Grade	Strand	Substrand	Standard	Code	Benchmark
K	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	0.1.1.2.1	Raise questions about the natural world and seek answers to some of them by making careful observations and doing something to an object, noting what happens, and sharing the answers with others.
K	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	0.1.1.2.2	Describe and compare things in terms of number, shape, texture, size, weight, color and motion.
K	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	0.1.1.2.3	Correctly portray the major features of an object or phenomenon with words or pictures.
K	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create products or processes based on the needs and wants of society.	0.1.2.1.1	Identify items from everyday life that are engineered or designed (for example, cars, playgrounds, buildings and building heating/cooling systems).
K	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	0.1.3.1.1	Describe a natural system by identifying its interactive parts.
1	1. The Nature of Science and Engineering	1. The Practice 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 evidence when likewise questioned.
1	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science involves group interactions, emphasizing evidence and communication.	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. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	1.1.3.1.1	Know that a designed system made by humans is a group of interrelated parts (components) designed collectively to achieve a desired goal.
1	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	1.1.3.1.2	Distinguish between systems found in nature and those made by humans.
1	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	1.1.3.1.3	Describe the parts of a system and their influence on one another.
1	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	1.1.3.1.4	Describe the impact on a system when parts are broken or missing.
1	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	1.1.3.1.5	Describe how the parts of a system, when put together, can do things that are not possible when the parts are separated.
1	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. All people, including scientists and engineers, use tools and techniques to help them do things.	1.1.3.2.1	Know that tools are simple objects that help humans do science and engineering.
1	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. All people, including scientists and engineers, use tools and techniques to help them do things.	1.1.3.2.2	Use tools to observe, measure and make things.

1	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. All people, including scientists and engineers, use tools and techniques to help them do things.	1.1.3.2.3	Explain how tools can be used to improve observations.
2	1. The Nature of Science and Engineering	1. The Practice of Science	1. Scientific knowledge is based on the systematic observation and investigation of the natural world.	2.1.1.1.1	Understand that when a science investigation is done the way it was done before, even in a different place, a very similar result is expected.
2	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	2.1.1.2.1	Use observations to develop an accurate description of a natural phenomenon and compare one's observations and descriptions with those of others.
2	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create products or processes based on the needs and wants of society.	2.1.2.1.1	Explain how engineered or designed items from everyday life benefit people.
2	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems and devising a product or solution. There is no one prescribed sequence for the process of design.	2.1.2.2.1	Brainstorm everyday needs and wants and identify problems that can be solved through design.
2	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems and devising a product or solution. There is no one prescribed sequence for the process of design.	2.1.2.2.2	Based on an identified need or problem, build or construct an object that helps accomplish a task.
2	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems and devising a product or solution. There is no one prescribed sequence for the process of design.	2.1.2.2.3	Investigate how a simple object (such as a pencil, notebook, lunch box) is constructed by taking it apart and suggest how it can be improved.
2	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems and devising a product or solution. There is no one prescribed sequence for the process of design.	2.1.2.2.4	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.
3	1. The Nature of Science and Engineering	1. The Practice 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. The Nature of Science and Engineering	1. The Practice of Science	1. Scientists work as individuals and in groups; emphasizing evidence, open communication and skepticism.	3.1.1.1.2	Provide evidence for believing something, other than saying “Everyone knows that,” or “I just know,” and discount such reasons when given by others.
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	3.1.1.2.1	Generate questions that can be answered when scientific knowledge is combined with one's own observations or invetigations.
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	3.1.1.2.2	Design a fair test to answer a question.
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	3.1.1.2.3	Make notes in order to maintain a record of observations, procedures and explanations.
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	3.1.1.2.4	Distinguish actual observations from ideas and inferences about what was observed.
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	3.1.1.2.5	Use data to construct reasonable explanations.
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	3.1.1.2.6	Use tools to improve observations and keep a record that describes the observations made. Examples of tools are scales, thermometers, microscopes, balances and spring scales.

3	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	3.1.3.2.1	Understand that everybody can use science to learn about the natural world and identify natural patterns.
3	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	3.1.3.2.2	Understand that people-alone or in groups-use engineering design to invent new products and ways to solve problems.
3	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	3.1.3.2.3	Identify people who are engineers or scientists.
3	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	3.1.3.2.4	Recognize that the practice of science and/or engineering involves many different kinds of work and engages men and women of all ages and backgrounds.
4	1. The Nature of Science and Engineering	2. Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems (e.g., technologies) that improve society and may make humans more productive.	4.1.2.1.1	Describe the impact that the designed world has on the natural world as more and more engineered products and services are created and used.
4	1. The Nature of Science and Engineering	2. Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems (e.g., technologies) that improve society and may make humans more productive.	4.1.2.1.2	Understand that a technology that helps some people or organisms may hurt others, and that a solution to one problem may create others.
4	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.	4.1.2.2.1	Identify and collect information about everyday problems that can be solved by engineering designs, and generate ideas and possible constraints for solving a problem.
4	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.	4.1.2.2.2	Generate alternative solutions to an engineering problem and display them in graphic form.

4	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.	4.1.2.2.3	Test and evaluate solutions, including benefits and drawbacks for the engineering problem, and communicate the results effectively.
4	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	4.1.3.1.1	Describe a system in terms of inputs and outputs.
4	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. The needs of any society influence what aspects of technology are developed and how they are used.	4.1.3.3.1	Describe a technology that is an intrinsic part of human cultures and how the availablity of that technology greatly influences human life.
4	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. The needs of any society influence what aspects of technology are developed and how they are used.	4.1.3.3.2	Describe a situation in which one invention led to other inventions. Once an invention exists, people are likely to think of ways to use it that were never imagined before.
4	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. The needs of any society influence what aspects of technology are developed and how they are used.	4.1.3.3.3	Provide an example where science or technology does not provide an accceptable solution to a problem or fulfill every human need.
5	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical	5.1.1.1.1	Explain why evidence, clear communication and skeptisim is an essential part of doing science.
5	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical	5.1.1.1.2	Understand that because we expect science investigations that are done the same way to produce the same results, it is important to try to figure out why when they do not.

5	1. The Nature of Science and Engineering	1. The Practice of Science	1.Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical review.	5.1.1.1.3	Understand that sometimes there are different explanations for the same observations, which usually leads to making more observations to try to resolve the differences and determine which explanation is correct.
5	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical	5.1.1.1.4	Recognize the importance of accurate record keeping, openness to scrutiny and replication in building scientific knowledge that eventually becomes available to everyone in the world.
5	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical	5.1.1.1.5	Understand that different models can be used to represent the same thing.
5	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical review.	5.1.1.1.6	Provide examples of scientific investigations that take different forms based on the type of question asked: observing what things are like or what is happening somewhere; collecting specimens for analysis; doing experiments; or examining pre-existing data.
5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative	5.1.1.2.1	Share, critique and analyze one's own observations and speculations and those of classmates.
5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative	5.1.1.2.2	Refine and refocus broad and ill-defined questions so that they are answerable using a scientific investigation.
5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	5.1.1.2.3	Identify and collect relevant evidence, make systematic observations and accurate measurements, and identify and control variables in a scientific investigation.
5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative	5.1.1.2.4	Use appropriate tools (including computers) and techniques (including mathematics and graphing) in gathering, analyzing and interpreting data.
5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	5.1.1.2.5	Support one's statements with scientifically acceptable evidence found in books, articles and databases, and identify the sources using conventional guidelines.

5	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	5.1.3.2.1	Describe how science and engineering influence and are influenced by local traditions and beliefs.
5	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	5.1.3.2.2	Compare and contrast the work of scientists and the work of engineers.
6	1. The Nature of Science and Engineering	2. The Practice 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 its impact on the daily life of humans, the local environment and wildlife habitat.
6	1. The Nature of Science and Engineering	2. The Practice 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.	6.1.2.1.2	Recognize that there is no perfect design and that new technologies have side effects that may increase some risks and decrease others.
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of devising a product or solution to meet a desired need or solve a specific problem.	6.1.2.2.1	Apply an engineering design process to solve problems in and beyond the classroom.
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of devising a product or solution to meet a desired need or solve a specific problem.	6.1.2.2.2	Specify criteria and constraints for the design.
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of devising a product or solution to meet a desired need or solve a specific problem.	6.1.2.2.3	Make two- and three- dimensional representations of the design solutions.
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of devising a product or solution to meet a desired need or solve a specific problem.	6.1.2.2.4	Test and evaluate the design according to pre-established requirements, such as criteria and constraints, and refine the design as needed.
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of devising a product or solution to meet a desired need or solve a specific problem.	6.1.2.2.5	Construct a product or system and document the solution.

