Science and Engineering Practices

Asking questions and defining problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested.

Developing and using models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Planning and carrying out investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Analyzing and interpreting data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results.

Using mathematics and computational thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships.

Constructing explanations and designing solutions

The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

Engaging in argument from evidence

Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem.

Obtaining, evaluating, and communicating information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Crosscutting Concepts

Patterns

Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Cause and effect

Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

Scale, proportion, and quantity

In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Systems and system models

A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Energy and matter

Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Structure and function

The way an object is shaped or structured determines many of its properties and functions.

Stability and change

For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Disciplinary Core Ideas

Life Science	Earth & Space Science	Physical Science
From molecules to organisms: Structures and processes LS1.A: Structure and function LS1.B: Growth and development of organisms LS1.C: Organization for matter & flow in organisms LS1.D: Information processing	**Earth's place in the universe** ESS1.A: The universe and its stars ESS1.B: Earth and the solar system ESS1.C: The history of planet Earth	**Matter and its interactions** PS1.A: Structure and properties of matter PS1.B: Chemical reactions PS1.C: Nuclear processes
Ecosystems: Interactions, energy, and dynamics LS2.A: Interdependent relationships in ecosystems LS2.B: Cycles of matter and energy transfer in ecosystems LS2.C: Ecosystem dynamics, functioning, and resilience LS2.D: Social interactions and group behavior	**Earth's systems** ESS2.A: Earth materials and systems ESS2.B: Plate tectonics and large-scale system interactions ESS2.C: The roles of water in Earth's surface processes ESS2.D: Weather and climate ESS2.E: Biogeology	**Motion and stability: Forces and interactions** PS2.A: Forces and motion PS2.B: Types of interactions PS2.C: Stability and instability in physical systems
Heredity: Inheritance and variation of traits LS3.A: Inheritance of traits LS3.B: Variation of traits	**Earth and human activity** ESS3.A: Natural resources ESS3.B: Natural hazards ESS3.C: Human impacts on Earth systems ESS3.D: Global climate change	**Energy** PS3.A: Definitions of energy PS3.B: Conservation of energy & energy transfer PS3.C: Relationship between energy & forces PS3.D: Energy in chemical processes & everyday life
Biological evolution: Unity and diversity LS4.A: Evidence of common ancestry and diversity LS4.B: Natural selection LS4.C: Adaptation LS4.D: Biodiversity and humans		**Waves and their applications in technologies for information transfer** PS4.A: Wave properties PS4.B: Electromagnetic radiation PS4.C: Information technologies & instrumentation
Engineering, Technology, and the Application of Science		
ETS1.A: Defining and delimiting engineering problems ETS1.B: Developing possible solutions ETS1.C: Optimizing the design solution		

BCS 6th Grade Science Standards

Grading Period	Standards	Pacing
1st (8/1-10/5)	Engineering Design, Scientific Tools	7-8 days
	6.PS3.1 – Types of Energy	2-3 days
	6.PS3.3 – Relationship between kinetic energy and the mass of an object in motion	2-3 days
	6.PS3.2 – Transformation between potential and kinetic energy	2-3 days
	6.ETS1.2 – Solutions that impact energy transfer	1 week
	6.PS3.4 – Thermal energy moves through objects	1 week
	6.ESS2.2 – Convection patterns	1 week
	6.ESS2.1 – Oceanic convection currents	1 week
2nd (10/8-12/19)	6.ESS2.3 – Climate and heat transfer	1 week
	6.ESS2.6 – Air masses	1 week
	6.ESS2.5 – Weather data and predictions	1 week
	6.LS2.4 – Biomes	4-5 days
	6.LS2.3 – Food webs and energy pyramids	4-5 days
	6.LS2.2 – Competitive, symbiotic, and predatory interactions	4-5 days
	6.LS2.1 – Impact of environmental variables on population size	5-6 days
	6.LS2.7 – Auditory and visual methods of communication for survival	5 days
	6.LS2.5 – Invasive species in TN	5-6 days
3rd (1/7-3/15)	6.LS4.1 – Changes in biodiversity	1 week
	6.ESS2.4 – Impact of humans and other organisms on the hydrologic cycle	1 week
	6.LS2.6 – Ecosystems change over time	1 week
	6.LS4.2 – Maintaining biodiversity	1 week
	6.ETS1.1 – Solutions for maintaining ecosystems and biodiversity	1 week
	6.ESS3.1 – Renewable and nonrenewable resources	1 week
	6.ESS3.2 – Technology and Renewable/Alternative Energy	4-5 days
	6.ESS3.3 – Impact of Human Activity	4-5 days
4th (3/18-5/23)	Review	
	Testing	
	End of Year Activities	

Disciplinary Core Idea: 6.PS3: Energy

Standard: 6.PS3.1 - Analyze the properties and compare the sources of kinetic, elastic potential, gravitational potential, electric potential, chemical, and thermal energy.

Explanation: Students should develop an understanding of energy which has two components: energy storage (6.PS3.1) and transformation (6.ps3.2). Energy can be possessed by an object or stored in fields. Objects can possess energy as kinetic (motion of objects), thermal (motion of particles), or chemical energy (energy stored in chemical bonds). Fields can possess energy based on the position of an object within the field. Gravitational fields store/release gravitational potential energy when an object changes position within the gravitational field. Electric fields store/release electric potential energy as charges change position within an electric field. Finally, forces which distort the shapes of objects store energy in the elastic/distorted object (elastic potential). For example, the elastic bands of a sling shot store energy when they are pulled back. Upon release, the elastic bands then do work on the object in the slingshot transferring energy away from the bands and giving kinetic energy to the projectile.

Component Idea: *A. Definitions of Energy*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Developing and using models *Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models.*	**Energy and Matter** *Students give general descriptions of different forms and mechanisms for energy storage within a system.*	*A ball dropped from 1 m will bounce up but not return to the original height.* Trampoline: Potential energy *When you jump on a trampoline, different types of energy are present.*

Formative Assessments

1. TE p. lxviii Create a flow chart to show conversions of energy associated with a rechargeable flashlight battery
2. For the bouncy ball phenomenon: Students develop an argument for how the evidence they collected supports their explanation for the causes of the ball bouncing lower with each bounce
3. Observe your classroom and note examples of energy. Make a set of diagrams depicting the examples and explain the properties that give you clues
4. Prepare a presentation to explain how kinetic energy and potential energy differ. Include the forms of kinetic and potential and show the differences between some of these forms of energy.
5. Create a collage cut-out of images related to energy and the environment from magazines and newspapers. Arrange them to make a collage and include at least 6 energy resources and identify them.

