4th Grade Science
Year-at-a-Glance

Processes that Shape the Earth	Structure, Function, and Information Processing	Energy	Waves and Information
September-November	December-January	February-April	May-June
4-ESS1-1 (ESS1.C) 4-ESS2-1 (ESS2.A) 4-ESS2-2 (ESS2.B) 4-ESS3-1 (ESS3.A) 4-ESS3-2 (ESS3.B) 3-5-ETS1-2 (ETS1.B)	4-LS1-1 (LS1.A) 4-LS1-2 (LS1.D) 4-PS4-2 (PS4.B)	4-PS3-1 (PS3.A) 4-PS3-2 (PS3.B) 4-PS3-3 (PS3.C) 4-PS3-4 (PS3.D) 4-ETS1-1 (ETS1.A) 3-5-ETS1-2 (ETS1.B) 3-5-ETS1-3 (ETS1.C)	4-PS4-1 (PS4.A) 4-PS4-2 (PS4.B) 4-PS4-3 (PS4.C) 3-5-ETS1-3 (ETS1.C)

Standards are listed in a numerical order only and may be taught in any order within the unit.

*The standards listed in red are the Disciplinary Core ideas as they relate to the Performance Expectations within the units.

NOTE: The Science and Engineering Practices are interwoven and should be addressed throughout the year in as many different units and tasks as possible in order to stress the natural connections that exist among mathematical concepts.

Science Curriculum 4th Grade

Unit 1
Processes that Shape the Earth

Performance Expectation(s)

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. [Clarification Statement: Examples of evidence from patterns could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from water to land over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]

4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes and earthquakes.]

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Essential Question(s)

- How can evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation be observed or measured?
- What can rock formations tell us about the past?
- What can maps tell us about the features of the world?
- In what ways can the impacts of natural Earth processes on humans be reduced?

Learning Plan		
Science/Engineering Practices	**Disciplinary Core Idea(s)**	**Crosscutting Concept(s)**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ● Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1) **Analyzing and Interpreting Data** Analyzing data in 3-5 builds on K-2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. ● Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3-5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Identify the evidence that supports particular points in an explanation. (4-ESS1-1)	**ESS1.C: The History of Planet Earth** ● Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1) **ESS2.A: Earth Materials and Systems** ● Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water feature areas of Earth. (4-ESS2-2)	**Patterns** ● Patterns can be used as evidence to support an explanation. (4-ESS1-1), (4-ESS2-2) **Cause and Effect** ● Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-1) ● Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1), (4-ESS3-2) **----------** **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** • Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1) **Influence of Engineering, Technology, and Science on Society and the Natural World** ● Over time, people's needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1) ● Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 3-5 builds on K-2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.

- Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)

ESS2.E: Biogeology

- Living things affect the physical characteristics of their regions. (4-ESS2-1)

ESS3.A: Natural Resources

- Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1)

ESS3.B: Natural Hazards

- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

ETS1.B: Designing Solutions to Engineering Problems

- Testing a solution involves investigating how well it performs under a range of likely conditions.

risks, and to meet societal demands. (4-ESS3-2)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes consistent patterns in natural systems. (4-ESS1-1)

Resources and Links

Videos
ESS1.C. The History of Planet Earth – Bozeman Science Video
ESS2.A. Earth Materials & Systems – Bozeman Science Video
ESS2.B. Plate Tectonics & Large-Scale System Interactions – Bozeman Science Video
ESS2.E. Biogeology – Bozeman Science Video
ESS3.A. Natural Resources – Bozeman Science Video
ESS3.B. Natural Hazards – Bozeman Science Video
BrainPOP: Earth System

Other Resources
Mystery Science:
Mystery 1: Could a volcano pop up in your backyard?
Mystery 2: Why do some volcanoes explode?
Mystery 3: Will a mountain last forever?
Mystery 4: How could you survive a landslide?