6	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	6.1.3.1.1	Describe a system in terms of parts, processes, subsystems, inputs and outputs.
6	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	6.1.3.1.2	Distinguish between open and closed systems.
7	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world that is characterized by empirical criteria, logical argument and	7.1.1.1.1	Understand that prior expectations may create bias when conducting scientific investigations.
7	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world that is characterized by empirical criteria, logical argument and skeptical review.	7.1.1.1.2	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 whether there are different results because of differences in the things being investigated, the methods used, the circumstances in which the investigation is carried out, or just because of uncertainties.
7	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	7.1.1.2.1	Generate a variety of scientific questions and match them with appropriate methods of investigation (for example: observational, experimental, reviewing existing work and making models).
7	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural and engineered world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	7.1.1.2.2	Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, and pointing out statements that go beyond the evidence; suggest alternative explanations.
7	1. The Nature of Science and Engineering	2. The Practice 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, and durability and cost; describe reasonable personal tradeoffs among them.

7	1. The Nature of Science and Engineering	2. The Practice 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.	7.1.2.1.2	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. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. The needs of any society influence what aspects of technology are developed and how they are used.	7.1.3.3.1	Identify a technology that has dramatically changed how people live and work and explain how it resulted in rapid increases in the human population.
8	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world that is characterized by empirical criteria, logical argument and skeptical review.	8.1.1.1.1	Notice and criticize the reasoning in arguments in which fact and opinion are intermingled or when conclusions do not follow logically from the evidence given.
8	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world that is characterized by empirical criteria, logical argument and skeptical review.	8.1.1.1.2	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. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry.	8.1.1.2.1	Use logical reasoning and imagination to develop descriptions, explanations, predictions and models based on evidence; differentiate between explanation and description.
8	1. The Nature of Science and Engineering	2. The Practice 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 constraints like scientific laws, engineering principles, properties of materials and construction techniques must be taken into account in designing engineering solutions.
8	1. The Nature of Science and Engineering	2. The Practice 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.	8.1.2.1.2	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. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	8.1.3.2.1	Recognize that increased participation and contribution in science and engineering by women and racial minorities is due to increased opportunities in education and employment for all.
8	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	8.1.3.2.2	List examples of important contributions to the advancement of science, engineering and technology made by individuals of different kinds of people and different cultures at different times.
8	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. The needs of any society influence what aspects of technology are developed and how they are used.	8.1.3.3.1	Describe a situation in which science can 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 moral or immoral.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. 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 and peer	9.1.1.1.1	Explain how the strongly held traditions of science, (including its commitment to peer review, publications and presentations) serve to keep the vast majority of scientists well within the bounds of ethical professional behavior.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. Science is based on the assumption that the universe is a vast single system in which the basic rules are the same everywhere and that things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study and peer	9.1.1.1.2	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 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. Science is based on the assumption that the universe is a vast single system in which the basic rules are the same everywhere and that things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study and peer	9.1.1.1.3	Identify sources of bias and how bias might influence the direction of research and the interpretation of data.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. Science is based on the assumption that the universe is a vast single system in which the basic rules are the same everywhere and that things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study and peer	9.1.1.1.4	Understand that scientific knowledge is a particular kind of knowledge with its own sources of justifications and uncertainties.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. Science is based on the assumption that the universe is a vast single system in which the basic rules are the same everywhere and that things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study and peer	9.1.1.1.5	Recognize that the usefulness of a model can be tested by comparing its prediction to actual observations in the real world. A phenomenon may have more than one model that explains observations.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. Science is based on the assumption that the universe is a vast single system in which the basic rules are the same everywhere and that things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study and peer	9.1.1.1.6	Understand that changes occur in scientific knowledge, but generally in small ways and almost always building on earlier knowledge.

9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. Science is based on the assumption that the universe is a vast single system in which the basic rules are the same everywhere and that things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study and peer	9.1.1.1.7	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, germ theory of disease, and the big bang theory.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a complex social enterprise with a goal of understanding the natural world. Science is based on the assumption that the universe is a vast single system in which the basic rules are the same everywhere and that things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study and peer	9.1.1.1.8	Understand that scientists conduct investigations for a wide variety of reasons: to discover new aspects of the natural world, to explain recently observed phenomena, to test the conclusions of prior investigations or to test the predictions of current theories.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.1	Formulate testable hypotheses and demonstrate the logical connections between the scientific concepts guiding an hypothesis and the design of an experiment.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.2	Design and conduct scientific investigations using various approaches such as field studies, observational studies and experimental studies.

9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.3	Use appropriate tools (including computers) and techniques (including mathematical formulas, statistics and graphing) in gathering, analyzing and interpreting data.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.4	Express concepts, summarize data, use appropriate terminology, explain statistical analysis, construct a reasonable argument, make charts and diagrams, and respond appropriately to critical comments verbally and in writing.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.5	Identify the critical assumptions behind a line of reasoning so that the validity of the position being taken can be judged.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.6	Evaluate personal models and/or explanations in light of scientifically acceptable alternative explanations and revise one's work in light of reasonable criticism.

9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.7	Use scientifically acceptable evidence, apply logic, create explanations and/or models, and construct arguments for one's proposed explanations and/or models.
9 through 12	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes used to pose questions about the natural world and investigate phenomena. There are multiple sequences that may be used for the process of inquiry. It requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations based on scientifically	9.1.1.2.8	Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific explanations.
9 through 12	1. The Nature of Science and Engineering	2. The Practice 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 for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.2	Recognize that failure is an important component of engineering. Systems fail because they have faulty or poorly matched parts, were used in ways that exceed what was intended by the design, or were poorly designed from the start.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.3	Suggest alternative tradeoffs and decisions in designs and criticize those ideas in which major tradeoffs are not acknowledged.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.4	Recognize that risk analysis is used to minimize the likelihood of unwanted side effects of a new technology.

9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.5	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 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.6	Explain and give examples of how, in the design of 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 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.7	Understand that perfect solutions to engineering problems do not exist and that solutions may not be permanent.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems which may impact society and may make humans more productive.	9.1.2.1.8	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 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the creative 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.	9.1.2.2.1	Identify a design problem and decide whether it is feasible to address it.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the creative 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.	9.1.2.2.2	Identify criteria and constraints and determine how these will affect the design process.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the creative 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.	9.1.2.2.3	Refine a design by using prototypes and modeling to ensure the quality, efficiency and productivity of the final product.

9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the creative 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.	9.1.2.2.4	Evaluate the designed solution using conceptual, physical and mathematical models at various intervals of the design process, to check for proper design and to note areas where improvements are needed.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the creative 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.	9.1.2.2.5	Develop and produce a product or system using a design process.
9 through 12	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the creative 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.	9.1.2.2.6	Evaluate final solutions and communicate observations, processes and results of the entire design process using verbal, graphic, quantitative, virtual, and written means, and three-dimensional models.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	9.1.3.1.1	Describe the interaction between systems in terms of boundaries, relation to other systems, and inputs and outputs.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	9.1.3.1.2	Identify systems in which the systems' interactions can create properties that are different from the properties of each of the individual systems.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	9.1.3.1.3	Describe how both positive and negative feedback are used in a system to make it more efficient; describe how systems change over time.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	1. 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.	9.1.3.1.4	Identify a system and provide examples of unintended consequences.

9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	9.1.3.2.1	Provide examples of the many scientific and mathematical ideas and technological inventions contributed from diverse cultures, including: natives from all of the Americas, Egyptians, Greeks, Chinese, Hindus, Arabs and Europeans.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. Science and engineering are not separate from society but rather are a part of society and reflect society's values. Science, engineering and technology alone can only indicate what can happen, not what should	9.1.3.3.1	Provide examples of different types of realistic constraints (economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability) involved in science and engineering.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. Science and engineering are not separate from society but rather are a part of society and reflect society's values. Science, engineering and technology alone can only indicate what can happen, not what should	9.1.3.3.2	Provide examples in which the value of any given technology may be different for different groups at different points in time.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. Science and engineering are not separate from society but rather are a part of society and reflect society's values. Science, engineering and technology alone can only indicate what can happen, not what should	9.1.3.3.3	Understand that science and engineering are not separate from society but rather are a part of society and reflect society's values. Understanding science and technology alone will not resolve local, national, or global challenges.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	3. Science and engineering are not separate from society but rather are a part of society and reflect society's values. Science, engineering and technology alone can only indicate what can happen, not what should happen.	9.1.3.3.4	Describe a situation when scientists cannot bring definitive answers to matters of public debate because there may be little reliable data available, 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 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Science, technology and engineering rely on each other to enhance knowledge and understanding within each discipline-and across disciplines-in industry as well as academia.	9.1.3.4.1	Describe how 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 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Science, technology and engineering rely on each other to enhance knowledge and understanding within each discipline-and across disciplines-in industry as well as academia.	9.1.3.4.2	Provide an example in which engineers use knowledge of science and technology, together with strategies of design, to solve practical problems.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Science, technology and engineering rely on each other to enhance knowledge and understanding within each discipline-and across disciplines-in industry as well as academia.	9.1.3.4.3	Provide examples of how different types of questions and their associated methodology are used by scientists and engineers for investigations in different disciplines.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Science, technology and engineering rely on each other to enhance knowledge and understanding within each discipline-and across disciplines-in industry as well as academia.	9.1.3.4.4	Describe how scientific investigations and engineering processes require multidisciplinary contributions and efforts, and that disciplines do not have fixed boundaries. Scientific disciplines are being formed where existing ones meet, and some sub-disciplines spin off to become disciplines of their own.
9 through 12	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Science, technology and engineering rely on each other to enhance knowledge and understanding within each discipline-and across disciplines-in industry as well as academia.	9.1.3.4.5	Provide examples of how of the use of technology and mathematics by scientists and engineers improves investigations and communication.