Textbook Connections	Standard Connections
SE: Chapter 1 (p. 8-29) TE: Lesson Planner (p 8A – 8B; 14A – 14B; 20A – 20B)	6.PS3.2—Transformation between potential and kinetic energy 6.PS3.3—Relationship between kinetic energy and the mass of an object in motion 6.ETS1.2—Solutions that impact energy transfer

Lesson Resources

Energy Introduction Lesson
Bouncing Ball Lab Activity
Energy Detectives Activity
BrainPOP Types of energy
Energy Quizlet

Where Learning Comes From	Where Learning Goes Next
Grades K, 3,5	7th

Writing and Speaking

Describe the properties and compare the sources of kinetic, elastic potential, gravitational potential, electrical potential, chemical, and thermal energy.

Disciplinary Core Idea: 6.PS3: Energy

Standard: 6.PS3.3 - Analyze and interpret data to show the relationship between kinetic energy and the mass of an object and its speed.

Explanation: Students should analyze data to see that kinetic energy is directly proportional to mass and to the square of velocity. Students can be provided data to carry out this analysis. Alternately, heavy objects can be dropped into beds of flour or soft material and comparisons of the indentions can be made. Doubling the mass and dropping from the same height will produce an indention with a volume twice as great. Dropping an object from a height twice as great leaves and indention with four times the volume. *(Instruction of this standard can be limited to recognizing that as the speed of an object increases, the kinetic energy increases at a greater rate and describing qualitative changes to kinetic energy. Creating proportionalities, graphing linear/quadratic relationships and exponents all exceed sixth grade Tennessee math standards, but can be used for enrichment in with advanced students.)*

Component Idea: *A. Definitions of Energy*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Analyzing and interpreting data *Students should create and analyze graphical presentations of data to identify linear and non-linear relationships, consider statistical features within data and evaluate multiple data sets for a single phenomenon.*	**Scale, Proportion, and Quantity** *Students create proportional and algebraic relationships from graphical representations*	*When an adult does a cannonball into the swimming pool, their splash is much larger than a kid's cannonball splash.* Trampoline: Potential energy *The more you compress the trampoline, the higher you go.* Water bottle mass demo: Kinetic energy *The water bottle that is more full rolls across the table faster.*

Formative Assessments

1. TE p. lxx Create and interpret graphs describing the relationship of kinetic energy to mass and speed of an object. Reports should explain the results and integrate visual displays with in the text.
2. Students write a reflection on their observations and draw a diagram using arrows to explain why the most massive object has the most speed.

Textbook Connections	**Standard Connections**
SE: Chapter 1 (10-11) TE: Lesson Planner (p 8A – 8B)	6.PS3.1—Types of energy 6.PS3.2—Transformation between potential and kinetic energy 6.ETS1.2—Solutions that impact energy transfer

Lesson Resources

Making a Splash (Phenomenon-Bases Lesson)
Maximize kinetic energy at a skate park
Relationships Between Kinetic Energy, Mass, and Speed

Lessons from the Tennessee Department of Education—Using mathematics and computational thinking

Where Learning Comes From	**Where Learning Goes Next**
Grades 1,2,3,4	Physical Science

Writing and Speaking

What has a greater effect on an object's kinetic energy-doubling its mass or doubling its speed? Explain.

Disciplinary Core Idea: 6.PS3: Energy

Standard: 6.PS3.2 Construct a scientific explanation of the transformation between potential and kinetic energy.

Explanation: Students are first exposed to potential energy in fourth grade, but at that time students were not expected to classify types of energy. Students should develop an understanding of energy which has two components: energy storage (6.ps3.1) and transformation (6.ps3.2). Transfer of energy can move the energy from one energy type to a different energy type. (Types of energy are included in 6.ps3.1) The methods of energy transfer include work, heat, and radiation. For example: If fired upwards, a projectile slows down as it ascends, doing work on Earth's gravitational field and storing gravitational potential energy in the field. Ultimately it stops at a maximum height. For this moment of rest, the object possesses no energy. Earth's gravitational field can then do work on the object speeding it up as it then descends and returning energy to the projectile as kinetic energy while the object returns to the ground. *(A focus should be placed on examples in which work is the means of energy transfer.)*

Component Idea: *A. Definitions of Energy*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Constructing explanations and designing solutions *Students form explanations using source (including student developed investigations) which show comprehension of parsimony, utilize quantitative and qualitative models to make predictions, and can support or cause revisions of a particular conclusion.*	**Energy and Matter** *Students track energy changes through transformations in a system.*	*If I throw a ball up in the air, it slows down as it ascends, stops at its maximum height, and then speeds up as it descends back towards the ground.* Rollercoaster video *In the design of a rollercoaster, the first hill is the highest.* Kinetic and potential energy pendulum *After the pendulum is dropped, it never returns to the same height.* Energy transfer from Slow Mo Guys *Elastic potential energy is transferring into kinetic energy* Sled Wars *The higher the sled's starting position is, the more snowmen is knocks over.*

Formative Assessments

1. TE p. lxix Create a model of transportation system and describe how kinetic and potential energy are converted in transportation system. Include in depth captions that describe the components and how they work together.
2. Students design an experiment to demonstrate kinetic and potential energy and the factors that affect them.
3. Students use model of a pendulum and use the data collected to explain how the force of gravity affects a falling object
4. Make a pendulum and explain how mechanical energy works during the movements.
5. Write a journal entry that describes how energy behaves in a closed system
6. Look at a cyclist conquering a mountain. (biking up, resting at the top, and third coasting down) Explain to a small group the concepts of potential, kinetic, and mechanical energy in the diagram.
7. Construct a working model rollercoaster and calculate the speed, kinetic energy, mass, and potential energy.

Textbook Connections	Standard Connections
SE: Chapter 1 (p 2-19) TE: Lesson Planner (p 8A – 8B; 14A – 14B;)	6.PS3.1—Types of energy 6.PS3.3—Relationship between kinetic energy and the mass of an object in motion 6.ETS1.2—Solutions that impact energy transfer

Lesson Resources

Pendulum lesson
Marble rollercoaster: Energy and Engineering
https://www.georgiascienceteacher.org/phenomena
Investigating Kinetic and potential energy
BrainPOP Kinetic Energy Lesson
Energy Stations
Kinetic and Potential
Lesson comparing a bouncing ball to a roller coaster
Lessons from the Tennessee Department of Education— Constructing explanations and designing solutions

Where Learning Comes From	Where Learning Goes Next
Grades 1,2,3,4	Grade 7

Writing and Speaking

Explain the difference between potential energy and kinetic energy. Be sure to give examples.

Disciplinary Core Idea: 6.ETS1: Engineering Design

Standard: 6.ETS1.2 Design and test different solutions that impact energy transfer.

Explanation: Even design solutions that meet criteria and constraints for a successful design may fail in production. The tests should be designed to expose failure in specific components of a device. The results of these tests can then be used to create a comprehensive solution. Design tasks might relate to selecting materials to minimize or maximize energy transfer into or out of a system by minimizing heat loss, or sound production or by maintaining initial kinetic energies.

Component Idea: *C. Optimizing the Solution Design*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Planning and carrying out controlled investigations *Students can design tests which determine the effectiveness of a device under varying conditions.*	**Energy and Matter** *Students track energy changes through transformations in a system*	Wind turbines *Electricity can be generated from wind as an alternative energy source.* Mickey mouse solar panels *Solar panels help provide power to Walt Disney World.*

Formative Assessments

1. TE p. 1 Construct and test a device to observe differences in thermal energy transfer among different materials. Compare the rate of transfer of thermal energy from water using cups made of different materials (Styrofoam, coffee mug, and glass cup) by creating a line graph of the data they collected, plotting changes in temperatures.
2. Using a ping pong ball and a popper toy, students will construct an experiment to see how different materials impact how energy transfers. Students will make comparisons between the data collected.

Textbook Connections	Standard Connections
SE: Chapter 1 (p 20-25) TE: Lesson Planner (p 20A – 20B)	6.PS3.1—Types of energy 6.PS3.2—Transformation between potential and kinetic energy 6.PS3.3—Relationship between kinetic energy and the mass of an object in motion 6.PS3.4—Thermal energy moves through objects

Lesson Resources

Do Different Colors Absorb Heat Better?
Measurement Stations Lab
Working with Wind Energy
Developing Possible Solutions Video
Powering the Future Video
Lab Report: Do Different Colors Absorb Heat Better?

Where Learning Comes From	Where Learning Goes Next
Grades K-5	Grade 8

Writing and Speaking

When a light bulb is turned on, electrical energy is transformed into 2 other types of energy. What are they and support your answer with evidence.

Disciplinary Core Idea: 6.PS3: Energy

Standard: 6.PS3.4 Conduct an investigation to demonstrate the way that heat (thermal energy) moves among objects through radiation, conduction, or convection.

Explanation: In everyday language, "heat" is used to refer to thermal energy. Students should emphasize the difference between these two terms. Heating is a method by which energy can be transferred from one object to another. Thermal energy is the energy stored by the movement of particles and is measured using a thermometer. There are three specific means of heating: conduction, convection, and radiation. Radiation (light) can be seen as a form of heating, but is unique from conduction and convection, because it can transfer energy across empty space. Students can observe changes in thermal energy (by recording temperature) using any of the above methods of heating.

Component Idea: *A. Definitions of Energy*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Planning and carrying out controlled investigations *Students begin to investigate independently, select appropriate independent variables to explore a dependent variable and recognize the value of failure and revision in the experimental process.*	**Cause and Effect** *Students begin to connect their explanations for cause and effect relationships to specific scientific theory*	Snow shadow: conduction and radiation *After an overnight snow shower, most of the snow has melted from the parking lot in the picture. The remaining snow seems to match the shape of a shadow cast by an adjacent building.* Convection *The windmill is moving because of the rising and falling air.*

Formative Assessments

1. TE p. lxxi Design a device and conduct a procedure where energy absorbed or released by chemical reaction can move among objects through radiation, conduction, or convection. Devices should release and absorb thermal energy in a controlled measurable way.
2. Draw a cartoon in which several methods of thermal transfer are shown. Include captions that identify the methods of transfer and explain how the methods are related.
3. Explain the method of energy transfer in the following example in your journal: Your friend ordered hot cocoa at a restaurant. When she tries to take a sip, she finds it is too hot. Your friend sets her mug on the table. You notice steam rising from the mug. A few minutes later, your friend can drink her cocoa because it has cooled. What do you know about the energy transfer that happened.
4. Ocean currents travel in a convection current. Explain how the sun heats the water and how the heat is transferred to different parts of the ocean.
5. You bite into a slice of hot apple pie. The filling and the crust are the same temperature. Explain why the filling burns your mouth but the crust does not.

Textbook Connections	Standard Connections
SE: Chapter 2 (p 32-55) TE: Lesson Planner (p 38A – 38B; 42A – 42B; 46A – 46B)	6.ETS1.2—Solutions that impact energy transfer 6.ESS2.2—Convection patterns 6.ESS2.1—Oceanic convection currents 6.ESS2.3—Climate and heat transfer

Lesson Resources

Modeling CCR
Take a walk with heat transfer (gallery walk CFA)
Convection, Conduction, Radiation Oh My!
CCF video
Lessons from the Tennessee Department of Education – Planning and carrying out investigations

Where Learning Comes From	Where Learning Goes Next
Grades 1-4	Physical Science

Writing and Speaking

Describe how thermal energy moves among objects through conduction, convection, and radiation.

Disciplinary Core Idea: 6.ESS2: Earth's Systems

Standard: 6.ESS2.2 Diagram convection patterns that flow due to uneven heating of the earth.

Explanation: The process of convection is explored both in the ocean (6.ESS2.1) and in the atmosphere (6.ESS2.2). Models for oceanic convection based on temperature differences are appropriate for use to explain atmospheric convection processes. Atmospheric movements lead to the transport of water from stores and to certain areas of Earth's surface. A model for heating of the Earth shows more direct heating of the earth's equator relative to the poles creating two large convection cycles which move upward at the equator and descend at the poles. When the rotation of the earth is factored in, the two convection cycles are broken into a total of six cycles. This effect (Coriolis effect) can be modeled by a pair of students using a marker and a large sphere. If the sphere is stationary, a student can use a marker to draw a straight line from the equator to the poles. If the ball is rotated while drawing this same straight line, the resulting line drawn on the sphere will curve. Rate of rotation determines the severity of the curvature, Earth's angular velocity results in three cells, with deserts focused at latitudes near 30 degrees and 60 degrees north and south, and predictable surface winds. (Memorization of global wind patterns and layers of the atmosphere are beyond the scope of this standard.)

Component Idea: *D. Weather and Climate*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Developing and using models *Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models.*	**Energy and Matter** *Students give general descriptions of different forms and mechanisms for energy storage within a system.*	When heat transfers through convection *Convection currents can be seen throughout the earth and play a huge role in our everyday lives.* The Ocean Clean Up Project studies convection currents to come up with a solution *Ocean currents concentrate plastic in five areas of the world.*

Formative Assessments

1. Construct an explanation about wind formation, using the terms Coriolis effect, convection cells, and global pressure belts. Create a model showing how winds form.
2. Create a model illustrating how the sun's uneven heating causes convection cells in Earth's atmosphere and creates global winds. (include caption and labels explaining what the model is showing)
3. Journal reflection- Model how wind forms, sources of energy that cause atmospheric movement, why air moves, how convection cells affect wind, and the Coriolis effect through explanations and illustrations.

Textbook Connections	Standard Connections
SE: Chapter 7 (p 228-233, 242-247) TE: Lesson Planner (p 228A – 228B)	6.ETS1.2—Solutions that impact energy transfer 6.ESS2.1—Oceanic convection currents 6.ESS2.3—Climate and heat transfer 6.PS3.4—Thermal energy moves through objects

Lesson Resources

Convection
Convection Currents
Land and Sea Breezes
Lessons from the Tennessee Department of Education – Developing and Using Models

Where Learning Comes From	Where Learning Goes Next
Grades K, 2,3,4	Grade 8

Writing and Speaking

Draw and label convection patterns and how they flow due to uneven heating of the earth.

Disciplinary Core Idea: 6.ESS2: Earth's Systems

Standard: 6.ESS2.1 Gather evidence to justify that oceanic convection currents are caused by the sun's transfer of heat energy and differences in salt concentration leading to global water movement.

Explanation: Understanding of ocean convection currents requires that students are familiar with: unequal heating of the earth's surface (built from 5.ess1.5), the density-related rise of heated fluids, and the density-related descent of cooler fluids. From third grade, students will have developed understandings of mass and volume; however, the topic of density will need to be explored to fully support 6.ESS2.1 and 6.ESS2.2. Demonstrations of the temperature-based behavior can be performed by heating one side of a water-filled baking dish and cooling the opposite side. If the water is initially allowed to settle, drops of food coloring will trace out the convection patterns which develop. Pipets can be used to insert the food coloring into the lower currents. Models for the effect of salt on creating a sinking mass of water can be accomplished by partially filling a large container with water then covering the surface of the water with plastic wrap and pouring an additional volume of salt-containing, colored water onto the wrap. With the gentle removal of the plastic wrap, the mixing will be visible. Reversing the order that the waters are added will provide alternate effects, and finally using two samples with coloring but no salt can provide a control. (Calculations of density are beyond the scope of this standard.)

Component Idea: *C. The Roles of Water in Earth's Surface Processes*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Constructing explanations and designing solutions *Students form explanations using source (including student developed investigations) which show comprehension of parsimony, utilize quantitative and qualitative models to make predictions, and can support or cause revisions of a particular conclusion.*	**Cause and Effect** *Students use cause and effect relationships to make predictions.*	**Convection Currents** *Convection is created by a circular pattern caused by uneven heating of the sun.* **Salinity in Water** *The more salt in the water, the denser the water will be, and it will sink.*

Formative Assessments

1. Collect, use, and display data associated with ocean currents due to differences in temperature from the sun's energy and salt concentration. Describe the pattern or relationship they can infer from the data.
2. Plan an investigation demonstrating how temperature affects water movement. Describe how the investigation will generate relevant patterns that occur between the sun's heating and the movement of ocean water.
3. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the salinity of ocean water.

Textbook Connections	Standard Connections
SE: Chapter 7 (p 242-247) TE: Lesson Planner (p 144A – 144B; 150A – 150B)	6.ETS1.2—Solutions that impact energy transfer 6.ESS2.2—Convection patterns 6.ESS2.3—Climate and heat transfer 6.PS3.4—Thermal energy moves through objects

Lesson Resources

Ocean Currents Lab
Ocean Currents Quizlet
Convection Currents Demo Video

Where Learning Comes From	Where Learning Goes Next
Grades K,2,3,4	Grade 8

Writing and Speaking

Explain how the sun's heat energy and salinity lead to global water movement.

Disciplinary Core Idea: 6.ESS2: Earth's Systems

Standard: 6.ESS2.3 Construct explanation for how atmospheric flow, geographic features, and ocean currents affect the climate of a region through heat transfer.

Explanation: Weather describes the immediate atmospheric conditions in a particular location, whereas climate describes long term patterns in a region's weather. It is possible for the climate in a region to vary from the climate seen at similar latitudes due to the presence of geographic features such as mountains or lakes. Coastal air rising over mountains will be depleted of its moisture and create deserts on the back side of the mountain. Likewise, large bodies of water can influence the temperature and humidity of a region due to the ability of water to store large amounts of thermal energy.

Component Idea: *D. Weather and Climate*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Engaging in argument from evidence *Students critique and consider the degree to which competing arguments are supported by evidence.*	**Stability and Change** *Students explain that systems in motion or dynamic equilibrium can be stable.*	"Melting Permafrost in the Arctic" video *Permafrost melting is releasing methane gas into the atmosphere.*

Formative Assessments

1. (TE p. lxxxiii) Develop a model to describe global winds and ocean surface currents. Label the components, interactions, and mechanism in each model. Write an explanation for each phenomenon using the model as supporting evidence.
2. Compare models of global winds and surface ocean currents to identify both common and unique model components, relationships, and mechanisms. Write an explanation comparing and contrasting the heat flow causing each phenomenon.
3. Imagine you are a message in a bottle lost at sea who has just traveled hundreds of miles on an ocean current. Write an evidence based account of your movements on the current. Include where you began your journey and the steps that took you to your final destination.

Textbook Connections	**Standard Connections**
SE: Chapter 9 (p 318- 335) TE: Lesson Planner (p 318A – 318B)	6.ETS1.2—Solutions that impact energy transfer 6.ESS2.2—Convection patterns 6.ESS2.1—Oceanic convection currents 6.PS3.4—Thermal energy moves through objects

Lesson Resources

Effect of Latitude on Climate
Ocean Currents and Climate Zones
Ocean Science Simulations
Ocean Currents Study Jam Video
Ocean Current and Roller Coaster Comparison

Where Learning Comes From	**Where Learning Goes Next**
Grades K,2,3,4,	Grade 8

Writing and Speaking

Describe how atmospheric flow, geographic features, and ocean currents affect the climate of a region through heat transfer.

Disciplinary Core Idea: 6.ESS2: Earth's Systems

Standard: 6.ESS2.6 Explain how relationships between the movement and interactions of air masses, high and low-pressure systems, and frontal boundaries result in weather conditions and severe storms.

Explanation:
The underlying principle is that high-pressure areas will push into or fill low-pressure areas. Low-pressure areas are columns of the atmosphere with a lower-pressure than surrounding air. As the surrounding higher-pressure air pushes in to fill this area, the air in this low-pressure column is displaced upward where condensation and precipitation occur as the elevation of this air increases. This air mass spins due again to Earth's rotation (Coriolis Effect). The opposite phenomenon occurs for high pressure areas, with a resulting spin in the opposite direction. The convergence of opposing pressure fronts creates severe weather phenomena due to the inverse nature of the air masses. This standard includes both occluded and stationary fronts, but not the memorization of specific air masses (e.g., continental polar or maritime tropical).

Component Idea: *D. Weather and Climate*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Developing and using models *Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models.*	**Systems and System Models** *Students develop models for systems which include both visible and invisible inputs and outputs for that system.*	A Year of Weather *The cloud formation over the equator is more frequent than over the poles.* Tornadoes *The greater the pressure difference in a tornado, the stronger and more destructive it will be.*

Formative Assessments

1. Use weather data from the local newspaper to predict & draw conclusions about the changes in upcoming local weather. Present a two-day weather forecast that predicts temperature, pressure, humidity, precipitation, and wind.
2. Use weather maps to have students analyze weather symbols and data. Have students describe a pattern or relationship they can infer from the observations of the weather maps.
• Weather Maps Activity
• Weather Maps Assessment

Textbook Connections	Standard Connections
SE: Chapter 8 (p 264-299) TE: Lesson Planner (p 264A – 264B)	6.ESS2.5—Weather data and predictions

Lesson Resources

Air mass and Front
What is Air Pressure
High and Low Pressure

Where Learning Comes From	Where Learning Goes Next
Grades K,2,3,4	Grade 8

Writing and Speaking

Scientists say that conditions must be "just right" for a hurricane to start up. Name and describe the three key factors that cause the birth of a hurricane.

Disciplinary Core Idea: 6.ESS2: Earth's Systems

Standard: 6.ESS2.5 Analyze and interpret data from weather conditions, weather maps, satellites, and radar to predict probable local weather patterns and conditions.

Explanation: The ability to recognize global patterns in climate distributions, describe deviations such as deserts created by the rain shadow effect is dependent, or to make predictions for future weather is dependent on collecting and interpreting weather related data. Examples of data from weather conditions include wind speed, wind direction, air temperature, humidity, and air pressure. In 3.ESS2.3, students were introduced to the use of tools to read temperature, precipitation, wind speed, and wind direction. By making a barometer, students are able to gain a better understanding of the intangible idea of air pressure. A vacuum demonstration is a good method to experience the phenomenon of air pressure. At this grade level, understanding should move beyond making readings and include a focus on using data to make predictions. *(Emphasis should be how high and low pressures are related to current weather conditions. Differentiation of cloud types was addressed in 3.ESS2.2.)*

Component Idea: *D. Weather and Climate*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Analyzing and interpreting data *Students should create and analyze graphical presentations of data to identify linear and non-linear relationships, consider statistical features within data and evaluate multiple data sets for a single phenomenon.*	**Cause and Effect** *Students use cause and effect relationships to make predictions*	Earth's Changing Climate *Earth's climate changes over a long period of time and organisms adapt to live in the variety of climates that exist on Earth.*

Formative Assessments

1. (TE p. lxxxv) Create a model of the water cycle using a clear plastic cup, re-sealable bag, and water. Observe the bag recording observations. Describe what caused the changed observed. Students may conduct brief research on the steps in the cycle to help them interpret the model. Write an explanation describing how the model represents the water cycle and diagram the model including labels and captions that explain the different steps represented.
2. Students will sketch or describe a design approach that develops a possible solution to the structures stability due to the specific weather condition. Describe why a form of severe weather is a major challenge for building and shelter structures. Students design a structure to withstand a randomly chosen weather forecast (natural elements may include rain, wind, storms, floods, drought) Explain how the relevant scientific ideas are taken into account within their design.
3. Record, analyze, and interpret daily weather measurements over an extended period of time using a variety of instruments (i.e., barometer, anemometer, sling psychrometer, rain gauge and thermometer) Describe a pattern or relationship they can infer from the observations. Compare how the representation s and analyses help them to identify patterns in the data.

Textbook Connections	Standard Connections
SE: Chapter 8 (300-305) TE: Lesson Planner (p 30A – 300B)	6.ESS2.6—Air masses

Lesson Resources

How to interpret weather data
National Centers for Environmental Information
Predict the weather
Weather Forecasting NEA
Lessons from the Tennessee Department of Education – Analyzing and interpreting data

Where Learning Comes From	Where Learning Goes Next
Grades K,2,3,4	Grade 8

Writing and Speaking

The Sun is responsible for many *cycles* on Earth including the water cycle. The Sun drives our weather and the wind. Explain how energy from the Sun causes the movement of air, specifically at Earth's equator.

isciplinary Core Idea: *6.LS2: Ecosystems: Interactions, Energy, and Dynamics*

Standard: 6.LS2.4 Using evidence from climate data, draw conclusions about the patterns of abiotic and biotic factors in different biomes, specifically the tundra, taiga, deciduous forest, desert, grasslands, rainforest, marine, and freshwater ecosystems.

Explanation: Ecosystems can be seen as "organisms" with specific needs for energy in the same way that a single organism has energy demands that must be met. Just as organisms have identifiable characteristics, so too do ecosystems. This standard allows students to look at various regions on Earth and observe that similar combinations of biotic and abiotic factors persist and that these allow the classification of ecosystems into certain types. Emphasis is on the relationship between temperature and pattern of global ocean and wind currents, the temperature of the air that is blown onto land, and then the causation of climate to dictate the type of abiotic factors. For example, the tundra has a lot of ice and permafrost because it is in the northern Hemisphere, does not receive direct sunlight so the water currents and resulting wind currents are cold, which causes a cold climate. Only biotic factors adapted to those abiotic factors can survive in that biome.

Component Idea: *C. Ecosystem Dynamics, Functioning, and Resilience*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Engaging in argument from evidence *Students form explanations using source (including student developed investigations) which show comprehension of parsimony, utilize quantitative and qualitative models to make predictions, and can support or cause revisions of a particular conclusion.*	**Pattern** *Students recognize, classify, and record patterns in data, graphs, and charts.*	Deciduous Forest: chipmunk adaptation *Chipmunks stuff their cheeks with large amounts of food.* Hibernation *Bears in certain climates go into hibernation.*

Formative Assessments

1. TE p. lxxv Investigate a specific biome and determine how climate has affected patterns associated with biotic and abiotic factors.
2. Students research specific organisms in a biome. Students will then create an adaptation chart for specific plants or animals found in that biome and communicate with the class how the adaptation helps it survive in that biome.
3. Biome sort- students analyze cards with the biome characteristics, biotic, and abiotic factors and interpret the information to determine which biome the data belongs in.

Textbook Connections	Standard Connections
SE: Chapter 4 (p 112—129) TE: Lesson Planner (p 112A – 112B; 122A – 122B)	6.LS2.3—Food webs and energy pyramids 6.PS3.1—Types of energy 6.LS2.2—Competitive, symbiotic, and predatory interactions 6.LS2.3—Food webs and energy pyramids

Lesson Resources

Resurrection plant video clip: desert biome
Article: Seeds designed to last forever destroyed by climate
Mission Biome
Biome Resources
Mission: To Plant or Not to Plant

Where Learning Comes From	Where Learning Goes Next
Grades K,2,3,4	Grade 8

Writing and Speaking

For each of the following biomes, describe the biotic and abiotic feature that are unique to this biome. a. tundra b. desert c. rainforest

Disciplinary Core Idea: 6.LS2: Ecosystems: Interactions, Energy, and Dynamics

Standard: 6.LS2.3 Draw conclusions about the transfer of energy through a food web and energy pyramid in an ecosystem.

Explanation: Students should be able to consider the transfer of energy between three groups: producers, consumers, and decomposers. Transfer of energy into an ecosystem by consumers is accompanied by transfer of matter; energy radiated by the sun is captured by plants as chemical energy is stored as food. Consumers combine the food with oxygen, permitting the use of the stored energy. Throughout its lifetime, an organism will use, on average, 90 percent of the energy it consumes. Ultimately, this 90% of energy is released back into the environment as heat. The remaining 10% can be passed along to further consumers or decomposers. *(Emphasis should be placed on the 10% rule and how energy is transferred to the environment as heat and approximately 10% of potential energy is passed to the next trophic level.)*

Component Idea: *B. Cycles of Matter and Energy Transfer in Ecosystems*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Developing and using models *Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models.*	**Energy and Matter** *Students track energy changes through transformations in a system.*	Oceanic Feeding Frenzy *Oceanic feeding frenzy, in which predators interact to obtain food (energy), is a food web in action.*

Formative Assessments

1. TE p. lxxiv Make a food web diagram for a local ecosystem that can be used to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. Students should be able to explain the role of photosynthesis, in terms of cycling matter and flow of energy within the ecosystem
2. Students use wildlife magazines and string to make a food chain/web (refer to lesson resource #5)
3. Relating to energy flow, students explain why very few food chains exist beyond five members
4. Make a commercial in which you promote producers. Explain how producers make their own food and how they get energy. Describe where producers are in an energy pyramid and why. Also, explain why producers are vital to their ecosystem and give 3 examples.
5. Choose one food you eat and draw a food chain that shows how you receive energy from that food.

Textbook Connections	Standard Connections
SE: Chapter 4 (p 102- 111) TE: Lesson Planner (p 102A – 102B)	6.LS2.4—Biomes 6.PS3.1—Types of energy 6.LS2.2—Competitive, symbiotic, and predatory interactions

Lesson Resources

Energy Pyramid Lab
Popcorn relay race
Food Chain game
Biodome Engineering Design
Got Energy? Spinning a Food Web
Food Web with yarn

Where Learning Comes From	Where Learning Goes Next
Grades 1-4	Grade 7

Writing and Speaking

Take a look at this pyramid. It shows us how energy and matter are transferred through a simple food chain. As we get to the top of the pyramid, the amount of available energy decreases. The producers at the bottom of the pyramid needed energy too. Where did that energy come from? What do the producers use the energy for?

Disciplinary Core Idea: 6.LS2: Ecosystems: Interactions, Energy, and Dynamics

Standard: 6.LS2.2 Determine the impact of competitive, symbiotic, and predatory interactions in an ecosystem.

Explanation: Population sizes are influenced by the interactions of organisms within the ecosystem. Predators can decrease population sizes, while mutualistic relationships create a sort of interdependence where the two populations within a community move in tandem. It should be noted that changes in one population result in changes to different populations. Students should be familiar with the basic parasitic, mutualistic, and communalistic relationships that exist between species. *(The focus should be on relationships within a food web of an ecosystem and the recognition of types of symbiosis, not on specific examples.)*

Component Idea: *A. Interdependent Relationships in Ecosystems*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Engaging in argument from evidence *Students critique and consider the degree to which competing arguments are supported by evidence*	**Cause and Effect** *Students infer and identify cause and effect relationships from patterns.*	A Group of Orca Whales *-A group of whales work with one another, and their environment, in order to capture food.* *-By using the biotic and abiotic factors within their environment, Interactions between organism change in order to obtain energy and survive.* Predation impact on Lizard Niche *A new predator can cause devastating effects on the food web.*

Formative Assessments

1. TE p. lxxiii Create a Venn diagram comparing and contrasting mutualism, parasitism, and commensalism relationships between two ecosystems, including examples. Ask students to write an explanation using the Venn diagram as supporting evidence.
2. TE p. lxxiii Research and Compare the impact of competitive, symbiotic, and predatory interactions in an ecosystem, and ask students to describe how the patterns of evidence in the data help to explain the interactions.
3. Identify symbiotic relationships in varying biomes and ecosystems (using symbiosis stations in lesson resources)
4. Write a story about an organism that competes with another organism for food or a resource in their ecosystem. Describe the ecosystem and the organism's interactions.

Textbook Connections	Standard Connections
SE: Chapter 3 (p 76-87) TE: Lesson Planner (p 76A – 76B) Scenario-based Investigation: That Can't Possibly Work! pg. 22	6.LS2.1—Impact of environmental variables on population size 6.LS2.6—Ecosystems change over time 6.LS2.7—Auditory and visual methods of communication for survival

Lesson Resources

Symbiotic relationship diagram lesson
Symbiosis game
Symbiotic Strategies PBS Lesson
Lessons from the Tennessee Department of Education – Engaging in argument from evidence

Where Learning Comes From	Where Learning Goes Next
Grades 1-4	Grade 7

Writing and Speaking

Identify a predator-prey relationship in each of the following ecosystems, describe the ecosystem and discuss how this relationship affects the behavior of each animal:
-African savannah
-Georgia forest
-Atlantic ocean

Disciplinary Core Idea: *6.LS2: Ecosystems: Interactions, Energy, and Dynamics*

Standard: 6.LS2.1 Evaluate and communicate the impact of environmental variables on population size.

Explanation: Students have developed a basic understanding that organisms are sustained by their environments (2.LS2.1) and the roles within an ecosystem (producers and consumers) (4.LS2). Populations are sustained by producers capturing and converting energy from the sun. An ecosystem will increase in size until it reaches its carrying capacity. (Organisms within a resource) have needs for similar resources: food, water, and habitat. Increasing population sizes result in increased competition for these resources. Examples may include a population of antelope decreasing because of a drought and then the lion population decreasing also as a result. Another example could include the relationship between deer and wolf populations: When the deer population increases, the wolf population will increase until it causes the deer population to decrease, which in turn causes the wolf population to decrease, and the cycle continues. Each of these variables dictates the niche of the organism, for example, the wolf is the carnivore and tertiary consumer in its ecosystem.

Component Idea: *A. Interdependent Relationships in Ecosystems*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Analyzing and interpreting data. *Students should create and analyze graphical presentations of data to identify linear and non-linear relationships, consider statistical features within data and evaluate multiple data sets for a single phenomenon.*	**Stability and Change** *Students explain that systems in motion or dynamic equilibrium can be stable.*	*Certain types of plants survive in harsh conditions due to their adaptations.* Drought tolerant plants

Formative Assessments

1. Four corners or response cards- Students will go to their assigned corner. (Corners: A – Producer, B – Herbivore, C – Carnivore, & D – Decomposer) Given an example, students will Identify the role within an ecosystem and argue using evidence if it belongs in their corner.
2. Index cards – Draw pictures of producers and/or consumers and on the back list what the organism eats. Create a model of food web showing the direction that energy flows.
3. Imagine that you are a decomposer. Decomposers do not get the respect they deserve. Write a persuasive essay describing the roles of decomposers and the reasons why they are important to an ecosystem.
4. Write 3 equations. One should show how populations can increase in a year (should have a positive number as the answer) and one should show a stable population (with zero as its answer), and one should show how population can decrease in a year. (should have a negative number as the answer)
5. Create two models, one should have a high carrying capacity and the other show a low carrying capacity. Explain why the carrying capacity is high or low.
6. Journal Entry-explain why one ecosystem may have a high carrying capacity and another a low one. Explain how the resources and the populations may change.

Textbook Connections	**Standard Connections**
SE: Chapter 3 (p 56- 75) TE: Lesson Planner (p 62A – 62B; 68A – 68B) Scenario-based Invest.: Fantasy Food Chain: Pg. 13 Scenario-based Invest.: Mealworm Migration-pg.50	6.LS2.2—Competitive, symbiotic, and predatory interactions 6.LS2.6—Ecosystems change over time 6.LS2.7—Auditory and visual methods of communication for survival

Lesson Resources

Oh Deer! Activity
Population Growth Patterns
Population Growth Limits

Where Learning Comes From	**Where Learning Goes Next**
Grades K-4	Grade 7

Writing and Speaking

Name the relationship between the alligators and the small mammals, birds, and reptiles. Describe how the change in the alligator population would affect the food chain of the swamp over time.

Disciplinary Core Idea: 6.LS2: Ecosystems: Interactions, Energy, and Dynamics

Standard: 6.LS2.7 Compare and contrast auditory and visual methods of communication among organisms in relation to survival strategies of a population.

Explanation: Prior to this standard, discussions of group dynamics have included the structures of groups and variety of groups. Students should draw conclusions about the advantages and disadvantages of group sociality in animal populations. Additionally, a group will cease to exist if that group no longer provides a benefit to its individuals. Patterns established between and among taxa could be recognized. Students may begin to draw conclusions about survival and reproduction based on observed communications. Examples include communication in social animals such as meerkats in the presence of different predators and how that can impact individual survival. Other examples include the predatory communication of group hunters such as the spotted hyena, African Hunting Dogs, and Orcas. Plant communication may include pheromones.

Component Idea: *D. Social Interaction and Group Behavior*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Engaging in argument from evidence *Students present an argument based on empirical evidence, models, and invoke scientific reasoning*	**Cause and Effect** *Students infer and identify cause and effect relationships from patterns.*	Hawaiian Crickets Go Silent *Crickets are everywhere, but they are not making as much noise as they used to.* Video: Can Animals Talk *Animals use different ways of "talking" with one another.*

Formative Assessments

1. (TE p. lxxviii) Research a non-verbal communication in a group or colony of organisms and develop a simple, non-verbal method of communicating a set 5 to 10 messages that a population would need to communicate with each other. Model this phenomenon to a classmate.
2. Have students present their non-verbal communication or other phenomena to students with a short explanation of it. Then ask the students to identify gaps or weaknesses in the communication method and how it explains the phenomena, based on their level of understanding.

Textbook Connections	**Standard Connections**
SE: Chapter 3 (p 76-79) TE: Lesson Planner (p 76A – 76B)	6.LS2.1—Impact of environmental variables on population size 6.LS2.2—Competitive, symbiotic, and predatory interactions 6.LS2.6—Ecosystems change over time

Lesson Resources

Video Animal Communications
Video- Do Animals have a language
Types of Animal Communication: Khan Academy
Visual Communication
Auditory Communication

Where Learning Comes From	**Where Learning Goes Next**
Grades K-4	Grade 7

Writing and Speaking

Describe the following animal behaviors including a specific example and explain internal and external cues that responsible for each:
-hibernation
-migration
-courtship displays

Disciplinary Core Idea: 6.LS2: Ecosystems: Interactions, Energy, and Dynamics

Standard: 6.LS2.5 Analyze existing evidence about the effect of a specific invasive species on native populations in Tennessee and design a solution to mitigate its impact.

Explanation: In 6.LS4.1, students discuss biodiversity. Invasive species that take hold in an ecosystem often outcompete native species in an ecosystem. In doing so, this single species may fill the niche of a variety of organisms, thereby decreasing the overall biodiversity of an ecosystem and reducing the availability of natural resources to native species. Tennessee-specific examples may include kudzu, Tree of Heaven, fire ants, Africanized bees, and zebra mussels. Solution may impact both native and invasive species. Firewood transport ban for various counties is a good example.

Component Idea: *C. Ecosystem Dynamics, Functioning, and Resilience*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Obtaining, evaluating, and communicating information *(Observe) Students can evaluate text, media, and visual displays of information with the intent of clarifying claims and reconciling explanations. Students can communicate scientific information in writing utilizing embedded tables, charts, figures, graphs*	**Cause and Effect** *Students use cause and effect relationships to make predictions.*	Kudzu plant/vine (picture) *Kudzu was introduced to the south in the 1930's - 1950's to prevent soil erosion, causing it to grow uncontrollably and killing out natural species.* Kudzu bug (picture) *Kudzu bugs were the answer to stopping the uncontrollable growth of the Kudzu Vines.* Zebra Mussel (picture) *Traveling down the Mississippi River, Zebra Mussels invaded Tennessee water.*

Formative Assessments

1. TE p. lxxvi Construct a poster to inform the public about Tennessee invasive species of plant or animal and suggest possible ways in which the impact of the organisms on the ecosystem can be reduced.
2. Have students debate and make an argument using evidence on whether or not Tennessee should introduce the Kudzu bug to control the Kudzu plant population
3. Have students draw a basic aquatic or terrestrial food chain, labeling the organisms and their trophic levels. Next, have students select a nuisance species and write a short descriptive paragraph about how this invasive species would disrupt their food chain.
4. Create a wanted poster identifying an invasive and non-invasive species that poses a threat to Tennessee. Explain the problems it poses.

Textbook Connections	Standard Connections
SE: Chapter 5 (p 142- 156- most specifically on p 147) TE: Lesson Planner (p 144A – 144B; 150A – 150B)	6.LS2.3—Food webs and energy pyramids 6.LS2.4—Biomes 6.LS2.6—Ecosystems change over time 6.LS4.1—Changes in biodiversity 6.ESS3.3—Impact of Human Activity

Lesson Resources

Food web with yarn – add an invasive species to activity to explore how it affects the ecosystem
National Geographic invasive species
Classroom Takeover
Zebra Mussels
TN Exotic species and response
Lessons from the Tennessee Department of Education – Asking questions and defining problems

Where Learning Comes From	Where Learning Goes Next
Grades K-4	Grade 7

Writing and Speaking

European rabbits strongly prefer living in burrows. The rabbits are introduced to an island off the US coast. The island has resident populations of seabirds such as puffins, which also use the burrows for nesting and incubation.
Explain how the seabird populations are likely to respond to a sharp increase in the European rabbit population on the island.

Disciplinary Core Idea: *6.LS4: Biological Change: Unity and Diversity*

Standard: 6.LS4.1 Explain how changes in biodiversity would impact ecosystem stability and natural resources.

Explanation: Healthy ecosystems exist in a state of dynamic equilibrium. In this state, ecosystems are able to recover from disturbances. The level of biodiversity in an ecosystem is an indicator of the health of an ecosystem. Low levels of biodiversity amplify the effects of disturbances, as the effect on a single species may spread across several niches. Biodiversity also includes the observation of a variety of characteristics within a single population or species to promote the survival of that species. To model the effects of biodiversity in an ecosystem, consider two food webs of varying biodiversity, and consider the effects of the removal of one of the species within this food web. Examples may include the loss of potentially medicinal plants in the rainforest, a shortage of potable water, ecosystems with population extinctions, and overfishing causing a decrease in the ability for human consumption of ocean species.

Component Idea: *D. Biodiversity and Humans*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Engaging in argument from evidence *Students present an argument based on empirical evidence, models, and invoke scientific reasoning*	**Stability and Change** *Students explain that systems in motion or dynamic equilibrium can be stable.*	*Loss of biodiversity impacts ecosystems.* *Over, 99% of all species that ever existed are today extinct.*

Formative Assessments

1. (TE p. lxxix) Students should gather information on how and why the biodiversity of an ecosystem might change. Give a detailed cause and effect of changes and how they affect the ecosystem. Create a poster describing to classmates the biodiversity of an ecosystem, the resources there that humans use (biotic and abiotic), and how changes to the biodiversity would impact ecosystem stability and natural resources.
2. Create a model of a food web that includes an endangered species. Then modify the model by crossing out the endangered species and consider how the food web would change without that organism. Write a paragraph explaining how biodiversity in the ecosystem would change due to the removal of the species from the ecosystem.

Textbook Connections	**Standard Connections**
SE: Chapter 5 (p 150-159) TE: Lesson Planner (p 150A – 150B) Scenario-based Invest.: Fantasy Zoo- Pg. 55	6.LS4.2—Maintaining biodiversity 6.ETS1.1—Solutions for maintaining ecosystems and biodiversity

Lesson Resources

How does biodiversity affect me and everyone else?
Consequences of changing biodiversity

Where Learning Comes From	**Where Learning Goes Next**
Grades K-5	Grade 8

Writing and Speaking

Biodiversity is a word that describes the variety of living beings on earth. Biodiversity also refers to the number of different species living within a particular region. Humans have upset the balance of biodiversity in many areas on Earth. One that stands out is the deforestation of tropical rainforests. Once these forests are cut down, the area turns into a desert (desertification). Why is it so important to maintain Earth's biodiversity? Give two reasons

Disciplinary Core Idea: 6.ESS2: Earth's Systems

Standard: 6.ESS2.4 Apply scientific principles to design a method to analyze and interpret the impact of humans and other organisms on the hydrologic cycle.

Explanation: Bioecological discussions in 4.ESS2.3 were general, whereas 6.ESS2.4 focuses specifically on the hydrologic cycle. Some organisms such as plants have very defined and ongoing involvement through transpiration. Other impacts have occurred over time including changes to water tables, and the effects of rates of weathering and erosion to land surfaces on watersheds and wetlands.

Component Idea: *E. Biogeology*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Obtaining, evaluating, and communicating information *(Observe) Students can evaluate text, media, and visual displays of information with the intent of clarifying claims and reconciling explanations. Students can communicate scientific information in writing utilizing embedded tables, charts, figures, graphs*	**Systems and System Models** *Students include relevant and exclude irrelevant factors when defining a system.*	Statues damaged over time *Natural causes such as wind and rain have eroded the statue, but human impact has increased the rate.*

Formative Assessments

1. TE p. lxxxiv Create a model of the water cycle, labeling the components and interactions in the model. Then illustrate the ways in which humans can impact the hydrologic cycle, in the model and write a description of what is shown in the drawing.
2. Choose one pollution source, ask the students to analyze and describe the societal needs and wants related to the problem. Explain the effects on drinkability, rivers and lakes, aquifers, ground water, surface water, reservoirs, oceans, water temperature, fresh water, and water quality.

Textbook Connections	Standard Connections
SE: Chapter 7 (p 208- 227) and Chapter 8 (p 260- 263) TE: Lesson Planner (p 208A – 208B; 214A – 214B; 222A – 222B; 260A – 260B) Scenario-based Invest.: The Problem with Runoff-Pg. 19	6.ESS3.1—Renewable and nonrenewable resources 6.ESS3.3—Impact of Human Activity

Lesson Resources

Code Blue: Endangered Ocean
Deforestation affects the water cycle
How is climate change effecting the water cycle?
Transpiration
Humans and the Water Cycle
Human Impacts on the Water Cycle

Where Learning Comes From	Where Learning Goes Next
Grades K,2,3,4	Grade 8

Writing and Speaking

Runoff. Runoff is an important part of Earth's hydrologic cycle. A larget portion of precipitation in forested watersheds is absorbed into soils (infiltration), is stored as groundwater, and then is slowly discharged to streams through seeps and springs.
How does this change when an area becomes urbanized?

Disciplinary Core Idea: 6.LS2: Ecosystems: Interactions, Energy, and Dynamics

Standard: 6.LS2.6 Research the ways in which an ecosystem has changed over time in response to changes in physical conditions, population balances, human interactions, and natural catastrophes.

Explanation: This standard should focus on the way that abiotic factors or external biotic factors can apply pressures and create disturbances in ecosystems. Healthy ecosystems (high biodiversity) are able to absorb these pressures. External agents will cause changes (even in healthy ecosystems), but a resilient ecosystem will stabilize. Examples may include the change in the world's oceans, changes in climate over time or an increase in human populations. Students can plan and carry out an investigation to model this process.

Component Idea: *C. Ecosystem Dynamics, Functioning, and Resilience*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Developing and using models *Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models.*	**Systems and System Models** *Students develop models to investigate scales that are beyond normal experiences.*	Wolves of Yellowstone *When the wolves of Yellowstone were missing and then later reintroduced there was an impact on the environment.* How wolves change rivers *Wolves had a positive impact on the changing landscape of Yellowstone in many different interconnected ways.*

Formative Assessments

1. (TE p. lxxvii) Using multiple forms of scientific text about the impact of human activity on biodiversity in an ecosystem, students will create a group presentation explaining the impact on biodiversity. (exotic species-nonnative species that affect an ecosystem in Tennessee, habitat preservation focusing on specific preserve or wilderness area)
2. (TE p. lxxvii) