish tasks.
5	2. Physical Science	3. Energy	3. Heat, light and electricity are forms of energy.	5.2.3.3.1	Explain what happens when a warm and a cool object are touching or placed near each other.
5	2. Physical Science	4. Human Interaction with Physical Systems	1. Humans have used ideas from the natural world to create tools and machines that can be used doing a task.	5.2.4.1.1	Give examples of tools and machines that humans have invented that mimic things in nature.
				5.2.4.1.2	Give examples of simple machines (lever, pulley, inclined plane) used in everyday life.
				5.2.4.1.3	Describe how simple machines change the input and output forces and distances.

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5	2. Physical Science	4. Human Interaction with Physical Systems	2. The use of an object is determined by its design and the properties of its materials.	5.2.4.2.1	Explain how tools used for holding, lifting and carrying differ from one another.
				5.2.4.2.2	Describe the different ways of fastening or separating things, and how to select the best way for a given situation.
				5.2.4.2.3	Describe the properties of materials that would have to be considered in making parts of different types of objects such as roads, cars, or houses.
				5.2.4.2.4	Explain how the design or structure of materials can be changed to make materials more useful for different applications.
5	3. Earth Science	1. Earth Structure and Processes	2. The surface of the Earth changes. Some changes are due to slow processes, and some changes are due to rapid processes.	5.3.1.2.1	Recognize the natural processes that cause rocks to break down into smaller pieces and eventually into soil, including erosion and weathering.
				5.3.1.2.2	Compare slow processes including erosion and weathering, with rapid processes including landslides, volcanic eruptions, and earthquakes.
5	3. Earth Science	1. Earth Structure and Processes	3. There are different kinds of rocks.	5.3.1.3.1.	Observe that rocks may be uniform or made of mixtures of different minerals, which are often different colors.
				5.3.1.3.2.	Classify rocks based on criteria the student has observed.
5	3. Earth Science	4. Human Interaction with Earth Systems	1. Human systems gather resources from the living and nonliving environment to meet the needs and wants of a population. Some resources are scarcer than others, some are renewable, and some are nonrenewable.	5.3.4.1.1.	Categorize energy resources and material resources into renewable and non-renewable.
				5.3.4.1.2.	Identify natural resources that are found in Minnesota. For example, iron ore, granite quarries, sand and gravel, wind, forests.
				5.3.4.1.3.	Give examples of how mineral and energy resources are obtained and processed to be used by human systems. For example, extraction of iron for steel, oil or coal for energy.

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				5.3.4.1.4.	Recognize naturally occurring materials may be processed and changed to modify their properties into more useful products.
5	3. Earth Science	4. Human Interaction with Earth Systems	3. Humans can influence changes in the environment.	5.3.4.3.1.	Describe the impact of individual decisions on environmental systems. For example, choosing paper or plastic bags impacts landfills as well as ocean life cycles.
5	4. Life Science	1. Structure and Function of Living Systems	1. All plants and animals have a definite life cycle, body parts, and systems to perform specific life functions.	5.4.1.1.1	Recognize that plants and animals are composed of different structures that serve various functions for growth, survival and reproduction.
				5.4.1.1.2	Describe the structures in plants and animals that serve different functions in growth, survival and reproduction at different times in their life cycle.
				5.4.1.1.3	Use a simple key to identify common plants and animals using observable physical characteristics, structures, and behaviors.
5	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many components that interact to maintain success.	5.4.2.1.1	Describe a natural system (such as a garden, terrarium, or an aquarium) in terms of the relationships among its components (living and nonliving), as well as inputs and outputs.
				5.4.2.2.2	Recognize a variety of natural systems in Minnesota.
				5.4.2.2.3	Explain what would happen to a system such as a garden, terrarium, or an aquarium if one of the components were changed.
5	4. Life Science	4. Human Interactions with Living Systems	1. Humans change environments in ways that can be either beneficial or harmful for themselves and other organisms.	5.4.4.1.1	Describe a system such as a garden, terrarium, or an aquarium in terms of the components (living and nonliving), as well as inputs and outputs that are influenced by humans.
				5.4.4.1.2	Give examples of human interaction with natural systems that are beneficial and harmful.

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6	1. History and Nature of Science	1. The Nature of Science	1. Science is a complex social enterprise in which individuals share common beliefs and values, all of which may be influenced by personal experience and cultural perspective.	6.1.1.1.1	Recognize the importance of accurate record keeping, openness to scrutiny, and replication in building scientific knowledge.
				6.1.1.1.2	Understand that no matter who does science and mathematics or when or where they do it, the resulting knowledge eventually becomes available to everyone in the world.
6	1. History and Nature of Science	1. The Nature of Science	2. Scientific knowledge builds from careful systematic study of the natural world in order to identify basic rules and patterns that apply to the universe.	6.1.1.2.1	Understand that different models can be used to represent the same thing.
				6.1.1.2.2	Understand that different explanations can be given for the same evidence. It is not always possible to tell which one is correct.
6	1. History and Nature of Science	2. The Nature of Engineering	1. Engineers create, develop, and manufacture machines, structures, processes, and systems, (e.g., technologies) that impact society and may make humans more productive.	6.1.2.1.1	Identify a common engineered system and evaluate it's impact on the daily life of humans, the local environment, and wildlife habitat.
				6.1.2.1.2	Recognize that new technologies have side effects that may increase some risks and decrease others.
				6.1.2.1.3	Recognize that there is no perfect design.
6	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Scientific Inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There is no one prescribed sequence for the process of inquiry.	6.1.3.1.1	Refine and refocus broad and ill-defined questions.
				6.1.3.1.2	Generate questions about objects and phenomena that can be described, explained, or predicted by scientific investigations.
				6.1.3.1.3	Relate one's questions to scientific ideas, concepts, and quantitative relationships that guide investigations.

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				6.1.3.1.4	Identify and collect relevant evidence, make systematic observations and accurate measurements, and identify and control variables in a scientific investigation.
				6.1.3.1.5	Use appropriate tools (including computers) and techniques (including mathematics and graphing) in gathering, analyzing and interpreting data.
				6.1.3.1.6	Provide detailed accounts of scientific procedures and explanations for one's own work and that of others.
6	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	2. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	6.1.3.2.1	Recognize and analyze alternative explanations and predictions.
6	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	3. Engineering design is the process of devising a product or solution to meet a desired need or solve a specific problem.	6.1.3.3.1	Apply an engineering design process to solve problems in and beyond the classroom.
				6.1.3.3.2	Specify criteria and constraints for the design.
				6.1.3.3.3	Make two- and three- dimensional representations of the design solutions.
				6.1.3.3.4	Test and evaluate the design according to pre-established requirements such as criteria and constraints and refine the design as needed.
				6.1.3.3.5	Construct a product or system and document the solution.
6	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	2. Designed and natural systems exist in the world. These systems are made up of components that act within a system and interact with other systems.	6.1.4.2.1	Describe a system in terms of parts and processes, subsystems, inputs and outputs.
6	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	3. Men and women of all cultures and across all ages have been involved in engineering design and scientific inquiry.	6.1.4.3.1	Recognize that important contributions to the advancement of science, mathematics and technology have been made by different kinds of people and different cultures at different times.

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6	2. Physical Science	1. Matter	3. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass of the system.	6.2.1.3.1	Differentiate between chemical and physical changes in matter.
				6.2.1.3.2	Identify evidence of chemical change through color, gas formation, solid formation, production of light and/or sound, and temperature change.
6	2. Physical Science	2. Motion	1. Changes in the motion of objects result from or can cause the transfer or transformation of energy.	6.2.2.1.1	Describe the energy in a moving object and compare the kinetic and potential energy in an object that is changing height.
				6.2.2.1.2	Describe how electricity, heat and chemical energy can be changed into motion energy and how motion energy can be changed into other forms.
6	2. Physical Science	3. Energy	1. Energy exists in many forms and can be transferred and transformed.	6.2.3.1.1	Trace the changes of energy forms, including heat, mechanical, chemical, electrical and nuclear, as it is used for transportation, lighting or other purposes.
				6.2.3.1.2	Describe the application of electric and magnetic forces in devices such as electromagnets, motors and loudspeakers.
6	2. Physical Science	3. Energy	2. Many of the properties of visible light are explained in terms of waves.	6.2.3.2.1	Describe the wave properties of light, including speed, wavelength and frequency and compare them to sound waves.
				6.2.3.2.2	Use wave properties of light to explain reflection, refraction, absorbance and the color spectrum.
				6.2.3.2.3	Apply wave properties of light to describe phenomena such as mirrors, lenses, rainbows, light sources and the color of objects.
6	2. Physical Science	4. Human Interaction with Physical Systems	1. People design and use machines and systems to use matter and energy to build societies.	6.2.4.1.1	Compare the advantages and disadvantages of generating electricity using various sources or energy, such as fossil fuels, nuclear fission, wind, sun or tidal energy.