Grade	Strand	Substrand	Standard	Code	Benchmark
K	2. Physical Science	1.Matter	1. Objects can be described in terms of the materials they are made of and their physical properties. Some objects are composed of a single substance and others are composed of more than one substance.	0.2.1.1.1	Sort objects in terms of color, size and shape.
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.
1	2. Physical Science	1. Matter	1. Objects can be described in terms of the materials they are made of and their physical properties. Some objects are composed of a single substance and others are composed of more than one substance.	1.2.1.1.1	Describe how parts are used to make up a whole object.
1	2. Physical Science	1. Matter	1. Objects can be described in terms of the materials they are made of and their physical properties. Some objects are composed of a single substance and others are composed of more than one substance.	1.2.1.1.2	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.
1	2. Physical Science	2. Motion	1. Motion of an object can be described by a change in its position over time. The motion of an object can be changed by a push or a pull.	1.2.2.1.1	Describe an object's position relative to other objects or a background.
1	2. Physical Science	2. Motion	1. Motion of an object can be described by a change in its position over time. The motion of an object can be changed by a push or a pull.	1.2.2.1.2	Recognize that objects move in a variety of ways, including a straight line, a curve, a circle, back and forth, and at different speeds.
1	2. Physical Science	2. Motion	1. Motion of an object can be described by a change in its position over time. The motion of an object can be changed by a push or a pull.	1.2.2.1.3	Demonstrate how push and pull forces can make objects move.
1	2. Physical Science	2. Motion	1. Motion of an object can be described by a change in its position over time. The motion of an object can be changed by a push or a pull.	1.2.2.1.4	Describe how things near Earth fall to the ground unless something holds them up.

2	2. Physical Science	1. Matter	1. Objects can be described in terms of the materials they are made of and their physical properties. Some objects are composed of a single substance and others are composed of more than one substance.	2.2.1.1.1	Describe objects in terms of color, size, shape, weight, texture, flexibility and strength.
2	2. Physical Science	1. Matter	2. Things can be done to materials to change some of their physical properties, but not all materials respond the same way to what is done to them.	2.2.1.2.1	Recognize that water can be a solid or liquid and can change from one state to the other and that the weight of water stays the same when it melts and freezes.
2	2. Physical Science	1. Matter	2. Things can be done to materials to change some of their physical properties, but not all materials respond the same way to what is done to them.	2.2.1.2.2	Recognize that objects and substances do not act the same when compacted, heated, cooled or dissolved in water.
3	2. Physical Science	3. Energy	1. Energy appears in different forms, including sound and light.	3.2.3.1.1	Recognize that vibrating objects produce a sound.
3	2. Physical Science	3. Energy	1. Energy appears in different forms, including sound and light.	3.2.3.1.2	Explain the relationship between the pitch of a sound and the rate of vibration of the source.
3	2. Physical Science	3. Energy	1. Energy appears in different forms, including sound and light.	3.2.3.1.3	Explain how shadows are formed when light strikes objects through which it cannot pass.
3	2. Physical Science	3. Energy	1. Energy appears in different forms, including sound and light.	3.2.3.1.4	Describe how light travels in a straight line until it is absorbed, redirected, reflected or allowed to pass through an object.
4	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.	4.2.1.1.1	Explain that the weight of an object is equal to the sum of the weights of its parts.
4	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.	4.2.1.1.2	Sort and classify objects using properties of matter, including volume, temperature, durability, resistance to water or fire, and ease of conducting heat.

4	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.	4.2.1.1.3	Use appropriate tools to measure temperature, volume, weight and length.
4	2. Physical Science	1. Matter	2. Solids, liquids and gases are states of matter that each have unique properties.	4.2.1.2.1	Describe how the states of matter change as a result of heating and cooling.
4	2. Physical Science	1. Matter	2. Solids, liquids and gases are states of matter that each have unique properties.	4.2.1.2.2	Distinguish between solids, liquids and gases in terms of shape, volume and compressability.
4	2. Physical Science	3. Energy	1. Energy appears in different forms, including heat and electromagnetism.	4.2.3.1.1	Recognize that heat results when substances burn, when certain materials are rubbed together, and when electricity flows through wires.
4	2. Physical Science	3. Energy	1. Energy appears in different forms, including heat and electromagnetism.	4.2.3.1.2	Identify objects and materials that conduct heat and electricity and those that are insulators.
4	2. Physical Science	3. Energy	1. Energy appears in different forms, including heat and electromagnetism.	4.2.3.1.3	Construct a simple electrical circuit using components such as wires, batteries, bells and bulbs.
4	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	4.2.3.2.1	Explain heat transfer when a warm and a cool object are touching or placed near each other.
4	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	4.2.3.2.2	Describe how increasing the temperature of a substance requires the addition of energy.
4	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	4.2.3.2.3	Demonstrate how the flow of electricity produces heat, light and sound.
4	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	4.2.3.2.4	Describe how magnets can repel or attract each other and how they can attract certain non-magnetic objects from a distance.
4	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	4.2.3.2.5	Demonstrate how an electric current can produce a magnetic force.

5	2. Physical Science	2. Motion	1. An object's motion is affected by forces and can be described by the object's speed and the direction it is moving.	5.2.2.1.1	Demonstrate that there must be unbalanced forces to cause a change in the speed or direction of the motion of an object.
5	2. Physical Science	2. Motion	1. An object's motion is affected by forces and can be described by the object's speed and the direction it is moving.	5.2.2.1.2	Recognize that when the forces are balanced, the object remains at rest or continues to move at a constant speed in a straight line.
5	2. Physical Science	2. Motion	1. An object's motion is affected by forces and can be described by the object's speed and the direction it is moving.	5.2.2.1.3	Explain how applied forces, including gravity and friction, affect the motion of objects.
5	2. Physical Science	2. Motion	1. An object's motion is affected by forces and can be described by the object's speed and the direction it is moving.	5.2.2.1.4	Give examples of simple machines and describe how they change the input and output of forces and motion.
6	2. Physical Science	1. Matter	1. Pure substances can be identified by properties which are independent of the sample of the substance and can be explained by a model of matter that is composed of small particles.	6.2.1.1.1	Compare the motion and arrangement of particles in solids, liquids and gases; explain melting, freezing, boiling and evaporation, in terms of particle motion and heat.
6	2. Physical Science	1. Matter	1. Pure substances can be identified by properties which are independent of the sample of the substance and can be explained by a model of matter that is composed of small particles.	6.2.1.1.2	Explain density, dissolving, compression, diffusion and thermal expansion using the small particle model of matter.
6	2. Physical Science	1. Matter	1. Pure substances can be identified by properties which are independent of the sample of the substance and can be explained by a model of matter that is composed of small particles.	6.2.1.1.3	Distinguish between a mixture and a pure substance and use physical properties including color, solubility, density, melting point and boiling point to separate mixtures and identify pure substances.
6	2. Physical Science	1. Matter	2. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass in a closed system.	6.2.1.2.1	Identify evidence of physical changes, including changes in phase, shape, crystalline structure and dissolving in other materials.
6	2. Physical Science	1. Matter	2. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass in a closed system.	6.2.1.2.2	Describe how matter is conserved during a physical change in a closed system.