Everything 4th Grade Science Mega Bundle: This bundle includes complete lesson sets that are aligned with the Next Generation Science Standards for 4th grade. The activities in these lesson sets are created to incorporate reading and writing into the Science curriculum. Teachers Pay Teachers

Engineering for the Three Little Pigs This activity helps to demonstrate the importance of rocks, soils, and minerals in engineering and how using the right material for the right job is important. The students build three different sand castles composed of varying amounts of sand, water, and glue. They then test them for strength (load bearing) and resistance to weathering. The students will then compare possible solutions and discuss how well each is likely to work while meeting the criteria and constraints of the problem. The students will be the engineers who figure out which materials are best for the buildings they are making, taking into consideration all the properties of materials that are discussed in the lesson. NSTA/TeachEngineering

Earthquakes in the Classroom Students investigate which building types are structured to withstand earthquake damage. They take on the role of engineers as they design their own earthquake resistant buildings, then test them in a simulated earthquake activity. Students also develop an appreciation for the job of engineers who need to know about earthquakes and their causes in order to design resistant buildings. NSTA/TeachEngineering

Getting the Right Angle on the Story This informational text explains how data is gathered using tools such as satellites in order to understand how tsunamis form and behave. Students can also learn how this data helps scientists design computer programs to predict tsunamis. Animations/computer models are included to enhance student knowledge of how tsunami warnings work. Warning systems for other types of natural disasters (e.g., volcanoes, avalanches) could be compared with tsunami warning systems. Students could learn how scientists work to gather information to predict and warn humans of potential natural disasters. NSTA/NASA Science

Reading Topographic Maps: Gizmos The Reading Topographic Maps Gizmo is an interactive simulation that allows students to understand how topographic maps work. Students create three-dimensional landscapes and observe the corresponding contour lines. They can see how mountains, depressions, valleys, and cliffs are represented on topographic maps. Students can fill in the landscape with water to demonstrate that contours are lines of constant elevation. Explore Learning

Bill Nye Video-Erosion Bill Nye, "The Science Guy," presents a video describing the effects of weathering (wind, water, ice) on landforms. Bryce Canyon is used as an example of the ways in which freezing water, plant roots, and wind weather the earth's surface creating the means for erosion. Students in video simulate effects of weathering which can be duplicated in a classroom setting. Nye also emphasizes the passage of time in millions of years as he explains the slower erosive effects of certain types of weathering. NSTA/School Tube

Weathering and Erosion: A Comprehension Instructional Sequence Lesson Plan This science lesson integrates the concepts of physical weathering and erosion with a systematic approach to the task of teaching informational text reading. This type of scaffolding allows the teacher to guide students as they read, write, and think about weathering and erosion and their impact on humans. This lesson can be used in conjunction with hands-on lessons in order to provide students with an opportunity to create their own explanations for earth changes. While students may work in pairs/groups/with scaffolding to complete these items, they could individually respond to the questions/comments as a type of formative assessment. NSTA/CPALMS

Weathering, Erosion, and Deposition This set of 31 Weathering and Erosion slides depicts landform changes that occur due to the natural processes of weathering and erosion. Captions explain/define the different causes of weathering and erosion (ice, wind, water, and vegetation). When students have observed the slide presentation, they might illustrate examples of depicted landforms in their journals, and

then illustrate changes that occur, labeling types of weather and diagramming movement caused by erosion. Students might discuss/research types of living things native to an area of weathering and erosion and determine how changes in landforms might affect those living things. Questions might include – What would animal and plant life have to do in order to survive if their habitats have changed due to the effects of weathering and erosion? How might these changes be both destructive and constructive to the animal/plant population? NSTA/SlideShare

Summative/Formative Assessment

Formative

Before

Pre-test (identify key concepts and vocabulary)
KWL charts
Brainstorming

During

Concept maps
Diagrams
Think-pair-shares
Summaries/Written responses
Interactive journals
Observations

Summative

After

Post-test
Presentation/Model report using rubric aligned with essential question

Literacy Standards

NJSLS.LA.4.RI.4.7. Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. (4-ESS2-2)

NJSLS.LA.4.W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS2-1)

NJSLS.LA.4.W.4.8. Recall relevant information from experiences or gather information from print and digital sources; take notes and categorize information and provide a list of sources. (4-ESS2-1)

NJSLS.LA.4.W.4.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS1-1)

Science Example 1: In this unit of study, students should have access to multiple sources of information about Earth's features and earth processes. Students should have opportunities to read, analyze, and interpret information from nonfiction text, charts, graphs, diagrams, timelines, and interactive elements of the Internet. Students use this information, along with data they collect during investigations, to help explain, both orally and in writing, the patterns they observe in the features of the Earth and in the natural hazards that occur on the Earth.

Science Example 2: As students engage in the engineering design process, they need opportunities to conduct research to build their understanding of how earth processes affect humans and to find examples of ways in which engineers reduce the effect of volcanic eruptions, earthquakes, floods, and tsunamis.