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				6.2.4.1.2	Explain how power and transportation management systems can be used to minimize costs and environmental impact.
				6.2.4.1.3	Describe emerging strategies to minimize waste produced in industrial and home activities.
				6.2.4.1.4	Describe how the invention and use of electrical devices has affected society.
6	3. Earth Science	1. Earth Structure and Processes	1. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from the movement of lithospheric plates.	6.3.1.1.1	Identify patterns in the global distribution of both volcanoes and earthquakes.
6	3. Earth Science	1. Earth Structure and Processes	2. Landforms are the result of the combination of constructive and destructive processes. Constructive processes include crustal deformation, volcanic eruptions, and deposition of sediment. Destructive processes include weathering and erosion.	6.3.1.2.1.	Describe the constructive and destructive impacts of earthquakes and volcanoes on the Earth.
				6.3.1.2.2.	Describe how waves, wind, water and ice shape and reshape the Earth's surface.
				6.3.1.2.3.	Compare and contrast the deposition of sediments in river beds, river deltas, and on the continental shelf.
6	3. Earth Science	2. Interdependence within the Earth system	1. The sun is the primary source of energy for the Earth's surface.	6.3.2.1.1.	Recognize that energy is transferred from the sun through the vacuum of space by radiation.
6	3. Earth Science	2. Interdependence within the Earth system	2. Transfer of heat energy at the boundaries between the atmosphere, the landmasses, and the oceans result in distinctive weather patterns.	6.3.2.2.1.	Describe local weather patterns associated with fronts and pressure systems, such as the changes in wind direction, temperature, humidity, and air pressure as a storm approaches and passes through.
				6.3.2.2.2.	Collect and use data to predict the weather.
				6.3.2.2.3.	Identify the composition of the atmosphere.

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6	3. Earth Science	3. The Universe	2. The earth is the third planet from the sun in a system that includes the moon, the sun, seven other planets and their moons, and smaller objects.	6.3.3.2.1.	Recognize that the sun is the principal energy source for the solar system and that this energy is transferred in the form of radiation, and the amount of energy received diminishes greatly as distance from the sun increases.
				6.3.3.2.2.	Compare and contrast the planets and the moons of our solar system in terms of their size, location and composition.
				6.3.3.2.3.	Describe the composition, structure, and motion of the small bodies in the solar system.
6	3. Earth Science	4. Human Interactions with Earth Systems	2. The output from a human or natural system can become the input to other parts of larger or smaller human and natural systems.	6.3.4.2.1.	Recognize that land use practices in specific areas affect natural processes. (Examples: 1. Levees to protect development on flood plains change the natural flooding process of a river. 2. Agricultural runoff joins the water cycle and influences natural systems far from the source, such as the Mississippi river delta dead zone.)
6	3. Earth Science	4. Human Interactions with Earth Systems	4. Humans have developed models to understand and communicate how the Earth system functions.	6.3.4.4.1.	Interpret patterns in data displayed on maps or satellite images. Examples include but are not limited to locations of volcanoes and earthquakes, ages of the seafloor, ocean surface temperatures, and ozone concentration in the stratosphere.
				6.3.4.4.3.	Understand that maps are models that are made to scale, and have some kind of distortion depending upon the kinds of projections used.
6	4. Life Science	2. Interdependence of Living Systems	1. Organisms are components of natural systems that interact with one another in several ways.	6.4.2.1.1	Identify a variety of populations and communities in an ecosystem and describe the relationships among the populations and communities in establishing a stable ecosystem.
				6.4.2.1.2	Compare and contrast predator/prey, parasite/host and producer/consumer/decomposer relationships.
				6.4.2.1.3	Explain that the number of populations an ecosystem can support depends on the biotic resources available and abiotic factors such as amount of light and water, temperature range and soil composition.

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6	4. Life Science	2. Interdependence of Living Systems	2. The flow of energy and the recycling of matter are essential to a stable ecosystem.	6.4.2.2.1	Recognize that producers (plants and some microorganisms) use the energy from sunlight to make sugars from carbon dioxide and water through a process called photosynthesis. This food can be used immediately, stored for later use, or used by other organisms.
				6.4.2.2.2	Recognize that consumers, including humans, eat and break down plant structures to produce the materials and energy they need to survive.
				6.4.2.2.3	Explain how dead organisms are broken down by decomposers (mainly bacteria and fungi) and how this process contributes to the ecosystem as a whole.
				6.4.2.2.4	Describe the roles and relationships among producers, consumers, and decomposers in changing energy from one form to another in a food web.
				6.4.2.2.5	Explain that the total amount of matter in an ecosystem remains the same as it is transferred between organisms and their physical environment even though its form and location change.
6	4. Life Science	4. Human Interactions with Living Systems	1. All organisms cause changes in the environments in which they live.	6.4.4.1.1	Provide examples of potentially irreversible effects of human activity on ecosystems.
				6.4.4.1.2	Describe ways that humans impact natural systems, such as farming, medicine, conservation.
7	1. History and Nature of Science	1. The Nature of Science	1. Science is a complex social enterprise in which individuals share common beliefs and values, all of which may be influenced by personal experience and cultural perspective.	7.1.1.1.1	Understand that prior expectations may create bias when conducting scientific investigations.

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7	1. History and Nature of Science	1. The Nature of Science	2. Scientific knowledge builds from careful systematic study of the natural world in order to identify basic rules and patterns that apply to the universe.	7.1.1.2.1	Understand that when similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant, and it often takes further studies to decide.
7	1. History and Nature of Science	2. The Nature of Engineering	1. Engineers create, develop, and manufacture machines, structures, processes, and systems, (e.g., technologies) that impact society and may make humans more productive.	7.1.2.1.1	Compare consumer products in terms of features, performance, durability and cost, and reasonable personal tradeoffs among them.
				7.1.2.1.2	Explain the importance of learning from past failures, such as bridges collapsing or ships sinking, in order to inform the future designs of similar products or systems.
7	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Scientific Inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There is no one prescribed sequence for the process of inquiry.	7.1.3.1.1	Generate a variety of scientific questions and match them with appropriate methods of investigation. (Examples: observational, experimental, reviewing existing work, making models)
7	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	7.1.3.2.1	Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, and pointing out statements that go beyond the evidence; and suggest alternative explanations.
7	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	1. Technology and science cannot always provide successful solutions for problems or fulfill every human need.	7.1.4.1.1	Recognize that societies influence what aspects of technology are developed and how they are used. People control technology, as well as science, and are responsible for its effects.
				7.1.4.1.2	Understand that technologies have dramatically changed how people live and work and have resulted in rapid increases in the human population.

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7	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	2. Designed and natural systems exist in the world. These systems are made up of components that act within a system and interact with other systems.	7.1.4.2.1	Distinguish between open and closed systems.
7	2. Physical Science	1. Matter	1. The effect of heat on matter can be explained by the idea that matter is made of small particles, which are in constant motion.	7.2.1.1.1	Provide evidence that matter is made of small particles that are always in motion, and how the state of matter depends on this motion.
				7.2.1.1.2	Explain melting, freezing, boiling, evaporation, in terms of particle motion and heat.
				7.2.1.1.3	Explain expansion and contraction of matter in terms of particle motion and heat.
7	2. Physical Science	1. Matter	2. Substances have characteristic properties that can be used to distinguish and separate them from other substances.	7.2.1.2.1	Use characteristic properties (including density, melting point, boiling point, chemical reactivity, and solubility) to identify substances and separate them from a mixture.
7	2. Physical Science	3. Energy	1. Energy exists in many forms and can be transferred and transformed.	7.2.3.1.1	Describe how heat energy is transferred through particle motion and electromagnetic waves in conduction, convection and radiation.
7	3. Earth Science	1. Earth Structure and Processes	1. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from the movement of lithospheric plates.	7.3.1.1.1	Use global topographic maps to evaluate distribution of ocean trenches, mid-ocean ridges, and mountain ranges relative to volcanic and seismic activity.
7	3. Earth Science	1. Earth Structure and Processes	2. Landforms are the result of the combination of constructive and destructive processes. Constructive processes include crustal deformation, volcanic eruptions, and deposition of sediment. Destructive processes include weathering and erosion.	7.3.1.2.1	Describe the role of glacial activity in Minnesota's past and compare Minnesota's landscape with nonglaciated areas.