6	2. Physical Science	2. Motion	1. The motion of an object can be described in terms of position, direction and speed.	6.2.2.1.1	Measure and calculate the speed of an object that is traveling in a straight line.
6	2. Physical Science	2. Motion	1. The motion of an object can be described in terms of position, direction and speed.	6.2.2.1.2	Graph an object's position as a function of time and an object's speed as a function of time for an object traveling in a straight line; use the graphs to describe the object's motion.
6	2. Physical Science	2. Motion	2. Forces have magnitude and direction and govern the motion of objects.	6.2.2.2.1	Recognize that some forces between objects act when the objects are in direct contact and others, such as magnetic, electrical, and gravitational forces can act from a distance.
6	2. Physical Science	2. Motion	2. Forces have magnitude and direction and govern the motion of objects.	6.2.2.2.2	Identify the forces acting on an object and describe how the sum of the forces affects the motion of the object.
6	2. Physical Science	2. Motion	2. Forces have magnitude and direction and govern the motion of objects.	6.2.2.2.3	Distinguish between mass and weight.
6	2. Physical Science	3. Energy	1. Waves involve the transfer of energy without the transfer of matter.	6.2.3.1.1	Describe properties of waves, including speed, wavelength, frequency and amplitude.
6	2. Physical Science	3. Energy	1. Waves involve the transfer of energy without the transfer of matter.	6.2.3.1.2	Explain how the vibration of particles in air and other materials results in the transfer of information and energy through sound waves.
6	2. Physical Science	3. Energy	1. Waves involve the transfer of energy without the transfer of matter.	6.2.3.1.3	Use wave properties of light to explain reflection, refraction and the color spectrum.
6	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	6.2.3.2.1	Recognize that objects and substances in motion have kinetic energy.
6	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	6.2.3.2.2	Recognize that potential energy is stored energy that can be in the form of gravitational, elastic and chemical energy.

6	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	6.2.3.2.3	Differentiate between kinetic and potential energy and identify situations where kinetic energy is converted to potential energy and vice versa.
6	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	6.2.3.2.4	Trace the changes of energy forms, including thermal, electrical, mechanical, or others as energy is used for transportation, lighting or other purposes.
6	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	6.2.3.2.5	Describe how energy is transferred in conduction, convection and radiation.
7	2. Physical Science	1. Matter	1. The idea that matter is made up of atoms and molecules provides the basis for understanding the properties of matter.	7.2.1.1.1	Recognize that all substances are composed of 1 or more of approximately 100 different elements and that the periodic table organizes the elements into groups with similar properties.
7	2. Physical Science	1. Matter	1. The idea that matter is made up of atoms and molecules provides the basis for understanding the properties of matter.	7.2.1.1.2	Describe the differences between elements and compounds in terms of atoms and molecules.
7	2. Physical Science	1. Matter	2. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass in a closed system.	7.2.1.2.1	Recognize that a chemical equation describes a chemical change where two or more substances react and produce one or more different substances whose properties are different from the reacting substances.
7	2. Physical Science	1. Matter	2. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass in a closed system.	7.2.1.2.2	Distinguish between chemical and physical changes in matter.
8	2. Physical Science	1. Matter	2. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass in a closed system.	8.2.1.2.1	Identify evidence of chemical changes such as color change, gas evolution, solid formation and temperature change.
8	2. Physical Science	1. Matter	2. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass in a closed system.	8.2.1.2.2	Explain how the rearrangement of atoms in a chemical reaction illustrates the law of conservation of mass.

8	2. Physical Science	1. Matter	2. Substances can undergo physical and/or chemical changes which may change the properties of the substance but do not change the total mass in a closed system.	8.2.1.2.3	Recognize that acids are compounds whose properties include a sour taste, characteristic color changes with litmus and other acid/base indicators, and the tendency to react with bases to produce a salt and water.
8	2. Physical Science	3. Energy	1. Waves involve the transfer of energy without the transfer of matter.	8.2.3.1.1	Explain how seismic waves transfer energy through the Earth and across its surfaces.
9 through 12	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical properties of matter. 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.	9.2.1.1.1	Identify protons, neutrons and electrons as the major components of a neutral atom; their mass relative to one another; their arrangement; and their charge.
9 through 12	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical properties of matter. 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.	9.2.1.1.2	Explain the relationship of an element's position on the periodic table to its atomic number and atomic mass; use the periodic table to identify regions, groups and periods.
9 through 12	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical properties of matter. 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.	9.2.1.1.3	Compare and contrast an element and its isotopes and describe how radioactive isotopes can be used in research, medicine and industry.
9 through 12	2. Physical Science	1. Matter	2. Chemical reactions involve the rearrangement of atoms as chemical bonds are broken and formed through transferring or sharing of electrons and the absorption or release of energy.	9.2.1.2.1	Describe the role of valence electrons in the formation of chemical bonds.
9 through 12	2. Physical Science	1. Matter	2. Chemical reactions involve the rearrangement of atoms as chemical bonds are broken and formed through transferring or sharing of electrons and the absorption or release of energy.	9.2.1.2.2	Use temperature change in a chemical reaction to identify the reaction as exothermic or endothermic.

9 through 12	2. Physical Science	2. Motion	1. The relationship between force, mass and acceleration determines the motion of objects.	9.2.2.1.1	Recognize that the mass (inertia) of an object causes it to resist changes in motion.
9 through 12	2. Physical Science	2. Motion	1. The relationship between force, mass and acceleration determines the motion of objects.	9.2.2.1.2	Explain how the magnitude of an object's acceleration depends directly on the strength of the net force and inversely on the mass of the object and use this relationship to calculate force, mass and/or acceleration of an object.
9 through 12	2. Physical Science	2. Motion	1. The relationship between force, mass and acceleration determines the motion of objects.	9.2.2.1.3	Recognize that whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted by the second object back on the first object.
9 through 12	2. Physical Science	2. Motion	1. The relationship between force, mass and acceleration determines the motion of objects.	9.2.2.1.4	Recognize that between all objects there is a gravitational force of attraction that is related to the mass of the objects and the distance between them.
9 through 12	2. Physical Science	3. Energy	1. Small amounts of matter are transformed into large amounts of energy in nuclear reactions.	9.2.3.1.1	Recognize that the forces holding the nucleus of an atom together are stronger than gravitational and electromagnetic forces.
9 through 12	2. Physical Science	3. Energy	1. Small amounts of matter are transformed into large amounts of energy in nuclear reactions.	9.2.3.1.2	Distinguish between nuclear and chemical reactions.
9 through 12	2. Physical Science	3. Energy	1. Small amounts of matter are transformed into large amounts of energy in nuclear reactions.	9.2.3.1.3	Distinguish between fission, fusion and radioactive decay.
9 through 12	2. Physical Science	3. Energy	1. Small amounts of matter are transformed into large amounts of energy in nuclear reactions.	9.2.3.1.4	Explain how materials can be dated based on the half-life of a radioactive isotope.

9 through 12	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	9.2.3.2.1	Use the kinetic molecular theory to explain the relationship between temperature and state.
9 through 12	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	9.2.3.2.2	Compare the wavelength, frequency and energy of different kinds of waves in the electromagnetic spectrum and describe their applications.
9 through 12	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	9.2.3.2.3	Describe the static-electric charge on an object and its effect upon other objects in terms of electron distribution.
9 through 12	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	9.2.3.2.4	Explain and calculate the relationship of current, voltage, resistance and power in simple electric circuits.
9 through 12	2. Physical Science	3. Energy	2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.	9.2.3.2.5	Calculate and explain the energy, work and power involved in energy transfers in a mechanical system.
9 through 12	2. Physical Science	4. Human Interaction with Physical Systems	1. The production and use of energy involves many advantages and disadvantages which must be considered when decisions are made.	9.2.4.1.1	Use the principle of conservation of energy to identify the primary energy transformations and transfers that describe the production, storage and transmission of electricity.
9 through 12	2. Physical Science	4. Human Interaction with Physical Systems	1. The production and use of energy involves many advantages and disadvantages which must be considered when decisions are made.	9.2.4.1.2	Compare the advantages and disadvantages of generating electricity using various sources or energy, such as fossil fuels, nuclear fission, wind, sun or tidal energy; include the environmental and financial impacts of each choice.

9 through 12	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 through 12	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.	9.2.4.2.2	Use unit conversions/dimensional analysis to solve problems and check results.
9 through 12	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.	9.2.4.2.3	Apply understanding of accuracy and precision to describe how measurements are uncertain based on the limitations of the measuring device and the technique used.
9 through 12	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.	9.2.4.2.4	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 through 12	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.	9.2.4.2.5	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.
CHEM	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical properties and changes in matter. 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 relationship of an element’s position on the periodic table to its atomic number and electron configuration.

CHEM	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical properties and changes in matter. 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.2.1.1.2	Identify and compare trends on the periodic table, including reactivity and relative sizes of atoms and ions; use the trends to explain the properties of subgroups, metals, nonmetals, alkali metals, alkaline earth metals, halogens and 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.	9C.2.1.2.1	Explain how elements combine to form compounds through ionic and covalent bonding.
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.	9C.2.1.2.2	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.
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.	9C.2.1.2.3	Compare and contrast the structure, properties and uses of organic compounds including hydrocarbons, alcohols, sugars, fats and proteins.
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.2.1.2.4	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.	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).
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.	9C.2.1.3.2	Balance chemical equations by applying the laws of conservation of mass and constant composition.