Students should take notes as they read and summarize or paraphrase their notes to support their work throughout the engineering design process.

Math Standards

NJSLS.MA.4.4.MD.A.1. Know relative sizes of measurement units within one system of units including km, m, cm, mm; kg, g; lb., oz.; l, ml; hr., min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS2-1)

NJSLS.MA.4.4.MD.A.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. (4-ESS2-1), (4-ESS2-2)

Science Example 1: To support integration of the Mathematics standards into this unit, students are expected to use mathematics when analyzing quantitative data to identify patterns, explain cause-and-effect relationships, and make predictions. Students need opportunities to measure earth materials using tools, such as balances and graduated cylinders, and to measure distances and heights using rulers or tape measures. Students should also be required to solve problems involving measurement and data.

Future Learning

Grade 5: Water on Earth

- Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

Grade 5: Earth Systems

- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.

Additional Information

-NGSS Interactive site: http://www.nextgenscience.org/search-standards

Science Curriculum - 4th Grade

Unit 2
Structure, Function, and Information Processing

Performance Expectation(s)

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]

4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. [Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. [Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]

Essential Question(s)

- How do internal and external parts of plants and animals help them to survive, grow, behave, and reproduce?
- How do animals receive and process different types of information from their environment in order to respond appropriately?
- What happens when light from an object enters the eye?

Learning Plan

Science/Engineering Practices	Disciplinary Core Idea(s)	Crosscutting Concept(s)
Engaging in Argument from Evidence Engaging in argument from evidence in 3-5 builds on K-2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct an argument with evidence, data, and/or a model. (4-LS1-1) **Developing and Using Models**	**LS1.A: Structure and Function** ● Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1) **LS1.D: Information Processing** • Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions	**Systems and System Models** ● A system can be described in terms of its components and their interactions. (4-LS1-1), (4-LS1-2) **Cause and Effect** ● Cause and effect relationships are routinely identified. (4-PS4-2)

Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2) • Develop a model to describe phenomena. (4-PS4-2)	and memories to guide their actions. (4-LS1-2) **PS4.B: Electromagnetic Radiation** • An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)	

Resources and Links

Videos

LS1.A. Structure & Function– Bozeman Science Video
LS1.D. Information Processing – Bozeman Science Video
PS4.B. Electromagnetic Radiation – Bozeman Science Video

Other Resources

Mystery Science:
Mystery 1: Why do your biceps bulge?
Mystery 2: What do blind people see?
Mystery 3: How can some animals see in the dark?
Mystery 4: How does your brain control your body?

Everything 4th Grade Science Mega Bundle: This bundle includes complete lesson sets that are aligned with the Next Generation Science Standards for 4th grade. The activities in these lesson sets are created to incorporate reading and writing into the Science curriculum. Teachers Pay Teachers

Animal Mouth Structures In this activity, students examine how the structure of various animal mouthparts affects their function. They will have an opportunity to predict what foods are likely to be eaten by birds with different beak types, watch a video comparing and analyzing snake and human mouth structures, and construct explanations about how other animals' mouths are related to their feeding strategies. NSTA/PBS Learning/Media

Feeding Frenzy In this activity, students experience the difficulty of trying to gather food with an ineffective model of an insect mouthpart, and then investigate how effective various insect mouth structures are for gathering different food sources. NSTA/Orkin Learning Center

Create Your Own Insect Students learn about insect body structures and their functions through print materials and a video, and then design their own insect to demonstrate their understanding of structure function. Students can be asked to write about how the function of their insect's structure supports its survivability to develop stronger argumentation before sharing verbally. NSTA/Discovery Science

Reverse the Field: Gizmos The Reverse the Field Gizmo is an interactive simulation that allows students to experience a situation in which your mouse cursor does not react to your movements in a normal way. Students can measure the time required to write a word when the mouse behaves in a normal fashion and when the direction of motion is reversed from left to right, up to down, or both. They can run several experiments in each mode to see if your brain and muscles are able to adapt to the new direction of motion. Students will determine which type of inversion is easiest to adjust to and whether you can train yourself to function when the inversion is present. Explore Learning

Pinhole Cameras and Eyes In this activity, students make pinhole cameras and see images on an internal screen. They then use a lens to see how this affects the images. Students investigate variables in its construction and explore how it models the human eye's ability to receive and process information.
NSTA/Science Learning Hub

Summative/Formative Assessment

Formative
Before
Pre-test (identify key concepts and vocabulary)
KWL charts
Brainstorming

During
Concept maps
Diagrams
Think-pair-shares
Summaries/Written responses
Interactive journals
Observations

Summative
After
Post-test
Presentation/Model report using rubric aligned with essential question

Literacy Standards

NJSLS.LA.4.W.4.1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (4-LS1-1)

Science Example 1: Students should use evidence from their observations of plants and animals to support the claim that all organisms are systems with structures that function in growth survival, behavior, and/or reproduction. Students need opportunities to observe plants and animals closely, taking notes and drawing pictures, so that they can describe various structures and their functions.

Science Example 2: Students should use text and online media resources when appropriate to help them understand how animals receive and process information they receive from the environment, and to develop a conceptual understanding of what happens when light reflects off objects and enters the eye. They should also use visual displays to enhance their observations and explanations of the concepts in this unit of study.

Math Standards

NJSLS.MA.4.4.G.A.1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular lines. Identify these in two-dimensional figures. (4-PS4-2)

NJSLS.MA.4.4.G.A.3. Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. (4-LS1-1)

Science Example 1: Students should model with mathematics as they draw points, lines, line segments, and angles to describe how light behaves when coming into contact with lenses, mirrors, and other

objects. Students will also use points, lines, and angles when drawing pictures and diagrams that show how light reflects off objects and into the pinhole viewer or into the human eye.

Science Example 2: Students describe the symmetry that can be observed in an organism's structures. For example, the leaves of many plants and the bodies of many animals display a bilateral symmetry. Students should be encouraged to draw each organism that they observe, pointing out any structures that are symmetrical. Students should also trace lines of symmetry in their drawings to support their thinking. In addition, students can conduct research to determine whether the symmetry serves a function in the growth, reproduction, or survival of the organism.

Future Learning

Grade 7: Structure and Function

- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.
- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.

Grade 7: Body Systems

- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.
- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.

Grade 8: Electromagnetic Radiation

- When light shines on an object, it is reflected, absorbed or transmitted through the object, depending on the object's material and the frequency (color) of the light.
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves.

Additional Information

-NGSS Interactive site: http://www.nextgenscience.org/search-standards

Science Curriculum - 4th Grade

Unit 3
Energy

Performance Expectation(s)

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, hear, and electric currents. [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Essential Question(s)

- How does energy move?
- From what natural resources are energy and fuels derived?
- In what ways does the human use of natural resources affect the environment?
- What is the relationship between the speed of an object and its energy?
- In what ways does energy change when objects collide?
- How can scientific ideas be applied to design, test, and refine a device that converts energy from one form to another?

Learning Plan

Science/Engineering Practices	Disciplinary Core Idea(s)	Crosscutting Concept(s)
Asking Questions and Defining Problems	**PS3.A: Definitions of Energy**	**Energy and Matter**

Asking questions and defining problems in 3-5 builds on grades K-2 experiences and progresses to specifying qualitative relationships.

- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3)
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-3)

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2)
- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

- The faster a given object is moving, the more energy it possesses. (4-PS3-1)
- Energy can be moved from place to place by moving objects or through sound light, or electric currents. (4-PS3-2), (4-PS3-3)

PS3.B: Conservation of Energy and Energy Transfer

- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2), (4-PS3-3)
- Light also transfers energy from place to place. (4-PS3-2)
- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4)

PS3.C: Relationship Between Energy and Forces

- When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3)
- Energy can be transferred in various ways and between objects. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Engineers improve existing technologies or develop new ones. (4-PS3-4)
- People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Connections to Nature of Science

Science is a Human Endeavor

- Most scientists and engineers work in teams. (4-PS3-4)
- Science affects everyday life. (4-PS3-4)

Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3-5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ● Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) ● Apply scientific ideas to solve design problems. (4-PS3-4) ● Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)	**PS3.D: Energy in Chemical Processes and Everyday Life** ● The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4) **ETS1.A: Defining Engineering Problems** ● Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Designing Solutions to Engineering Problems** ● Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) ● At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ● Tests are often designed to identify failure points or difficulties, which suggest the	

	elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution** ● Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	

Resources and Links

Videos

PS3.A. Definitions of Energy – Bozeman Science Video
PS3.B. Conservation of Energy and Energy Transfer – Bozeman Science Video
PS3.C. Relationship Between Energy and Forces – Bozeman Science Video
PS3.D. Energy in Chemical Processes and Everyday Life – Bozeman Science Video
ETS1.A. Defining & Delimiting Engineering Problems – Bozeman Science Video
ETS1.B. Developing Possible Solutions – Bozeman Science Video
ETS1.C. Optimizing the Design Solution – Bozeman Science Video
BrainPOP: Energy
BrainPOP: Force and Motion

Other Resources

Mystery Science:
Mystery 1: How can a car run without gas?
Mystery 2: What makes roller coasters go so fast?
Mystery 3: Why is the first hill of a roller coaster always the highest?
Mystery 4: Could you knock down a building using only dominoes?
Mystery 5: Can you build a chain reaction machine?
Mystery 6: What if there was no electricity?

Everything 4th Grade Science Mega Bundle: This bundle includes complete lesson sets that are aligned with the Next Generation Science Standards for 4th grade. The activities in these lesson sets are created to incorporate reading and writing into the Science curriculum. Teachers Pay Teachers

Hot Wheels Speedometry This resource includes STEM lesson plans and activities that will provide students with fun and engaging ways to learn about concepts such as energy, force, and motion using Hot Wheels cars and tracks. Students also learn scientific and engineering practices such as analyzing and interpreting data. Hot Wheels

Spool Racer Design & Competition In this lesson, students see how potential energy (stored energy) can be converted into kinetic energy (motion). Acting as if they were engineers designing vehicles, they use rubber bands, pencils and spools to explore how elastic potential energy from twisted rubber bands can roll the spools. They brainstorm, prototype, modify, test and redesign variations to the basic spool racer design in order to meet different design criteria, ultimately facing off in a race competition. These simple-to-make devices store potential energy in twisted rubber bands and then convert the potential energy to kinetic energy upon release. TeachEngineering

Force and Motion This video segment from Idaho Public Television defines gravity, force, friction and inertia through examples from amusement park rides. Examples and explanations of Sir Isaac Newton's Three Laws of Motion are also included. Idaho Public Television

Trebuchet: Gizmos The Trebuchet Gizmo is an interactive simulation that allows students to design their own trebuchet to fling a projectile at a castle wall. All of the dimensions of the trebuchet can be adjusted, as well as the masses of the counterweight and payload. Explore Learning

Looking Through the Energy Lens: Marble Collisions Colliding objects are the focus of this lesson. Students learn that a moving marble can cause another marble to move. To fully address the practice, students can be encouraged to ask their own questions involving different variables, such as marble size or number of marbles. They may also observe relationships between the launch height of the marble and the energy in the marble. NSTA/Science & Children

Sled Wars: Gizmos The Sled Wars Gizmo is an interactive simulation that allows students to explore what happens when objects collide. By crashing a virtual sled into a row of snowmen, students can observe how variables affect energy transfer in a collision. They can change the mass of the sled's rider or the launch height to increase the amount of energy, thus increasing the number of snowmen that can be knocked over. NSTA/Explore Learning

Light Your Way Using the engineering design process, students will use everyday household items to design their own operating series circuit flashlights. TeachEngineering

Shoebox Circuits In this activity, students explore the scientific phenomena of how electric circuits work in their everyday lives. Students will work in pairs to design and wire a shoebox "room" that meets well-defined circuit requirements using the engineering design process. Concepts related to conductivity, series and parallel circuits, bulb brightness, and switches, will be reinforced as students plan and build their shoebox circuits. NSTA/Science & Children

Circuit Builder: Gizmos The Circuit Builder Gizmo is an interactive simulation that allows students to create circuits using batteries, light bulbs, switches, fuses, and a variety of materials. Students can examine series and parallel circuits, conductors and insulators, and the effects of battery voltage. Explore Learning

Thermal Energy Transfer Explore the three methods of thermal energy transfer—conduction, convection, and radiation—in this interactive, through animations and real-life examples. PBS LearningMedia

Heat Absorption: Gizmos The Heat Absorption Gizmo is an interactive simulation that allows students to observe that objects heat up when they absorb light. Students are able to shine a powerful flashlight on a variety of materials and measure how quickly each material heats up. They can see how the light angle, light color, and type of material affect heating. A glass cover can be added to simulate a greenhouse. Explore Learning

Energy Conversions: Gizmos The Energy Conversions Gizmo is an interactive simulation that allows students to trace the path of energy and see how energy is converted from one form to another. Explore Learning

Working with Wind Energy This activity explores the growing use of wind energy to generate or augment energy in businesses and homes worldwide. Student teams design and build a working windmill out of everyday items, which they select and purchase with a budget. Student windmills must be able to sustain the wind generated by a fan or hair dryer at medium speed at 3 feet and rotate, lifting a small object upward. Students evaluate the effectiveness of their windmill and those of other teams and present their findings to the class.

Summative/Formative Assessment

Formative

Before

Pre-test (identify key concepts and vocabulary)
KWL charts
Brainstorming

During

Concept maps
Diagrams
Think-pair-shares
Summaries/Written responses
Interactive journals
Observations

Summative

After

Post-test
Presentation/Model report using rubric aligned with essential question

Literacy Standards

NJSLS.LA.4.RI.4.1. Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS3-1)

NJSLS.LA.4.RI.4.3. Explain events procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. (4-PS3-1)

NJSLS.LA.4.RI.4.9. Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS3-1)

NJSLS.LA.4.W.4.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (4-PS3-1)

NJSLS.LA.4.W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-2), (4-PS3-3), (4-PS3-4)

NJSLS.LA.4.W.4.8. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4)

NJSLS.LA.4.W.4.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-PS3-1)

Science Example 1: To integrate English Language Arts into this unit, students should conduct research to build their understanding of energy transfers. They will need access to a variety of texts and should use information from their class experiences and from print and digital sources to write informative/explanatory texts. As students gather information, they should take notes and categorize information. In their writing, students should detail what they observed as they investigated simple force and motion systems, describe procedures they followed as they conducted investigations, and use information from their observations and research to explain the patterns of change that occur when

objects move and collide. As students participate in discussions and write explanations, they should refer specifically to text, when appropriate.

Math Standards

NJSLS.MA.4.4.OA.A.1. Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 x 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations. (4-ESS3-1)

NJSLS.MA.4.4.OA.A.3. Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (4-PS3-4)

Science Example 1: Students reason abstractly and quantitatively as they gather and analyze data during investigations and while conducting research about transfers of energy and energy sources. Students model with mathematics as they represent and/or solve word problems. As students research the environmental effects of obtaining fossil fuels, they might be asked to represent a verbal statement of multiplicative comparison as a multiplication equation. For example, students might find information about a spill that was 5 million gallons of oil and was 40 times larger than a previous oil spill in the same location. They can be asked to represent this mathematically using an equation to determine the number of gallons of oil that were spilled in the previous event.

Future Learning

Grade 5: Energy and Matter in Ecosystems

- The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).
- Plants acquire their material for growth chiefly from air and water.

Grade 5: Earth Systems

- Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

Grade 6: Forces and Motion

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

Grade 7: Organization for Matter and Energy in Organizations

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.
- Cellular respiration in plants and animals involves chemical reactions with oxygen that release stored energy. In these processes complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.

Grade 7: Earth Systems

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.

Grade 8: Stability and Change on Earth

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

Grade 8: Human Impact

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

Grade 8: Relationships Among Forms of Energy

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.
- A system of objects may also contain stored (potential) energy, depending on their relative positions.
- When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

Grade 8: Thermal Energy

- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.
- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones.

Grade 8: Electromagnetic Radiation

- When light shines on an object, it is reflected, absorbed or transmitted through the object, depending on the object's material and the frequency (color) of the light.
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves.

Additional Information

-NGSS Interactive site: http://www.nextgenscience.org/search-standards

Science Curriculum - 4th Grade

Unit 4
Waves and Information

Performance Expectation(s)

4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. [Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]

4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information. [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Essential Question(s)

- If a beach ball lands in the surf, beyond the breakers, what will happen to it?
- Which team can design a way to use patterns to communicate with someone across the room?

Learning Plan

Science/Engineering Practices	Disciplinary Core Idea(s)	Crosscutting Concept(s)
Developing and Using Models Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1) • Develop a model to describe phenomena. (4-PS4-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3-5 builds	**PS4.A: Wave Properties** ● Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (4-PS4-1) ● Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)	**Patterns** ● Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1) ● Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3) **Cause and Effect** ● Cause and effect relationships are routinely identified. (4-PS4-2) ----------

on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns. (4-PS4-1)

PS4.B: Electromagnetic Radiation

- An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)

PS4.C: Information Technologies and Instrumentation

- Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. (4-PS4-3)

ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)

Resources and Links

Videos

PS4.A. Wave Properties– Bozeman Science Video
PS4.B. Electromagnetic Radiation – Bozeman Science Video
PS4.C. Information Technologies & Instrumentation – Bozeman Science Video
ETS1.C. Optimizing the Design Solution
BrainPOP: Waves

Other Resources

Mystery Science:
Mystery 1: How far can a whisper travel?
Mystery 2: What would happen if you screamed in outer space?
Mystery 3: Why are some sounds high and some sounds low?

Everything 4th Grade Science Mega Bundle: This bundle includes complete lesson sets that are aligned with the Next Generation Science Standards for 4th grade. The activities in these lesson sets are created to incorporate reading and writing into the Science curriculum. Teachers Pay Teachers

Electric Messages: Then and Now This lesson integrates social studies and energy transfer concepts as students explore the history of electronic messaging systems (Morse Code and text messaging) before applying concepts of energy transfer through the construction of a simple signaling device by which they can send messages to each other via Morse Code. NSTA/TryEngineering

Pop Bottle Waves and Hair Dryer Ripples This is an exploratory lesson where students observe, draw, and think about how waves are shaped, how they move, and what creates them. The teacher creates a model using a plastic bottle with colored water inside. Students make their own models using the materials and procedures set up by the teacher. Students observe and record the waves and how they change. Students also observe how a hair dryer creates ripples on water. NSTA/BetterLesson

What Are Waves? Students explore making waves using everyday objects to begin developing an understanding of how waves are made, that waves carry energy, and that there are different types of waves. Students investigate examples of transverse and longitudinal waves at stations and use their science journals to record observations and predict the type of wave they are creating. NSTA/BetterLesson

Bite-Size Physics The Bite-Size Physics website uses humor and simple hands-on activities to teach physics principles. This lesson gives a background lesson on waves, followed by several simple experiments to teach transverse and longitudinal waves, frequency, wavelength, and amplitude. The activities use rope, a slinky, and colored tape to teach the concepts. NSTA

Waves: Gizmos The Waves Gizmo is an interactive simulation that allows students to observe and measure transverse, longitudinal, and combined waves on a model of a spring moved by a hand. Students can adjust the amplitude and frequency of the hand and the tension and density of the spring. The speed and power of the waves is reported and the wavelength and amplitude can be measured. Explore Learning

Summative/Formative Assessment

Formative

Before

Pre-test (identify key concepts and vocabulary)
KWL charts
Brainstorming

During

Concept maps
Diagrams
Think-pair-shares
Summaries/Written responses
Interactive journals
Observations

Summative

After

Post-test
Presentation/Model report using rubric aligned with essential question

Literacy Standards

NJSLS.LA.4.RI.4.1. Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS4-3)

NJSLS.LA.4.RI.4.9. Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS4-3)

NJSLS.LA.4.SL.4.5. Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-PS4-1), (4-PS4-2)

Science Example 1: To integrate English Language Arts into this unit, students should conduct short research projects using both print and digital sources to build their understanding of wave properties and of the use of waves to communicate over a distance. Students should take notes, categorize information collected, and document a list of the sources used. Using the information they collect during research, as well as information from their experiences with waves, sound, and light, students integrate the information and use it to design a device or process that can be used to communicate over a distance using patterns. As students create presentations that detail how their design solutions can be used to communicate, they should use details and examples from both their research and experiences to explain how patterns are used in their design to communicate over a distance. They can include audio or video recordings and visual displays to enhance presentations.

Math Standards

NJSLS.MA.4.4.G.A.1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular lines. Identify these in two-dimensional figures. (4-PS4-1), (4-PS4-2)

Science Example 1: Students should have opportunities to draw points, lines, line segments, rays, angles, and perpendicular and parallel lines, and identify these in two-dimensional drawings as they identify rays and angles in drawings of the ways in which waves move. Students should also have opportunities to use the four operations to solve problems. As students represent and solve word problems, they reason abstractly and quantitatively and model with mathematics. As students create models of waves and engage in engineering design, they have opportunities to use tools strategically while measuring, drawing, and building.

Future Learning

In middle school, students will know that:

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.
- A sound wave needs a medium through which it is transmitted.
- Digitized signals (sent as wave impulses) are a more reliable way to encode and transmit information.

Additional Information

-NGSS Interactive site: http://www.nextgenscience.org/search-standards