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7	3. Earth Science	4. Human Interactions with Earth Systems	1. Humans need natural resources to maintain and improve their existence, however, the Earth does not have infinite resources. The supply of many of these resources is limited, but can be extended through decreased use and recycling.	7.3.4.1.1.	Describe examples of land use, and recognize that there may be multiple uses for a single area; land uses may include agriculture, residential/commercial development, recreation, or preservation.
				7.3.4.1.3.	Investigate how usage rates and conservation efforts affect the availability of a resource.
				7.3.4.1.3.	Describe how many mineral and fossil fuel resources have formed over millions of years, and explain why these resources are finite and nonrenewable over human time frames.
7	4. Life Science	1. Structure and Function of Living Systems	1. All organisms are composed of cells that carry on the many functions needed to sustain life.	7.4.1.1.1	Recognize that cells are small, were discovered by Leeuwenhoek with a simple microscope, and that all living things consist of one or more cells.
				7.4.1.1.2	Recognize that about two thirds of the weight of cells is accounted for by water, and that cells need food, water, air, and a way to dispose of waste.
				7.4.1.1.3	Recognize that cells repeatedly divide to make more cells for growth and repair.
				7.4.1.1.4	Use the presence of the cell wall, a central vacuole and chloroplasts to distinguish between plant and animal cells.
7	4. Life Science	1. Structure and Function of Living Systems	2. Tissues, organs and organ systems are composed of cells and function to serve the needs of all cells for food, air, and waste removal.	7.4.1.2.1	Recognize that cells carry out life functions such as extracting energy from food or getting rid of waste are carried out in a similar way in all organisms.
				7.4.1.2.2	Recognize that all cells do not look alike and that specialized cells in multicellular organisms perform specialized functions and are organized into tissues and organs.
				7.4.1.2.3	Describe how tissues and organs have a distinct structure and a set of functions that serve the organism as a whole.

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				7.4.1.2.4	Recognize how the respiratory, circulatory, digestive, reproductive, excretory (including urinary and skin), muscular and skeletal systems interact to serve the needs of cells in the human organism.
8	1. History and Nature of Science	1. The Nature of Science	1. Science is a complex social enterprise in which individuals share common beliefs and values, all of which may be influenced by personal experience and cultural perspective.	8.1.1.1.1	Notice and criticize the reasoning in arguments in which fact and opinion are intermingled or conclusions do not follow logically from the evidence given.
8	1. History and Nature of Science	1. The Nature of Science	2. Scientific knowledge builds from careful systematic study of the natural world in order to identify basic rules and patterns that apply to the universe.	8.1.1.2.1	Understand that scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.
8	1. History and Nature of Science	2. The Nature of Engineering	1. Engineers create, develop, and manufacture machines, structures, processes, and systems, (e.g., technologies) that impact society and may make humans more productive.	8.1.2.1.1	Explain how scientific laws, engineering principles, properties of materials and construction techniques must be taken into account in designing engineering solutions.
				8.1.2.1.2	Recognize that design usually requires taking constraints into account. Some constraints, such as gravity or the properties to be used, are unavoidable. Others, including economic, political, social, ethical, and aesthetic constraints, limit choices.
8	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Scientific Inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There is no one prescribed sequence for the process of inquiry.	8.1.3.1.1	Use logical reasoning and imagination to develop descriptions, explanations, predictions, and models based on evidence, and differentiate between explanation and description.

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8	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	1. Technology and science cannot always provide successful solutions to all problems or fulfill all human needs.	8.1.4.1.1	Understand that science can sometimes be used to inform ethical decisions by identifying the likely consequences of particular actions, but science cannot be used to establish whether an action is immoral or moral.
8	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	2. Designed and natural systems exist in the world. These systems are made up of components that act within a system and interact with other systems.	8.1.4.2.1	Describe how the output of a system can be an input to another system.
8	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	3. Men and women of all cultures, including Minnesota American Indian tribes and communities, and across all ages have been involved in engineering design and scientific inquiry.	8.1.4.3.1	Recognize that the relatively recent lifting of restrictions on education and employment opportunities for women and racial minorities has restulted in greater participation and contributions in science and engineering.
8	2. Physical Science	1. Matter	2. Substances have characteristic properties that can be used to distinguish and separate them from other substances.	8.2.1.2.1	Compare mixtures, elements, and compounds, in terms of atoms and molecules.
8	2. Physical Science	1. Matter	3. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass of the system.	8.2.1.3.1	Recognize that in a chemical reaction, the properties of the products are different from the properties of the reactants, although the mass remains the same.
8	2. Physical Science	2. Motion	1. The motion of an object is determined by forces acting on it and can be described in terms of position, direction and speed.	8.2.2.1.1	Measure, calculate and graph the position and speed versus time for an object traveling in a straight line.
8	2. Physical Science	2. Motion	2. Changes in the motion of objects result from or can cause the transfer or transformation of energy.	8.2.2.2.1	Explain how energy can be transferred by the vibration of particles in waves, including sound and earthquake waves.

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				8.2.2.2.2	Analyze how unbalanced forces on an object affect its speed and/or direction of motion.
				8.2.2.2.3	Explain how gravity affects the weight of an object and how gravity affects the motion of objects, including planets.
8	3. Earth Science	1. Earth Structure and Processes	3. Rocks are the evidence of changes that have happened in the past. There are different kinds of rocks and their composition and textures provide evidence for how they formed.	8.3.1.3.1.	Describe the various processes and interactions of the rock cycle, including but not limited to erosion, deposition, crystallization, and metamorphism.
				8.3.1.3.2.	Interpret successive layers of sedimentary rocks and their fossils to infer relative ages of rock sequences and past events.
				8.3.1.3.3.	Recognize that constructive and destructive Earth processes can affect the evidence of Earth's history.
				8.3.1.3.4.	Classify and identify rocks and minerals using characteristics including but not limited to density, hardness and streak (for minerals) and texture and composition (for rocks). Relate rock composition to physical conditions at the time of formation of the rock.
				8.3.1.3.5.	Describe the rock cycle and compare and contrast the processes and environments in which igneous, sedimentary and metamorphic rocks form. Cite Minnesota locations where each of the rock types may be found.
8	3. Earth Science	2. Interdependence within the Earth system	1. The sun is the primary source of energy for the Earth's surface.	8.3.2.1.1.	Describe how energy is distributed in the atmosphere primarily through convection.
8	3. Earth Science	2. Interdependence within the Earth system	2.Transfer of heat energy at the boundaries between the atmosphere, the landmasses, and the oceans result in distinctive weather patterns.	8.3.2.2.1.	Explain how heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
				8.3.2.2.2.	Describe how pressure and density differences create and maintain currents and layers in the Earth's atmosphere and water systems.

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				8.3.2.2.3.	Explain how the combination of the Earth's tilted axis and revolution around the sun causes the progression of seasons.
				8.3.2.2.4.	Describe the effect of Earth's rotation on the winds and ocean currents.
				8.3.2.2.5.	Describe local weather patterns associated with fronts and pressure systems, such as the changes in wind direction, temperature, humidity, and air pressure as a storm approaches and passes through.
				8.3.2.2.6.	Collect and use data to predict the weather.
				8.3.2.2.7.	Identify the composition of the atmosphere.
8	3. Earth Science	3. The Universe	1. Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.	8.3.3.1.1.	Use the predictability of the motions of the Earth and sun to explain the length of day, length of year, and changes in shadows.
				8.3.3.1.2.	Use the predictability of the motions of the Earth, sun, and moon to explain the phases of the moon, eclipses, tides and shadows.
8	3. Earth Science	3. The Universe	3. The age and scale of the universe span billions of years and immense distances.	8.3.3.3.1.	Recognize that the universe consists of many billions of galaxies, each containing many billions of stars and that there are vast distances that separate these galaxies and stars from one another.
				8.3.3.3.2.	Recognize that the sun is a medium-sized star and is the closest star to Earth. It is the central and largest body in the solar system and is one of billions of stars in the Milky Way Galaxy.
8	3. Earth Science	4. Human Interactions with Earth Systems	2. The output from a human or natural system can become the input to other parts of larger or smaller human and natural systems.	8.3.4.2.1.	Cite evidence and describe how common materials used by individuals from human systems affect both physical and chemical cycles of the Earth. (Examples: 1. Some household wastes, such as paper products are easily decomposed and enter the carbon cycle. Other waste, such as plastic, interferes with natural processes. 2. Motor oil entering storm drains affecting the hydrologic cycle.)

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				8.3.4.2.2.	Cite evidence and describe how natural processes interfere and interact with human systems. (Example: Natural sedimentation of navigable waterways limits the ability of commercial boat traffic, or hurricanes may cause a massive amount of property damage and economic disruption.
8	4. Life Science	3. Variation and Change in Living Systems	1. Reproduction is a characteristic of all organisms and is essential for continuation of a species. Hereditary information is contained in genes which are inherited through asexual or sexual reproduction.	8.4.3.1.1	Recognize that cells contain genes and that each gene carries a single unit of information that either alone, or with other genes, determines the inherited traits of an organism.
				8.4.3.1.2	Recognize that in asexually reproducing organisms, all the genes come from a single parent and that in sexually reproducing organisms, half of the genes come from each parent.
				8.4.3.1.3	Identify sex organs and cells in plants and animals.
				8.4.3.1.4	Recognize that some characteristics of organisms are influenced by the environment.
8	4. Life Science	3. Variation and Change in Living Systems	2. There are millions of different kinds of plants, animals and microorganisms. Many seemingly dissimilar organisms have similarities and these similarities can be used to infer relationships between them. Variation in organisms can help or hinder their ability to survive and reproduce.	8.4.3.2.1	Recognize that there are millions of different kinds of plants, animals and microorganisms alive today and explain how the fossil record documents the appearance, diversification and extinction of many life forms.
				8.4.3.2.2	Use internal and external anatomical structures to compare and infer relationships between living organisms as well as those in the fossil record.
				8.4.3.2.3	Recognize that variation exists in every population and describe how a variation can help or hinder an organism's ability to survive.

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				8.4.3.3.3	Recognize that extinction is a common event and it occurs when the environment changes and an organism's ability to adapt is insufficient to allow its survival.
8	4. Life Science	4. Human Interactions with Living Systems	1. All organisms cause changes in the environments in which they live.	8.4.4.1.1	Recognize that selective breeding has resulted in new varieties of cultivated plants and domesticated animals for particular traits.
8	4. Life Science	4. Human Interactions with Living Systems	2. Human beings are constantly interacting with other organisms that cause disease.	8.4.4.2.1	Explain how viruses, bacteria, fungi and parasites may infect the human body and interfere with normal body functions.
				8.4.4.2.2	Recognize that vaccines induce the body to build immunity to a disease without actually causing the disease itself.
				8.4.4.2.3	Recognize that specific kinds of germs cause specific diseases and that specific medicines work to kill specific germs.
				8.4.4.2.4	Recognize that the human immune system protects against microscopic organisms and foreign substances that enter from outside the body and against some cancer cells that arise within.
9	1. History and Nature of Science	1. The Nature of Science	1. Science is a complex enterprise with a goal of understanding the natural world. Scientists share common beliefs and values, all of which may be influenced by personal experience and cultural perspective.	9.1.1.1.1	Explain how the strongly held traditions of science, including its commitment to peer review and publication, serve to keep the vast majority of scientists well within the bounds of ethical professional behavior.
				9.1.1.1.2	Discern that there are different traditions in science about what is investigated and how, but they all have in common certain basic beliefs about the value of evidence, logic and good arguments.

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				9.1.1.1.3	Know that current ethics in science holds that research involving human subjects may be conducted only with the informed consent of the subjects, even if this limits some kinds of potentially important research.
				9.1.1.1.4	Identify sources of bias and how bias might influence the direction of research and interpretation of data.
				9.1.1.1.5	Understand that part of the process of building scientific knowledge is making it public through presentations and publications.
9	1. History and Nature of Science	1. The Nature of Science	2. Science is based on the assumption that the universe is a vast single system in which the basic rules are everywhere the same and that the things and events in the universe occur in consistent patterns that are comprehensible through careful systematic study.	9.1.1.2.1	Understand that scientific knowledge is a particular kind of knowledge with its own sources of justifications and uncertainties.
				9.1.1.2.2	Recognize that the usefulness of a model can be tested by comparing its prediction to actual observations in the real world. But a close match does not means that the model is the only model that will work.
				9.1.1.2.3	Understand that changes occur in scientific knowledge but generally in small ways and almost always building on earlier knowledge.
				9.1.1.2.4	Explain how scientific and technological innovations as well as new evidence can challenge portions of or entire accepted theories and models including, but not limited to, cell theory, atomic theory, theory of evolution, plate tectonic theory, gem theory of disease and big bang theory.
				9.1.1.2.5	Explain how advances in technology and/or new discoveries can lead to shifts in scientific knowledge.

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				9.1.1.2.6	Understand that scientists conduct investigations for a wide variety of reasons including: to discover new aspects of the natural world, to explain recently observed phenomena, to test the conclusions of prior investigations or the predictions of current theories.
9	1. History and Nature of Science	2. The Nature of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.1	Understand that engineering designs need to be continually checked and critiqued concerning alternatives, risks, costs, and benefits, so that subsequent designs are refined and improved.
				9.1.2.1.2	Recognize that failure is an important component of engineering. Systems fail because they have faulty or poorly matched parts, or were used in ways that exceed what was intended by the design, or were poorly designed from the start.
				9.1.2.1.3	Suggest alternative tradeoffs and decisions in designs and criticize those ideas in which major tradeoffs are not acknowledged.
				9.1.2.1.4	Recognize that risk analysis is used to minimize the likelihood of unwanted side effects of a new technology.
				9.1.2.1.5	Recognize that not all factors can be known all the time, and engineers use “safety factors” to build publicly used items such as bridges, roads and buildings, in order to keep them safe even in the presence of uncertainties.
				9.1.2.1.6	Understand that in designing a device or process, thought should be given to how it will be manufactured, operated, maintained, replaced, and disposed of and who will sell, operate, and take care of it.
				9.1.2.1.7	Understand that perfect solutions to engineering problems do not exist and that the solutions may not permanent.

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				9.1.2.1.8	Recognize that technological knowledge is not always freely shared due to competition and economics, and may be protected as intellectual property through patents, copyrights and trade secrets.
9	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	1. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There is no one prescribed sequence for the process of inquiry.	9.1.3.1.1	Formulate testable hypotheses and demonstrate the logical connections between the scientific concepts guiding an hypothesis and the design of an experiment.
				9.1.3.1.2	Design and conduct scientific investigations using various approaches such as field studies, observational studies, experimental studies.
				9.1.3.1.3	Use appropriate tools (including computers) and techniques (including mathematical formulas, statistics and graphing) in gathering, analyzing and interpreting data.
				9.1.3.1.4	Express concepts, summarize data, use appropriate terminology, explain statistical analysis, construct a reasonable argument, and respond appropriately to critical comments both verbally and in writing, as well as make charts and diagrams.
9	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	9.1.3.2.1	Identify the critical assumptions behind a line of reasoning so that the validity of the position being taken can be judged.
				9.1.3.2.2	Evaluate personal models and/or explanations in light of alternative explanations and revise one's work in light of reasonable criticism.
				9.1.3.2.3	Use evidence, apply logic, create explanations and/or models and construct arguments for one's proposed explanations and/or models.

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				9.1.3.2.4	Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence and suggesting alternative explanations for the same observations.
9	1. History and Nature of Science	3. Scientific Inquiry and Engineering Design	3. Engineering design is a creative decision making process of devising a product or solution to meet a desired need or solve a specific problem. Redesign of the problem and/or solution can happen at any point in the design process.	9.1.3.3.1	Identify a design problem and decide whether it is feasable to address it.
				9.1.3.3.2	Identify criteria and constraints and determine how these will affect the design process.
				9.1.3.3.3	Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.
				9.1.3.3.4	Evaluate the designed solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
				9.1.3.3.5	Develop and produce a product or system using a design process.
				9.1.3.3.6	Evaluate final solutions and communicate observations, processes, and results of entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
9	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	1. Science, Technology, and Engineering each rely on the other two to enhance knowledge and understanding within each discipline and across disciplines in industry as well as academia.	9.1.4.1.1	Understand that technological problems and advances often create a demand for new scientific knowledge, and new technologies make it possible for scientists and engineers to extend their research in new ways or to undertake entirely new lines of research.
				9.1.4.1.2	Understand that engineers use knowledge of science and technology, together with strategies of design, to solve practical problems.

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9	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	2. Designed, and natural systems exist in the world. These systems are made up of components that act within a system and interact with other systems.	9.1.4.2.1	Recognize that the interaction of systems can create properties that are different from the properties of each of the individual systems.
				9.1.4.2.2	Describe the interaction between systems in terms of boundaries, relation to other systems, and inputs and outputs.
				9.1.4.2.3	Describe how both positive and negative feedback are used in a system to make it more efficient and how systems change over time.
				9.1.4.2.4	Recognize that there are sometimes unintended consequences when systems interact.
9	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	3. Scientist and engineers in different disciplines and locations utilize common skills and sometime work toward common goals.	9.1.4.3.1	Understand that scientists and engineers in different disciplines ask different types of questions and use different methods for investigations.
				9.1.4.3.2	Understand that disciplines do not have fixed boundaries and new scientific disciplines are being formed where existing ones meet, and some sub-disciplines spin off to become disciplines on their own.
				9.1.4.3.3	Describe how scientific investigations and engineering processes require multidisciplinary contributions and efforts.
				9.1.4.3.4	Recognize that scientists and engineers use technology and mathematics to improve investigations and communication.
9	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	4. Science and engineering are not separate from society but rather a part of society and reflect society's values. Science, engineering and technology alone can only indicate what can happen, not what should happen.	9.1.4.4.1	Recognize that science and engineering involve realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

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				9.1.4.4.2	Understand that science and engineering are not separate from society but rather a part of society and reflect society's values. Understanding science and technology alone will not resolve local, national, or global challenges.
				9.1.4.4.3	Recognize that the value of any given technology maybe different for different groups and at different points in time.
				9.1.4.4.4	Understand that scientists often cannot bring definitive answers to matters of public debate. There may be little reliable data available, or there may not yet be adequate theories to understand the phenomena involved, or the answer may involve a comparison of values that is outside the realm of science.
9	1. History and Nature of Science	4. Interactions among Science, Engineering, Technology and Society	5. Men and women of all cultures and across all ages have been involved in engineering design and scientific inquiry.	9.1.4.5.1	Recognize that the early Americans, Egyptians, Greeks, Chinese, Hindus, and Arabs are responsible for many scientific and mathematical ideas, and technological inventions. Modern science is based on traditions of thought that came together in Europe about 500 years ago. People from all cultures now contribute to those traditions.
9	2. Physical Science	1. Matter	1. An element's physical and chemical properties are related to its atomic structure.	9.2.1.1.1	Identify protons, neutrons, and electrons as the major components of the atom, their mass relative to one another, their arrangement, and their charge.
				9.2.1.1.2	For elements 1-20, explain how the properties of the elements are determined by their atomic structure and provide a basis for the organization of the periodic table. (Examples: atomic group, period, ion formation, boiling point, melting point, atomic radius, density).
				9.2.1.1.3	Describe how experimental evidence led Dalton, Rutherford, Thompson, Chadwick and Bohr to develop increasingly accurate models of the atom.
9	2. Physical Science	1. Matter	2. Some solids, liquids and gases can dissolve some other solids, liquids or gases to form solutions, which are distinct from mixtures.	9.2.1.2.1	Explain the interactions between solutes and solvents, and give examples of soluble and insoluble mixtures of materials. (Examples: slurries, suspensions, aerosols, alloys)

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				9.2.1.2.2	Describe the dissolving process at the molecular level by using the concept of random molecular motion.
				9.2.1.2.3	Describe how temperature, pressure, and surface area affect the dissolving process.
9	2. Physical Science	1. Matter	3. Chemical reactions involve the rearrangement of atoms as chemical bonds are broken and formed through transferring or sharing of electrons, with the absorption or release of energy.	9.2.1.3.1	Describe a chemical reaction using words and symbols and explain how the rearrangement of atoms in a chemical reaction illustrates the law of conservation of mass.
				9.2.1.3.2	Explain the influence of temperature, surface area, agitation, concentration and catalysts on the rate of a chemical reaction.
				9.2.1.3.3	From their position on the periodic table, for elements 1 – 20, use the transfer of valence electrons to predict and name the ions and compounds formed.
				9.2.1.3.4	Use indicators to compare the strengths of various common acids and bases such as vinegar, baking soda, soap, and citrus juice, and determine whether a solution is an acid, base or neutral solution.
				9.2.1.3.5	Use temperature change in a chemical reaction to identify the reaction as exothermic or endothermic.
				9.2.1.3.6	Describe how carbon atoms bond covalently to form organic compounds and recognize polymers, sugars and alcohols as common organic molecules.
9	2. Physical Science	1. Matter	4. Atoms are changed into other atoms or isotopes through changes in the atomic nucleus and often produce energy and ionizing radiation as a result of these changes.	9.2.1.4.1	Explain how some isotopes of elements are unstable and undergo radioactive decay, at a predictable rate, releasing energy as ionizing radiation; and that such decay processes can be used for determining the age of materials, and for medical treatments of disease.
				9.2.1.4.2	Describe alpha decay, beta decay, fission reactions and fusion reactions in terms of structural nuclear changes, products of the reactions, uses, and effects on the environment.
9	2. Physical Science	2. Motion	1. The change of motion of objects is determined by forces acting on them and can be described quantitatively.	9.2.2.1.1	Use Newton's Laws of Motion to explain, analyze and calculate the effect of forces on the straight line motion of an object.

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				9.2.2.1.2	Explain how applied forces, including gravity and friction, affect the motion of objects on earth and in the solar system.
9	2. Physical Science	2. Motion	2. When objects change their motion or interact with other objects, the total energy remains constant.	9.2.2.2.1	Apply the concept of conservation of energy to analyze the changes in kinetic and potential energy in a frictionless system. (Examples: mass and spring, pendulum, roller coaster)
				9.2.2.2.2	Calculate the work and power involved in energy transfers in a mechanical system.
9	2. Physical Science	3. Energy	1. Electrons flow through electrical circuits due to electrical forces, and can generate or interact with magnetic forces.	9.2.3.1.1	Describe the electric charge on an object and the current in a circuit in terms of electrons and their motion.
				9.2.3.1.2	Explain and calculate the relationship of current, voltage, resistance and power in simple electric circuits.
				9.2.3.1.3	Describe how electric and magnetic forces are used in the operation of electrical devices such as the motor, generator, and transformer.
9	2. Physical Science	3. Energy	2. In a closed system, the total amount of energy does not change.	9.2.3.2.1	Compare the caloric and kinetic molecular models of heat and describe the relationship between heat and temperature.
				9.2.3.2.2	Describe and calculate how energy is conserved when changing between motion, heat, electrical and chemical energy.
9	2. Physical Science	3. Energy	3. The motion of charged particles produces electromagnetic waves of differing wavelengths, properties and uses.	9.2.3.3.1	Compare the wavelength, frequency and energy of different kinds of waves in the electromagnetic spectrum and describe their applications.
				9.2.3.3.2	Qualitatively describe what happens when waves undergo reflection and refraction.
9	2. Physical Science	4. Human Interaction with Physical Systems	1. Production and use of energy involve many risks and benefits which must be taken into consideration when decisions are made.	9.2.4.1.1	Describe and compare the benefits, costs, and risks associated with using one energy resource over another.
				9.2.4.1.2	Compare the method of light production and efficiency for incandescent, fluorescent, solid state, and gas discharge light bulbs.

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				9.2.4.1.3	Compare the relative advantages and disadvantages of different modes of transportation.
9	2. Physical Science	4. Human Interaction with Physical Systems	2. Physical and mathematical models are used to describe physical systems, and careful consideration of units is essential in any scientific work.	9.2.4.2.1	Use equations and graphs to show the relationships between physical quantities.
				9.2.4.2.2	Use unit conversions/dimensional analysis to solve problems and check results.
				9.2.4.2.3	Apply understanding of accuracy and precision to describe how measurements are uncertain based on the limitations of the tool and measurement techniques used.
				9.2.4.2.4	Demonstrate the conversion of units within the Systeme Internationale (SI, or metric) and estimate the magnitude of common objects and quantities using metric units.
				9.2.4.2.5	Explain how new evidence leads to changes in models and theories related to physical science concepts, such as heat, electricity, atomic structure, motion and energy.
9	3. Earth Science	1. Earth Structure and Processes	1. Relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers, and ocean features are evidence that support the theory of plate tectonics. Tectonic plates constantly move at rates of centimeters per year in response to movements in the mantle.	9.3.1.1.1.	Describe the distribution of low silica and high silica volcanism; explain how those magmas form, and are evidence of differing types of activity at plate boundaries.
				9.3.1.1.2.	Using current earthquake data, plot global distribution of earthquakes based on depth and magnitude to show seismic activity at plate boundaries. Describe seismic activity at subduction zones and show how this is evidences for a diving plate edge.
				9.3.1.1.3.	Explain how the symmetric pattern of magnetic reversals and rock ages on both sides of a mid-ocean ridge are evidence of sea floor spreading.
				9.3.1.1.4.	Cite examples of how changes in past environments as recorded in the rock record are evidence of plate movement.

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				9.3.1.1.5.	Explain how movement of material in the mantle results in plate motion.
9	3. Earth Science	1. Earth Structure and Processes	3. By observing rock sequences and using fossils to correlate the sequences at various locations, geologic events can be inferred and geologic time can be estimated.	9.3.1.3.1.	Use fossils, relative dating techniques, and radiometric dating to correlate rock sequences from separate locations. Use that data to explain how the Earth has changed globally over short and long periods of time.
				9.3.1.3.2.	Interpret the physical and biological characteristics of sedimentary rock and the physical and chemical characteristics of igneous and metamorphic rocks to infer the conditions of past environments.
				9.3.1.3.3.	Cite evidence in the rock record and ice cores that shows atmospheric change as life evolved.
9	3. Earth Science	2. Interdependence within the Earth System	1. The Earth system has internal and external sources of energy, both of which create heat and drive the motion of material in the oceans, atmosphere, and solid earth.	9.3.2.1.1.	Compare and contrast the energy sources of the Earth including the sun, the decay of radioactive isotopes, and the gravitational energy from the Earth's original formation.
				9.3.2.1.2.	Explain how the outward transfer of earth’s internal heat drives the convection circulation in the mantle that propels the plates comprising the surface features across the face of the globe.
9	3. Earth Science	2. Interdependence within the Earth system	2. Global climate is determined by energy transfer from the sun at the Earth's surface. The energy transfer is influenced by static and dynamic processes, including Earth's rotation, cloud cover and the position of mountain ranges and oceans.	9.3.2.2.1.	Explain how the transfer of energy and motions of the Earth contribute to global climatic patterns in the oceans, including thermohaline circulation and ocean temperature patterns.
				9.3.2.2.2.	Explain how the transfer of energy, motions of the Earth, and location of mountain ranges contribute to global climatic patterns.
				9.3.2.2.3.	Describe and explain climate changes that have occurred over time as evidenced in ice core data.

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9	3. Earth Science	2. Interdependence within the Earth system	3. Material in the Earth system cycles through different reservoirs. The total amount of material stays the same as its form and location change. The movement and change are driven by Earth's internal and external sources of energy. Recognize that water on Earth cycles and exists in many forms.	9.3.2.3.1.	Trace the cyclical movement of carbon and oxygen through the lithosphere, hydrosphere, atmosphere and biosphere.
				9.3.2.3.2.	Trace the cyclical movement of water through the lithosphere, hydrosphere, atmosphere and biosphere.
				9.3.2.3.3.	Trace the cyclical movement of nitrogen through the lithosphere, hydrosphere, atmosphere and biosphere.
9	3. Earth Science	3. The Universe	2. The sun, the earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 million years ago. Early earth evolved into its present habitable form because of interactions among solid earth, the oceans, the atmosphere, and organisms.	9.3.3.2.1.	Explain how the sun, Earth and solar system formed.
				9.3.3.2.2.	Compare the characteristics of Earth with the characteristics and movement patterns of the other planets, their satellites and other objects in our solar system.
				9.3.3.2.3.	Compare and contrast the environmental parameters that make life possible on Earth with conditions found on the other planets of our solar system.
9	3. Earth Science	3. The Universe	Our understanding of the nature of the universe and its formation and composition has been supported, refined, and challenged as technology advances. The current theory is that its entire contents expanded explosively from a hot, dense chaotic mass after which elements clumped together to eventually form stars and galaxies.	9.3.3.3.1.	Identify different types of stars and galaxies and describe how stars, galaxies and the universe change over time.

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				9.3.3.3.2.	Explain how nuclear fusion produces energy and chemical elements.
				9.3.3.3.3.	Describe the evidence from current technologies that has been used to understand the composition and the early history of the universe.
				9.3.3.3.4.	Explain how the Doppler shift of light provides evidence for expansion of the universe.
9	3. Earth Science	4. Human Interactions with the Earth System	The interaction of human and natural systems can create properties that are different from either individual system.	9.3.4.2.1.	Analyze how human activities (such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming) have changed the Earth's land, oceans, and atmosphere. Some of these changes have decreased the capacity of the environment to support some life forms.
				9.3.4.2.2.	Cite evidence and describe how materials from human systems affect both chemical cycles of the Earth. (Examples: 1. Industrialization has released carbon dioxide that has entered the carbon cycle and altered earth's ability to store heat, which affects Earth's climate. 2. Mining of copper sulfide deposits releases sulfur, causing acid mine drainage.)
				9.3.4.2.3.	Recognize that the atmosphere, oceans, and land have a limited capacity to absorb and recycle waste materials.
				9.3.4.2.4.	Identify, predict and investigate the factors that influence the quality of water and how it can be reused, recycled and conserved.
9	3. Earth Science	4. Human Interactions with the Earth System	3. The interaction of human systems and natural systems can present hazards to humanity's well being. Humans use tools to minimize the hazards and to assess the potential danger and risk associated with the hazards. Humans use this information to make decisions on how they interact with natural systems.	9.3.4.3.1.	Analyze the benefits, costs, and risks associated with selecting one land use over another. (Example: Building a levee benefits the neighboring landowner, but has a cost to development downstream.) The risk analysis may include a discussion of likelihood of 100-year and 500-year floods.

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				9.3.4.3.2.	Compare the costs and tradeoffs of various hazards ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and accuracy with which scientists and engineers can (and cannot) predict events are important considerations.
9	3. Earth Science	4. Human Interactions with the Earth System	4. Technology provides tools for investigations, inquiry, and analysis that enhance scientific understanding.	9.3.4.4.1.	Recognize that raw data from satellites and space probes can be converted to false color images that can bring out particular characteristics of a planet, star, galaxy.
				9.3.4.4.2.	Understand how geographical information systems and satellite information have aided humans in generating and using models. Use large data sets to understand and convey information about the Earth. (Example: Evaluate effects of storms by looking at stream flow data from USGS.)
				9.3.4.4.3.	Explain how geographical information systems (GIS) can be used to identify and answer questions about Earth systems.
				9.3.4.4.3.	Interpret a geologic map of Minnesota.
9	4. Life Science	1. Structure and Function of Living Systems	1. All living systems are composed of one or more cells and the life processes in a cell are based on complex interactions at the molecular level. The structures that make up the cell have specific functions that allow an organism to grow, survive and reproduce.	9.4.1.1.1	Recognize that organisms are composed primarily of very few elements (C, H, O, N, and P) and describe the basic molecular structures and primary functions of the four important organic macromolecular groups (carbohydrates, lipids, proteins, and nucleic acids).
				9.4.1.1.2	Recognize that the work of the cell is carried out primarily by proteins (most of which are enzymes), and that protein function depends on amino acid sequence and the shape it takes as a consequence of the interactions between those amino acids.
				9.4.1.1.3	Explain how viruses, prokaryotic cells, and eukaryotic cells differ in relative size, complexity and general structure.

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				9.4.1.1.4	Explain the function and importance of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, nucleus, cytoplasm, mitochondrion, central vacuole, cell wall, chloroplast, ribosome, and centrioles, as related to the basic cell processes of respiration, photosynthesis, protein synthesis, and cell reproduction.
				9.4.1.1.5	Compare and contrast passive transport (diffusion including osmosis and facilitated transport) and active transport (endocytosis and exocytosis).
				9.4.1.1.6	Describe the cell cycle and explain the process of mitosis and its role in the formation of identical new cells and the importance of maintaining chromosome number during asexual reproduction.
9	4. Life Science	1. Structure and Function of Living Systems	2. Unicellular and multicellular organisms use the interaction of cellular processes and organ systems in order to maintain homeostasis.	9.4.1.2.1	Explain how cell processes are influenced by internal and external environments, such as pH and temperature, and how cells and organisms respond to changes in their environment to maintain homeostasis.
				9.4.1.2.2	Describe how, in multicellular organisms, cells can become specialized to form tissues and organs by the expression of different genes.
				9.4.1.2.3	Describe how the functions of individual organ systems are integrated to maintain homeostasis in an organism.
9	4. Life Science	2. Interdependence of Living Systems	1. The interrelationship and interdependence of organisms generate biological communities in stable ecosystems. These ecosystems can change as the environment changes.	9.4.2.1.1	Explain how organisms cooperate and compete in a stable ecosystem using examples of predation, mutualism and parasitism.
				9.4.2.1.2	Explain how ecosystems can change as a result of natural disasters, climate change or the introduction of one of more new species from migration or localized evolution.

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9	4. Life Science	2. Interdependence of Living Systems	2. Matter cycles and energy flows through different levels of organization of living systems and the physical environment as chemical elements are recombined in different ways. Each recombination results in both storage and dissipation of energy.	9.4.2.2.2	Differentiate between the processes of photosynthesis and respiration in terms of energy flow (including ATP) and reactants and products using both words and chemical equations.
				9.4.2.2.2	Explain how the total amount of matter and energy in an ecosystem is transferred among organisms, or in the case of energy, is dissipated as heat into the physical environment.
9	4. Life Science	3. Variation and Change in Living Systems	1. Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.	9.4.3.1.1	Apply the terms phenotype, genotype, allele, homozygous dominant, homozygous recessive, and heterozygous when determining the outcome of monohybrid crosses.
				9.4.3.1.2	Differentiate between dominant, recessive, codominant, incompletely dominant, polygenic, and sex-linked traits.
				9.4.3.1.3	Define the relationship between DNA, gene, and chromosome and describe the contributions of Watson, Crick, and Franklin in determining the structure of DNA.
				9.4.3.1.4	Explain the functions of DNA and RNA, and distinguish between the processes of DNA replication, transcription, and translation.
				9.4.3.1.5	Recognize the process and explain the importance of being able to move genes from one organism to another.
9	4. Life Science	3. Variation and Change in Living Systems	2. Variation within a species is the result of new heritable characteristics occurring from new combinations of existing genes or from mutations of genes in reproductive cells. These variations may occur naturally or as the result of human interference.	9.4.3.2.1	Explain how sorting and recombination (crossing over) of genes during sexual reproduction (meiosis) increases the occurrence of variation in a species. Use concepts from Mendel's Laws of Segregation and Independent Assortment in the explanation.
				9.4.3.2.2	Use the processes of mitosis and meiosis to explain the advantages and disadvantages of asexual and sexual reproduction.

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				9.4.3.2.3	Explain how mutations like deletions, insertions, rearrangements, or substitutions of DNA segments in gametes can result in genetic variation within a species.
9	4. Life Science	3. Variation and Change in Living Systems	3. The theory of biological evolution, including natural selection and common ancestry, provides a scientific explanation for the history of life on Earth as depicted in the fossil record as well as molecular and anatomical similarities evident in the diversity of existing organisms.	9.4.3.3.1	Describe how evidence led Darwin to develop the theory of natural selection and common descent to explain evolution.
				9.4.3.3.2	Use scientific evidence, including the fossil record, homologous structures, and genetic and/or biochemical similarities to show evolutionary relationships.
				9.4.3.3.3	Recognize that artificial selection has led to offspring through successive generations that can be very different in appearance and behavior from their distant ancestors.
				9.4.3.3.3	Explain why genetic variation within a population is essential for evolution to occur.
				9.4.3.3.4	Explain how competition for finite resources and the changing environment promotes natural selection on offspring survival depending on whether the offspring have characteristics that are advantageous or disadvantageous in the new environment.
				9.4.3.3.5	Explain how genetic variation between two populations of a given species is due, in part, to different selective pressures acting independently on each population and how, over time, these differences can lead to the development of new species.
9	4. Life Science	4. Human Interactions with Living Systems	1. Human beings are part of the global ecosystem and human activity has deliberate or inadvertent consequences for other living organisms as well as global and local sustainability.	9.4.4.1.1	Describe the social, economic, and ecological risks and benefits of biotechnology including selective breeding, genetic engineering (including genetically modified organisms and gene therapy), food irradiation, antibiotic use, and medical technologies.

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				9.4.4.1.2	Describe the social, economic and ecological risks and benefits of changing a natural habitat as a result of human activity including introduction of foreign species, pollution of water, air, or soil, altering communities, and changes in the use of the land or water, such as the use of agricultural and biotechnology practices.
				9.4.4.1.3	Recognize the contributions of Minnesota American Indian tribes and communities, as well as other cultures, to the understanding of interactions among humans and living systems.
				9.4.4.1.4	Describe factors affecting population growth of all organisms, including humans, and relate these to factors affecting growth rates and carrying capacity of an ecosystem.
9	4. Life Science	4. Human Interactions with Living Systems	2. The environment, body functions and human behavior all influence personal and community health. Disease can be related to any of these three factors.	9.4.4.2.1	Describe how faulty genes can cause body parts or systems to work poorly and how some genetic diseases appear only when an individual has inherited a certain faulty gene from both parents.
				9.4.4.2.2	Describe how the immune system sometimes attacks some of the body's own cells and how some allergic reactions are caused by the body's immune responses to usually harmless environmental substances.
				9.4.4.2.3	Explain how the body produces antibodies to fight disease and how this impacts the development of vaccines, and immunity to disease.
				9.4.4.2.4	Recognize that a gene mutation in a cell can result in uncontrolled cell division called cancer and how exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.

GRADE	STRAND	SUBSTRAND	STANDARD	CODE	BENCHMARK
CHEM	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical and nuclear properties and reactions. The periodic table organizes the elements by increasing atomic number and illustrates how periodicity of the physical and chemical properties of the elements relates to atomic structure.	9C.2.1.1.1	Explain the factors that cause some nuclei to be stable and others to be unstable and lead to nuclear disintegration.
				9C.2.1.1.2	Explain the relationships among atomic number, mass number, isotope and radioisotope.
				9C.2.1.1.3	Explain the relationship of an element's position on the periodic table to its atomic number and electron configuration.
				9C.2.1.1.4	Identify and compare trends on the periodic table including reactivity, ionization energy, electronegativity, and relative sizes of atoms and ions, and use the trends to explain the properties of subgroups metals, nonmetals, halogens and noble gases.
				9C.2.1.1.5	Use the periodic table to identify metals, nonmetals, groups and periods and their properties, including the halogens, noble gases.
CHEM	2. Physical Science	1. Matter	2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds. Atoms bond with each other by transferring or sharing valence electrons to form compounds.	9C.2.1.2.1	Explain how atoms combine to form compounds through ionic and covalent bonding.
				9C.2.1.2.2	Use electronegativity to explain the difference between polar and nonpolar covalent bonds.
				9C.2.1.2.3	Explain how hydrogen bonding affects a variety of physical, chemical, and biological phenomena. (Examples: surface tension, capillary action, density, boiling point)

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				9C.2.1.2.4	Use the IUPAC system to write chemical formulas and name molecular compounds and ionic and compounds, including those that contain polyatomic ions ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate.
				9C.2.1.2.5	Compare and contrast the structure, properties and uses of organic compounds including hydrocarbons, alcohols, sugars, fats and proteins.
				9C.2.1.2.6	Determine percent composition, empirical formulas, and molecular formulas of simple compounds.
CHEM	2. Physical Science	1. Matter	3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products. Balanced chemical equations are used to show conservation of mass and to predict amounts of reactants needed and products produced.	9C.2.1.3.1	Predict the products and whether a chemical reaction will take place using the drivers of a chemical reaction (formation of water, formation of a precipitate, evolution of a gas, and changes in energy to the system).
				9C.2.1.3.2	Balance chemical equations by applying the laws of conservation of mass and constant composition.
				9C.2.1.3.3	Determine the molar mass of a compound from its chemical formula and a table of atomic masses and convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.
				9C.2.1.3.4	Use the mole concept to describe and calculate relationships in a chemical reaction, including molarity, mole/mass relationships, mass/volume relations, limiting reactants, and percent yield.
CHEM	2. Physical Science	1. Matter	4. Chemical equilibrium is a dynamic process that directs chemical interactions.	9C.2.1.4.1	Describe the process by which solutes dissolve in solvents and calculate concentrations, including grams per liter, molarity, and parts per million.
				9C.2.1.4.2	Describe the effects of solubility to phenomena and applications, such as water pollution, human body systems, and the atmosphere.

GRADE	STRAND	SUBSTRAND	STANDARD	CODE	BENCHMARK
				9C.2.1.4.3	Describe the factors that affect the rate of a chemical reaction including temperature, pressure, mixing, concentration, particle size, surface area, and catalyst.
				9C.2.1.4.4	Explain equilibrium in a chemical reaction at the particle level, including the factors that can cause a shift in equilibrium (concentration, pressure, volume, temperature) and predict the shift in equilibrium when a system is subjected to a stress (LeChatelier's principle).
CHEM	2. Physical Science	1. Matter	5. States of matter can be described in terms of motion of molecules. The properties and behavior of gases can be explained using the Kinetic Molecular Theory and quantitatively using the gas laws.	9C.2.1.5.1	Use kinetic molecular theory to describe how changes in energy content affect the state of matter (solid, liquid, gaseous phases).
				9C.2.1.5.2	Explain the roles of pressure and temperature in changes of phase of matter.
				9C.2.1.5.3	Use the kinetic theory of gases to relate the pressure, volume, temperature, and mass of an ideal gas system.
				9C.2.1.5.4	Explain and calculate changes in temperature, pressure, volume and number of particles of a gas in terms of the random motion of molecules in an ideal gas and using gas laws.
				9C.2.1.5.5	Relate the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.
				9C.2.1.5.6	Explain diffusion and Brownian motion in terms of molecular motion.
CHEM	2. Physical Science	3. Energy	1. Conservation of mass and energy and the increases of entropy help explain physical, chemical and nuclear changes.	9C.2.3.1.1	Explain at the particle level, the role of activation energy and degree of randomness in chemical reactions.
				9C.2.3.1.2	Explain endothermic and exothermic reactions based on the energy changes that occur when chemical bonds are formed and broken.
				9C.2.3.1.3	Explain how mass, heat capacity and change in temperature of an object determine the amount of heat it gains or loses.

GRADE	STRAND	SUBSTRAND	STANDARD	CODE	BENCHMARK
				9C.2.3.1.4	Explain how the interaction between energy and entropy determines whether a change or reaction will occur.
CHEM	2. Physical Science	4. Human Interactions with Physical Systems	1. Physical and mathematical models are used to describe physical systems.	9C.2.4.1.1	Select and use appropriate numeric, symbolic, graphical and standard modes of representation (including SI units and traditional/IUPAC nomenclature) to communicate scientific ideas, plans and experimental results.
				9C.2.4.1.2	Use an understanding of the accuracy and precision in scientific measurements to determine and express the uncertainty of a result using significant figures.
				9C.2.4.1.3	Compare the strengths and weakness of various visual, mathematical and computer models in describing chemical atoms, molecules and interactions.
CHEM	2. Physical Science	4. Human Interactions with Physical Systems	2. Developments in chemistry affect society and societal concerns affect the field of chemistry.	9C.2.4.2.1	Explain how materials can be modified at the molecular level to have new physical or chemical properties.
				9C.2.4.2.2	Explain the political, societal and environmental impact of chemical products and technologies, such as use and disposal of material, pollution effects, change in the atmosphere, petroleum products, and nano particles.
				9C.2.4.2.3	Identify safety and ethical considerations and principles involved in chemical research and the development of products.
				9C.2.4.2.4	Describe potential careers in chemistry related areas.
PHYS	2. Physical Science	1. Matter	1 The structure of the atom can be used to explain chemical and nuclear properties and reactions.	9P.2.1.1.1	Explain the factors that cause some nuclei to be stable and other to be unstable and lead to nuclear disintegration.
				9P.2.1.1.2	Describe the key factors that lead to nuclear fission and chain reactions.
				9P.2.1.1.3	Explain the relationships among atomic number, mass number, isotope and radioisotope.

GRADE	STRAND	SUBSTRAND	STANDARD	CODE	BENCHMARK
				9P.2.1.1.4	Compare fission and fusion reactions in terms of the general reactions, the energy released, the technology required and the environmental factors.
PHYS	2. Physical Science	2. Motion	1. Forces and momentum determine the motion of massive objects.	9P.2.2.1.1	Graphically represent position, velocity and acceleration of objects in one dimension.
				9P.2.2.1.2	Use vectors and free-body diagrams to explain force, position, velocity, and acceleration of objects in 2-dimensional space.
				9P.2.2.1.3	Apply Newton's three laws of motion to calculate and analyze the effect of forces and momentum on motion.
				9P.2.2.1.4	Describe circular motion in terms centrifugal/centripetal forces, angular velocity, and angular momentum.
				9P.2.2.1.5	Use Newton's law of gravitation to explain the motion of astronomical bodies.
PHYS	2. Physical Science	2. Motion	2. When objects change their motion or interact with other objects in the absence of frictional forces the total energy remains constant.	9P.2.2.2.1	Calculate the changes in potential and kinetic energy as well as amount of work and power of objects in a gravitational field.
				9P.2.2.2.2	Calculate the change in velocity for objects subject to forces along their direction of motion, and perpendicular to their direction of motion.
				9P.2.2.2.2	Use conservation of momentum and energy to analyze the elastic collision of two solid objects in one-dimensional motion.
PHYS	2. Physical Science	2. Motion	3. Oscillatory systems can be analyzed using Hook's law and Newton's laws. The natural frequency of such a system is its resonance frequency.	9P.2.2.3.1	Calculate the work done in moving an object against the force of a spring using Hook's Law.
				9P.2.2.3.2	Analyze the frequency, period, and amplitude of an oscillatory system, such as an ideal pendulum, a vibrating string, or a vibrating spring and mass system.
PHYS	2. Physical Science	2. Motion	4. Sound is generated from oscillating matter in a medium.	9P.2.2.4.1	Describe how vibration of physical objects sets up transverse and longitudinal sound waves in gases, liquids, and solid materials.

GRADE	STRAND	SUBSTRAND	STANDARD	CODE	BENCHMARK
				9P.2.2.4.2	Explain how wave properties such as interference, resonance, refraction, and reflection affect sound.
				9P.2.2.4.3	Calculate the energy in a spring and mass system from its amplitude of motion, mass, and spring constant.
				9P.2.2.4.3	Describe the changes in observed sound that result from motion of the source relative to the medium and/or the receiver (Doppler Shift).
PHYS	2. Physical Science	3. Energy	1. Electrical Forces result from interactions between charges, which can be described by electric fields.	9P.2.3.1.1	Use Coulomb's law to calculate the force between two charges.
				9P.2.3.1.2	Explain how the electric field and force on a charged particle are related to the electric potential.
				9P.2.3.1.3	Explain why currents flow when free charges are placed in an electrical field, and how that forms the basis for electrical circuits.
PHYS	2. Physical Science	3. Energy	2. Charged electrons respond to electrical voltages by moving through electrical circuits. This motion generates magnetic fields.	9P.2.3.2.1	Using Ohm's law, calculate the current and voltage at points in a resistive circuit with more than one resistor, and the power dissipated in a simple circuit.
				9P.2.3.2.2	Represent electrical circuits with components in parallel and series to one another.
				9P.2.3.2.3	Calculate the resistance of parallel and series resistors.
				9P.2.3.2.4	Explain how the current produced by a changing magnetic field in a loop of wire can be used to produce electricity.
				9P.2.3.2.5	Explain how the force produced on a magnet by a current carrying wire forms the basis for electrical motors.
				9P.2.3.2.6	Explain how transformers work, and can be used to change the AC voltage and current in electrical systems
PHYS	2. Physical Science	3. Energy	3. Magnetic and electric fields interact to produce electromagnetic waves which have both wave and particle properties.	9P.2.3.3.1	Explain the nature of the magnetic and electrical fields in a propagating electromagnetic wave.

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				9P.2.3.3.2	Quantitatively relate the speed of light in a medium to its frequency and wavelength in that medium, and in free space.
				9P.2.3.3.3	Use Snell's law to explain the refraction and Total Internal Reflection of light in transparent media, such as lenses and fiber optics.
				9P.2.3.3.4	Use properties of light, including reflection, refraction, interference, Doppler Effect and the photoelectric effect, to explain phenomena and describe applications.
				9P.2.3.3.5	Compare the wave model and particle models in explaining properties of light.
				9P.2.3.3.6	Describe the nature and uses of forms of electromagnetic radiation from radio frequencies through gamma radiation.
PHYS	2. Physical Science	3. Energy	4. Heat is energy that is transferred between objects or regions that are at different temperatures by the processes of convection, conduction and radiation.	9P.2.3.4.1	Describe the significance of temperature to the transfer of thermal energy (heat).
				9P.2.3.4.2	Describe and calculate the quantity of heat transferred by conduction based on specific heat, density, and temperatures of solids and liquids.
				9P.2.3.4.3	Explain the role of gravity, pressure and density in the convection of heat by a fluid.
				9P.2.3.4.4	Characterize the rate at which objects at different temperatures will transfer thermal energy by electromagnetic radiation.
PHYS	2. Physical Science	4. Human Interaction with Physical Systems	1. Developments in physics affect society and societal concerns affect the field of physics.	9P.2.4.1.1	Explain political, societal and environmental impacts of physics-related applications and inventions.
				9P.2.4.1.2	Examine potential careers in physics related areas.
				9P.2.4.1.3	Analyze the societal impacts of discoveries and technologies, such as the transistor, nuclear energy, radio, and microwaves.
PHYS	2. Physical Science	4. Human Interaction with	2. Physical and mathematical models are used to describe physical systems.	9P.2.4.2.1	Use equations, graphs and dimensional analysis to show the relationships between physical quantities and derived results.

GRADE	STRAND	SUBSTRAND	STANDARD	CODE	BENCHMARK
				9P.2.4.2.2	Use an understanding of the accuracy and precision in scientific measurements to determine the uncertainty of a result.