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.	9C.2.1.3.3	Determine the molar mass of a compound from its chemical formula and a table of atomic masses; convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.
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.	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.
CHEM	2. Physical Science	1. Matter	4. Chemical equilibrium is a dynamic process that directs chemical interactions.	9C.2.1.4.2	Describe the effects of solubility to phenomena and applications, such as water pollution, human body systems and the atmosphere.
CHEM	2. Physical Science	1. Matter	4. Chemical equilibrium is a dynamic process that directs chemical interactions.	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.
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 explain how changes in energy content affect the state of matter (solid, liquid, gaseous phases).
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.2.1.5.2	Explain the roles of pressure and temperature in changes of phase of matter.
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.2.1.5.3	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.

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.2.1.5.4	Relate the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.
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 the degree of randomness in chemical reactions.
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.
CHEM	2. Physical Science	4. Human Interactions with Physical Systems	1. Physical and mathematical models are used to describe physical systems.	9C.2.4.1.2	Use an understanding of the accuracy and precision in scientific measurements to determine and express the uncertainty of a result using significant figures.
CHEM	2. Physical Science	4. Human Interactions with Physical Systems	1. Physical and mathematical models are used to describe physical systems.	9C.2.4.1.3	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.
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.2.4.2.2	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.

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	Describe how experimental evidence led Dalton, Rutherford, Thompson, Chadwick and Bohr to develop increasingly accurate models of the atom.
PHYS	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical and nuclear properties and reactions.	9P.2.1.1.2	Explain the factors that cause some nuclei to be stable and others to be unstable, which leads to nuclear disintegration.
PHYS	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical and nuclear properties and reactions.	9P.2.1.1.3	Explain the relationships among atomic number, mass number, isotope and radioisotope.
PHYS	2. Physical Science	1. Matter	1. The structure of the atom can be used to explain chemical and nuclear properties and reactions.	9P.2.1.1.4	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 under the influence of external forces.
PHYS	2. Physical Science	2. Motion	1. Forces and momentum determine the motion of massive objects.	9P.2.2.1.2	Use vectors and free-body diagrams to describe force, position, velocity, and acceleration of objects in two-dimensional space.
PHYS	2. Physical Science	2. Motion	1. Forces and momentum determine the motion of massive objects.	9P.2.2.1.3	Apply Newton’s three laws of motion to calculate and analyze the effect of forces and momentum on motion.
PHYS	2. Physical Science	2. Motion	1. Forces and momentum determine the motion of massive objects.	9P.2.2.1.4	Describe circular motion in terms of centripetal force, angular velocity and angular momentum.
PHYS	2. Physical Science	2. Motion	1. Forces and momentum determine the motion of massive objects.	9P.2.2.1.5	Use Newton's law of gravitation to explain the motion of objects near earth and in the universe.
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 amount of mechanical energy remains constant.	9P.2.2.2.1	Explain and calculate the work, power, potential energy and kinetic energy involved in objects moving under the influence of gravity and other mechanical forces.

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 amount of mechanical energy remains constant.	9P.2.2.2.2	Calculate the change in velocity for objects subject to forces parallel to, and perpendicular to, the direction of motion.
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 amount of mechanical energy remains constant.	9P.2.2.2.3	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 Hooke's law and Newton's laws. The natural frequency of such a system is its resonance frequency.	9P.2.2.3.1	Using Hooke's Law, calculate the work done in moving an object against the force of a spring.
PHYS	2. Physical Science	2. Motion	3. Oscillatory systems can be analyzed using Hooke's law and Newton's laws. The natural frequency of such a system is its resonance frequency.	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	3. Oscillatory systems can be analyzed using Hooke's law and Newton's laws. The natural frequency of such a system is its resonance frequency.	9P.2.2.3.3	Calculate the energy in a spring-and-mass system from its amplitude of motion, mass and spring constant.
PHYS	2. Physical Science	2. Motion	4. Sound waves are generated from mechanical oscillations of objects and are propagated through 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.
PHYS	2. Physical Science	2. Motion	4. Sound waves are generated from mechanical oscillations of objects and are propagated through a medium.	9P.2.2.4.2	Explain how wave properties such as interference, resonance, refraction and reflection affect sound.
PHYS	2. Physical Science	2. Motion	4. Sound waves are generated from mechanical oscillations of objects and are propagated through a medium.	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.

PHYS	2. Physical Science	3. Energy	1. Electrical Forces result from interactions between charges, which can be described by electric fields.	9P.2.3.1.2	Explain how the electric field and force on a charged particle are related to the electric potential.
PHYS	2. Physical Science	3. Energy	1. Electrical Forces result from interactions between charges, which can be described by electric fields.	9P.2.3.1.3	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.
PHYS	2. Physical Science	3. Energy	2. Charged electrons respond to electrical voltages by moving through electrical circuits. This motion generates magnetic fields.	9P.2.3.2.2	Represent electrical circuits with components in parallel and series to one another and calculate the resistance in each case.
PHYS	2. Physical Science	3. Energy	2. Charged electrons respond to electrical voltages by moving through electrical circuits. This motion generates magnetic fields.	9P.2.3.2.3	Explain how the current produced by a changing magnetic field in a loop of wire can be used to produce electricity.
PHYS	2. Physical Science	3. Energy	2. Charged electrons respond to electrical voltages by moving through electrical circuits. This motion generates magnetic fields.	9P.2.3.2.4	Explain how the force produced on a magnet by a current carrying wire forms the basis for electrical motors.
PHYS	2. Physical Science	3. Energy	2. Charged electrons respond to electrical voltages by moving through electrical circuits. This motion generates magnetic fields.	9P.2.3.2.5	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.
PHYS	2. Physical Science	3. Energy	3. Magnetic and electric fields interact to produce electromagnetic waves which have both wave and particle properties.	9P.2.3.3.2	Quantitatively relate the speed of light in a medium to its frequency and wavelength in that medium, and in free space.
PHYS	2. Physical Science	3. Energy	3. Magnetic and electric fields interact to produce electromagnetic waves which have both wave and particle properties.	9P.2.3.3.3	Use Snell's law to explain the refraction and Total Internal Reflection of light in transparent media, such as lenses and fiber optics.
PHYS	2. Physical Science	3. Energy	3. Magnetic and electric fields interact to produce electromagnetic waves which have both wave and particle properties.	9P.2.3.3.4	Use properties of light, including reflection, refraction, interference, Doppler Effect and the photoelectric effect, to explain phenomena and describe applications.

PHYS	2. Physical Science	3. Energy	3. Magnetic and electric fields interact to produce electromagnetic waves which have both wave and particle properties.	9P.2.3.3.5	Compare the wave model and particle models in explaining properties of light.
PHYS	2. Physical Science	3. Energy	3. Magnetic and electric fields interact to produce electromagnetic waves which have both wave and particle properties.	9P.2.3.3.6	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 and calculate the quantity of heat transferred by conduction based on specific heat, density and temperatures of solids and liquids.
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.2.3.4.2	Explain the role of gravity, pressure and density in the convection of heat by a fluid.
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.2.3.4.3	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	Examine potential careers in physics related areas.
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.2.4.1.2	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 Physical Systems	2. Physical and mathematical models are used to describe physical systems.	9P.2.4.2.1	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.

PHYS	2. Physical Science	4. Human Interaction with Physical Systems	2. Physical and mathematical models are used to describe physical systems.	9P.2.4.2.2	Use the techniques of error propagation to analyze the degree of certainty in experimental results.

Grade	Strand	Substrand	Standard	Code	Benchmark
K	3. Earth Science	2. Interdependence within the Earth system	2. Weather changes from day to day and with the seasons. Weather can be described in measurable quantities.	0.3.2.2.1	Monitor daily and seasonal changes in weather and summarize the changes.
1	3. Earth Science	1. Earth Structure and Processes	3. Rocks and soil are Earth materials. Physical properties of Earth materials make them useful in different ways.	1.3.1.3.1	Group or classify rocks in terms of color, shape and size.
1	3. Earth Science	1. Earth Structure and Processes	3. Rocks and soil are Earth materials. Physical properties of Earth materials make them useful in different ways.	1.3.1.3.2	Describe the differences between soil and rocks.
1	3. Earth Science	1. Earth Structure and Processes	3. Rocks and soil are Earth materials. Physical properties of Earth materials make them useful in different ways.	1.3.1.3.3	Locate places in the community where rocks are used; for example, identify where rock is used within a school.
2	3. Earth Science	2. Interdependence within the Earth system	2. Weather changes from day to day with the seasons, and can be described in measurable quantities, including temperature, wind direction and speed, and precipitation.	2.3.2.2.1	Measure, record and describe weather conditions using common tools, including a thermometer and rain gauge.
2	3. Earth Science	2. Interdependence within the Earth system	2. Weather changes from day to day with the seasons, and can be described in measurable quantities, including temperature, wind direction and speed, and precipitation.	2.3.2.2.2	Correlate various cloud types, including cumulus, cirrus and stratus, with different weather conditions.
3	3. Earth Science	3. The Universe	1. The sun, moon and stars all have locations and movements that can be observed and described.	3.3.3.1.1	Observe and describe the changes in the position of the sun.
3	3. Earth Science	3. The Universe	1. The sun, moon and stars all have locations and movements that can be observed and described.	3.3.3.1.2	Relate the Earth's rotation to the apparent movement of the sun and moon in the sky, from east to west.
3	3. Earth Science	3. The Universe	1. The sun, moon and stars all have locations and movements that can be observed and described.	3.3.3.1.3	Recognize that there is a repeating pattern in the apparent changes in the shape of the moon over time.
3	3. Earth Science	3. The Universe	1. The sun, moon and stars all have locations and movements that can be observed and described.	3.3.3.1.4	Use models to demonstrate how the Earth’s rotation and revolution cause changes between day and night, and seasons of the year.

3	3. Earth Science	3. The Universe	2. The universe consists of countless more objects than we can see unaided, and from Earth those objects appear as points of light with distinctive patterns of motion.	3.3.3.2.1	Demonstrate how a large light source at a great distance looks like a small light that is much closer. Apply the previous principle to explain how the sun is really a star which looks big because it is relatively close to the Earth.
3	3. Earth Science	3. The Universe	2. The universe consists of countless more objects than we can see unaided, and from earth those objects appear as points of light with distinctive patterns of motion.	3.3.3.2.2	Recognize that the Earth is one of several planets that orbit the sun, and that the moon orbits the Earth.
4	3. Earth Science	1. Earth Structure and Processes	3. There are different kinds of rocks.	4.3.1.3.1	Observe that rocks may be uniform or made of mixtures of different minerals, which are often different colors.
4	3. Earth Science	1. Earth Structure and Processes	3. There are different kinds of rocks.	4.3.1.3.2	Develop a classification scheme based upon observations of collected rocks.
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	Illustrate how water moves through the Earth system via the processes of evaporation, condensation and precipitation.
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.	4.3.2.3.2	Identify where water exists on Earth, including atmosphere, ground water and at the Earth's surface.
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	Explain how, over time, rock weathers to form soil.
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.	5.3.1.2.2	Compare and contrast the features that form from slow processes (such as water eroding the earth surface to create valleys) with rapid processes (such as landslides and volcanic eruptions).
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, some are not.	5.3.4.1.1	Categorize energy resources and material resources into renewable and non-renewable.

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, some are not.	5.3.4.1.2	Identify natural resources that are found in Minnesota (for example, water, iron ore, granite quarries, sand and gravel, wind and forests).
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, some are not.	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).
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, some are not.	5.3.4.1.4	Explain how 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. Human systems affect the Earth system; individual decisions can influence the severity of those effects.	5.3.4.3.1	Compare the impact of different individual decisions on natural systems (for example, choosing paper or plastic bags impacts landfills as well as ocean life cycles).
5	3. Earth Science	4. Human Interaction with Earth Systems	4. Scientists use models to represent and communicate information about the Earth system.	5.3.4.4.1	Make a map of where the student lives showing natural and human-made features.
5	3. Earth Science	4. Human Interaction with Earth Systems	4. Scientists use models to represent and communicate information about the Earth system.	5.3.4.4.2	Examine different kinds of maps of the student's community and of Minnesota; use a map key to interpret symbols for the different kinds of maps (for example, city maps, aerial photos, regional maps, or online map resources).
8	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.	8.3.1.1.1	Identify patterns in the global distribution of both volcanoes and earthquakes.
8	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.	8.3.1.1.2	Use global maps to evaluate the distribution of ocean trenches, mid-ocean ridges, and mountain ranges relative to volcanic and seismic activity.

8	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.	8.3.1.2.1	Explain how waves, wind, water and ice transport and deposit sediment, and in the process, shape the Earth's surface. Describe the role of glacial activity in shaping Minnesota's surface. Compare Minnesota's landscape with nonglaciated areas.
8	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.	8.3.1.2.2	Compare and contrast the constructive and destructive impacts of tectonic (earthquake and volcanic) activity.
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 compositions and textures provide evidence for how they formed.	8.3.1.3.1	Interpret successive layers of sedimentary rocks and their fossils to infer relative ages of rock sequences and past events. Recognize that constructive and destructive Earth processes can affect the evidence of Earth's history.
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 compositions and textures provide evidence for how they formed.	8.3.1.3.2	Explore the rock cycle by comparing and contrasting 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	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 compositions and textures provide evidence for how they formed.	8.3.1.3.3	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. Earth Science	2. Interdependence Within the Earth system	2.Transfer of heat energy at the boundaries between the atmosphere, the landmasses and the oceans results in distinctive weather patterns.	8.3.2.2.1	Identify the composition and structure of the atmosphere.

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 results in distinctive weather patterns.	8.3.2.2.2	Explain how heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and hydrosphere.
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 results in distinctive weather patterns.	8.3.2.2.3	Use weather observation data (such as temperature, pressure and humidity) as evidence to make predictions about future weather conditions.
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 results in distinctive weather patterns.	8.3.2.2.4	Graph and analyze the changes in wind direction, temperature, humidity and air pressure as a storm approaches and passes through. Develop a model for local weather patterns associated with fronts and pressure systems.
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 results in distinctive weather patterns.	8.3.2.2.5	Demonstrate how pressure and temperature differences create and maintain currents and layers in the Earth’s atmosphere and water systems. Demonstrate with models the effect of Earth’s rotation on those currents.
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 results in distinctive weather patterns.	8.3.2.2.6	Explain how the combination of the Earth's tilted axis and revolution around the sun causes the progression of seasons.
8	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.	8.3.3.2.1	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.
8	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.	8.3.3.2.2	Compare and contrast the planets and the moons of our solar system in terms of their size, location and composition.

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 predictable motions of Earth to explain the regular changes in day length and shadow length throughout the year.
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.	8.3.3.1.2	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 spans 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. Earth Science	3. The Universe	3. The age and scale of the universe spans billions of years and immense distances.	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	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.	8.3.4.1.1	Differentiate among types of land use in Minnesota, and determine advantages and disadvantages of choosing one use over another use for a single area (such as agriculture, residential/commercial development and recreation).
8	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.	8.3.4.1.2	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.
8	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.	8.3.4.1.3	Investigate how usage rates and conservation efforts affect the availability and cost of a resource.

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	Recognize that land use practices in specific areas affect natural processes (for example, levees to protect development on flood plains change the natural flooding process of a river; agricultural runoff joins the water cycle and influences natural systems far from the source, such as the Mississippi river delta dead zone).
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.	8.3.4.2.2	Analyze how natural processes interfere and interact with human systems (for example, natural sedimentation of navigable waterways limits the ability of commercial boat traffic; hurricanes may cause a massive amount of property damage and economic disruption).
8	3. Earth Science	4. Human Interactions with Earth Systems	4. Humans have developed models to understand and communicate how the Earth system functions.	8.3.4.4.1	Interpret patterns in data displayed on maps or satellite images (for example, locations of volcanoes and earthquakes, ages of the seafloor, ocean surface temperatures and ozone concentration in the stratosphere).
9 through 12	3. Earth Science	1. Earth Structure and Processes	1. The relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence in support of 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	Compare and contrast the kinds of magma that form at convergent and divergent boundaries.
9 through 12	3. Earth Science	1. Earth Structure and Processes	1. The relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence in support of the theory of plate tectonics. Tectonic plates constantly move at rates of centimeters per year in response to movements in the mantle.	9.3.1.1.2	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 evidence for the process of subduction.

9 through 12	3. Earth Science	1. Earth Structure and Processes	1. The relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence in support of the theory of plate tectonics. Tectonic plates constantly move at rates of centimeters per year in response to movements in the mantle.	9.3.1.1.3	Describe the pattern of magnetic reversals and rock ages on both sides of a mid-ocean ridge; use that evidence to explain the mechanism of sea floor spreading.
9 through 12	3. Earth Science	1. Earth Structure and Processes	1. The relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence in support of the theory of plate tectonics. Tectonic plates constantly move at rates of centimeters per year in response to movements in the mantle.	9.3.1.1.4	Cite examples of how changes in past environments, as recorded in the rock record, are evidence of plate movement.
9 through 12	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 information to explain how the Earth and life on Earth has changed over short and long periods of time.
9 through 12	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.	9.3.1.3.2	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 through 12	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.	9.3.1.3.3	Cite evidence from the rock record for changes in the composition of the atmosphere as life evolved (for example, banded iron formations as found in Minnesota's Iron Range).
9 through 12	3. Earth Science	2. Interdependence Within the Earth System	1. The earth system has internal and external sources of energy, 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 through 12	3. Earth Science	2. Interdependence Within the Earth System	1. The earth system has internal and external sources of energy, which create heat and drive the motion of material in the oceans, atmosphere, and solid earth.	9.3.2.1.2	Explain how the outward transfer of Earth’s internal heat drives the convection circulation in the mantle, which contributes to the movement of tectonic plates.

9 through 12	3. Earth Science	2. Interdependence Within the Earth System	2. Global climate is determined by distribution of energy from the sun at the Earth's surface. The energy distribution is influenced by static and dynamic processes, including Earth's rotation, cloud cover, and the position and size of mountain ranges and oceans.	9.3.2.2.1	Diagram and explain how the distribution of energy through the ocean contributes to global climatic patterns.
9 through 12	3. Earth Science	2. Interdependence Within the Earth System	2. Global climate is determined by distribution of energy from the sun at the Earth's surface. The energy distribution is influenced by static and dynamic processes, including Earth's rotation, cloud cover, and the position and size of mountain ranges and oceans.	9.3.2.2.2	Diagram and explain how Earth's rotation and configuration of mountain ranges influence the distibution of energy which contributes to global climatic patterns.
9 through 12	3. Earth Science	2. Interdependence Within the Earth System	2. Global climate is determined by distribution of energy from the sun at the earth's surface. The energy distribution is influenced by static and dynamic processes, including earth's rotation, cloud cover, and the position and size of mountain ranges and oceans.	9.3.2.2.3	Explain how evidence from ice core samples indicates that climate changes have occurred over recent geologic time.
9 through 12	3. Earth Science	2. Interdependence Within the Earth System	3. Material in the Earth system cycles through different reservoirs, and is powered by the Earth's sources of energy. The total amount of material stays the same as its form and location change.	9.3.2.3.1	Trace the cyclical movement of carbon, oxygen and nitrogen through the lithosphere, hydrosphere, atmosphere and biosphere.
9 through 12	3. Earth Science	2. Interdependence Within the Earth System	3. Material in the Earth system cycles through different reservoirs, and is powered by the Earth's sources of energy. The total amount of material stays the same as its form and location change.	9.3.2.3.2	Trace the cyclical movement of water through the lithosphere, hydrosphere, atmosphere and biosphere.
9 through 12	3. Earth Science	3. The Universe	2. The solar system formed from a nebular cloud of dust and gas 4.6 billion 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 through 12	3. Earth Science	3. The Universe	2. The solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. Early Earth evolved into its present habitable form because of interactions among solid earth, the oceans, the atmosphere and organisms.	9.3.3.2.2	Compare and contrast the environmental conditions that make life possible on Earth with conditions found on the other planets and moons of our solar system.
9 through 12	3. Earth Science	3. The Universe	3. The origin of the universe remains one of the greatest questions in science. Current evidence indicates that the universe expanded from a hot, dense chaotic mass, after which elements clumped together to eventually form stars and galaxies. Our understanding of the nature of the universe and its formation and composition is supported, refined, and challenged as technology advances.	9.3.3.3.1	Explain how nuclear fusion produces energy and chemical elements within a star. Explain the role of nuclear fusion through the stellar life cycle.
9 through 12	3. Earth Science	3. The Universe	3. The origin of the universe remains one of the greatest questions in science. Current evidence indicates that the universe expanded from a hot, dense chaotic mass, after which elements clumped together to eventually form stars and galaxies. Our understanding of the nature of the universe and its formation and composition is supported, refined, and challenged as technology advances.	9.3.3.3.2	Compare and contrast different types of stars and galaxies.
9 through 12	3. Earth Science	3. The Universe	3. The origin of the universe remains one of the greatest questions in science. Current evidence indicates that the universe expanded from a hot, dense chaotic mass, after which elements clumped together to eventually form stars and galaxies. Our understanding of the nature of the universe and its formation and composition is supported, refined, and challenged as technology advances.	9.3.3.3.3	Analyze the evidence from technologies that have been used to understand the composition and the early history of the universe (for example, demonstrate how the Doppler shift of light provides evidence for expansion of the universe).

9 through 12	3. Earth Science	4. Human Interactions with the Earth System	2. 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.	9.3.4.2.1	Analyze the benefits, costs and risks associated with selecting one land use over another (for example, building a levee benefits the neighboring landowner, but has a cost to development downstream.) The risk analysis may include a discussion of the likelihood of 100-year and 500-year floods.
9 through 12	3. Earth Science	4. Human Interactions with the Earth System	2. 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.	9.3.4.2.2	Compare the costs and tradeoffs of various hazards ranging from those with minor risk to a few people to 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 through 12	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	Infer past geologic events from a geologic map of Minnesota.
9 through 12	3. Earth Science	4. Human Interactions with the Earth System	4. Technology provides tools for investigations, inquiry and analysis that enhance scientific understanding.	9.3.4.4.2	Use remote sensing data to learn about a problem the student has identified (for example, determining the status of a growing crop; defining urban patterns; delineating the extent of flooding; recognizing rock types; and pinpointing areas of deforestation).
9 through 12	3. Earth Science	4. Human Interactions with the Earth System	4. Technology provides tools for investigations, inquiry and analysis that enhance scientific understanding.	9.3.4.4.3	Analyze spatially related data using a geographical information system (for example, evaluate the effects of storms by looking at stream flow data from the U.S. Geological Information Survey).

Grade	Strand	Substrand	Standard	Code	Benchmark
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	Use the five senses to observe living and nonliving things.
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.	0.4.1.1.2	Sort things into living and nonliving groups.
K	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many parts that interact to maintain success.	0.4.2.1.1	Use the five senses to observe a natural system or its model (for example, a wetland, prairie or garden).
K	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many parts that interact to maintain success.	0.4.2.1.2	Identify living and nonliving parts of a natural system.
1	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many parts that interact to maintain success.	1.4.2.1.1	Recognize that living things need space, water, food and air.
1	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many parts that interact to maintain success.	1.4.2.1.2	Determine ways in which an organism’s habitat provides for its basic needs (for example, plants require air, water, nutrients and light; animals require food, water, air and shelter).
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 pass through life cycles that include a beginning, development into adults, reproduction and eventually death.
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.	1.4.3.1.2	Recognize that plants and animals pass through the same stages of their life cycles as their parents.
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 cycles.

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.	2.4.1.1.2	Describe and sort plants and animals into groups in many ways, according to their physical characteristics and behaviors.
2	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many parts that interact to maintain success.	2.4.2.1.1	Recognize that animals eat plants or other animals for food and may also use plants (and other animals) for shelter and nesting.
2	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many parts that interact to maintain success.	2.4.2.1.2	Predict what would happen to a natural system or its model (such as a wetland, prairie or garden) if any of the parts were broken or missing.
3	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.	3.4.1.1.1	Describe how the different structures of plants and animals serve the various functions of growth, survival and reproduction.
4	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.	4.4.1.1.1	Compare and contrast structures in plants and animals that enable them to survive and reproduce.
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 adults and offspring in plants and animals that can be inherited or learned.
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.	4.4.3.1.2	Give examples of differences among individuals that can sometimes give an individual an advantage in survival and reproduction.
4	4. Life Science	4. Human Interactions with Living Systems	2. Germs are able to get inside one’s body and they may keep it from working properly.	4.4.4.2.1	Recognize that for defense against germs, the human body has tears, saliva, skin, some blood cells and stomach secretions.
4	4. Life Science	4. Human Interactions with Living Systems	2. Germs are able to get inside one’s body and they may keep it from working properly.	4.4.4.2.2	Recognize that there are many diseases that can be prevented by vaccination.
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	Describe how plant and animal structures and their functions provide an advantage for survival in a given natural system.

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.	5.4.1.1.2	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 parts that interact to maintain success.	5.4.2.1.1	Describe a natural system in Minnesota in terms of the relationships among its parts (living and nonliving), as well as inputs and outputs.
5	4. Life Science	2. Interdependence of Living Systems	1. Natural systems have many parts that interact to maintain success.	5.4.2.1.2	Explain what would happen to a system such as a wetland, prairie or garden if one of its parts 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 to themselves and other organisms.	5.4.4.1.1	Describe a system such as a wetland, prairie or garden in terms of its parts (living and nonliving), as well as inputs and outputs that are influenced by humans.
5	4. Life Science	4. Human Interactions with Living Systems	1. Humans change environments in ways that can be either beneficial or harmful to themselves and other organisms.	5.4.4.1.2	Give examples of beneficial and harmful human interaction with natural systems.
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 with a simple microscope, and that all living things consist of one or more cells.
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.	7.4.1.1.2	Recognize that cells repeatedly divide to make more cells for growth and repair.
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.	7.4.1.1.3	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 (for example, extracting energy from food or getting rid of waste) and that these functions are carried out in a similar way in all organisms.
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.	7.4.1.2.2	Recognize that all cells do not look alike; specialized cells in multicellular organisms are organized into tissues and organs that perform specialized functions.

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.	7.4.1.2.3	Describe how tissues and organs have a distinct structure and a set of functions that serve the organism as a whole.
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.	7.4.1.2.4	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.
7	4. Life Science	2. Interdependence of Living Systems	1. Organisms are parts of natural systems that interact with one another in several ways.	7.4.2.1.1	Identify a variety of populations and communities in an ecosystem and describe the relationships among the populations and communities in establishing a stable ecosystem.
7	4. Life Science	2. Interdependence of Living Systems	1. Organisms are parts of natural systems that interact with one another in several ways.	7.4.2.1.2	Compare and contrast predator/prey, parasite/host and producer/consumer/decomposer relationships.
7	4. Life Science	2. Interdependence of Living Systems	1. Organisms are parts of natural systems that interact with one another in several ways.	7.4.2.1.3	Explain how the number of populations an ecosystem can support depends on the biotic resources available as well as abiotic factors such as amount of light and water, temperature range and soil composition.
7	4. Life Science	2. Interdependence of Living Systems	2. The flow of energy and the recycling of matter are essential to a stable ecosystem.	7.4.2.2.1	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.
7	4. Life Science	2. Interdependence of Living Systems	2. The flow of energy and the recycling of matter are essential to a stable ecosystem.	7.4.2.2.2	Recognize that consumers, including humans, eat and break down plant structures to produce the materials and energy they need to survive.
7	4. Life Science	2. Interdependence of Living Systems	2. The flow of energy and the recycling of matter are essential to a stable ecosystem.	7.4.2.2.3	Describe the roles and relationships among producers, consumers, and decomposers in changing energy from one form to another in a food web within an ecosystem.

7	4. Life Science	2. Interdependence of Living Systems	2. The flow of energy and the recycling of matter are essential to a stable ecosystem.	7.4.2.2.4	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.
7	4. Life Science	4. Human Interactions with Living Systems	1. All organisms cause changes in the environments in which they live.	7.4.4.1.1	Provide examples of potentially irreversible effects of human activity on ecosystems.
7	4. Life Science	4. Human Interactions with Living Systems	1. All organisms cause changes in the environments in which they live.	7.4.4.1.2	Describe ways that humans impact natural systems (for example, farming, medicine and conservation).
8	4. Life Science	3. Variation and Change in Living Systems	1. Reproduction is a characteristic of all organisms and is essential for the 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. Life Science	3. Variation and Change in Living Systems	1. Reproduction is a characteristic of all organisms and is essential for the continuation of a species. Hereditary information is contained in genes which are inherited through asexual or sexual reproduction.	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. Life Science	3. Variation and Change in Living Systems	1. Reproduction is a characteristic of all organisms and is essential for the continuation of a species. Hereditary information is contained in genes which are inherited through asexual or sexual reproduction.	8.4.3.1.3	Identify sex organs and cells in plants and animals.
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.	8.4.3.1.4	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 among 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; explain how the fossil record documents the appearance, diversification and extinction of many life forms.
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 among them. Variation in organisms can help or hinder their ability to survive and reproduce.	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. 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 among them. Variation in organisms can help or hinder their ability to survive and reproduce.	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.
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 among them. Variation in organisms can help or hinder their ability to survive and reproduce.	8.4.3.2.4	Recognize that extinction is a common event and it can occur 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. Life Science	4. Human Interactions with Living Systems	2. Human beings are constantly interacting with other organisms that cause disease.	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. Life Science	4. Human Interactions with Living Systems	2. Human beings are constantly interacting with other organisms that cause disease.	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. Life Science	4. Human Interactions with Living Systems	2. Human beings are constantly interacting with other organisms that cause disease.	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 from within.
9 through 12	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); describe the basic molecular structures and primary functions of the four important organic macromolecular groups (carbohydrates, lipids, proteins and nucleic acids).
9 through 12	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.	9.4.1.1.2	Recognize that the work of the cell is carried out primarily by proteins (most of which are enzymes), and that protein function depends on the amino acid sequence and the shape it takes as a consequence of the interactions between those amino acids.
9 through 12	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.	9.4.1.1.3	Explain how viruses, prokaryotic cells, and eukaryotic cells differ in relative size, complexity and general structure.
9 through 12	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.	9.4.1.1.4	Explain the function and importance of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, nucleus, cytoplasm, mitochondrion, central vacuole, chloroplast and ribosome, as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction.

9 through 12	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.	9.4.1.1.5	Compare and contrast passive transport (diffusion including osmosis and facilitated transport) and active transport (endocytosis and exocytosis).
9 through 12	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.	9.4.1.1.6	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 through 12	4. Life Science	1. Structure and Function of Living Systems	2. Organisms use the interaction of cellular processes to maintain homeostasis. Complex organisms use tissues and organ systems 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 through 12	4. Life Science	1. Structure and Function of Living Systems	2. Organisms use the interaction of cellular processes to maintain homeostasis. Complex organisms use tissues and organ systems to maintain homeostasis.	9.4.1.2.2	Describe how the functions of individual organ systems are integrated to maintain homeostasis in an organism.
9 through 12	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 through 12	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.	9.4.2.1.2	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.
9 through 12	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.	9.4.2.2.1	Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow (including ATP), reactants and products.

9 through 12	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	Explain how the total amount of matter and energy in an ecosystem is transferred among organisms, or in the case of energy, dissipated as heat into the physical environment.
9 through 12	4. Life Science	3. Variation and Change in Living Systems	1. Genetic information in the cell provides direction for assembling proteins, which dictate the expression of traits in an individual.	9.4.3.1.1	Apply the terms phenotype, genotype, allele, homozygous and heterozygous in determining the outcome of monohybrid crosses.
9 through 12	4. Life Science	3. Variation and Change in Living Systems	1. Genetic information in the cell provides direction for assembling proteins, which dictate the expression of traits in an individual.	9.4.3.1.2	Explain the relationships among DNA, genes and chromosomes.
9 through 12	4. Life Science	3. Variation and Change in Living Systems	1. Genetic information in the cell provides direction for assembling proteins, which dictate the expression of traits in an individual.	9.4.3.1.3	Explain the functions of DNA and RNA; distinguish among the processes of DNA replication, transcription and translation.
9 through 12	4. Life Science	3. Variation and Change in Living Systems	1. Genetic information in the cell provides direction for assembling proteins, which dictate the expression of traits in an individual.	9.4.3.1.4	Recognize the process and explain the importance of being able to move genes from one organism to another.
9 through 12	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.
9 through 12	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.	9.4.3.2.2	Use concepts from Mendel’s Laws of Segregation and Independent Assortment to explain the occurrence of genetic variation.

9 through 12	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.	9.4.3.2.3	Use the processes of mitosis and meiosis to explain the advantages and disadvantages of asexual and sexual reproduction.
9 through 12	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.	9.4.3.2.4	Explain how mutations like deletions, insertions, rearrangements or substitutions of DNA segments in gametes can result in genetic variation within a species.
9 through 12	4. Life Science	3. Variation and Change in Living Systems	3. Evolution by natural selection is the scientific explanation for the history and diversity of life on Earth.	9.4.3.3.1	Describe how evidence led Darwin to develop the theory of natural selection and common descent to explain evolution.
9 through 12	4. Life Science	3. Variation and Change in Living Systems	3. Evolution by natural selection is the scientific explanation for the history and diversity of life on Earth.	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 through 12	4. Life Science	3. Variation and Change in Living Systems	3. Evolution by natural selection is the scientific explanation for the history and diversity of life on Earth.	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 through 12	4. Life Science	3. Variation and Change in Living Systems	3. Evolution by natural selection is the scientific explanation for the history and diversity of life on Earth.	9.4.3.3.4	Explain why genetic variation within a population is essential for evolution to occur.
9 through 12	4. Life Science	3. Variation and Change in Living Systems	3. Evolution by natural selection is the scientific explanation for the history and diversity of life on Earth.	9.4.3.3.5	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 through 12	4. Life Science	3. Variation and Change in Living Systems	3. Evolution by natural selection is the scientific explanation for the history and diversity of life on Earth.	9.4.3.3.6	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 through 12	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 and on 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.
9 through 12	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 and on global and local sustainability.	9.4.4.1.2	2. Describe the social, economic and ecological risks and benefits of changing a natural habitat as a result of human activity that includes: introducing foreign species, changing the temperature or chemical composition of water or soil, altering the populations and communities, developing artificial ecosystems or changing the use of the land or water
9 through 12	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 and on global and local sustainability.	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 through 12	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 and on global and local sustainability.	9.4.4.1.4	Describe factors that affect population growth of all organisms, including humans, and relate these to factors affecting growth rates and the carrying capacity of an ecosystem.
9 through 12	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 through 12	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.	9.4.4.2.2	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 through 12	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.	9.4.4.2.3	Explain how the body produces antibodies to fight disease and how this impacts the development of vaccines and immunity to disease.

9 through 12	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.	9.4.4.2.4	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.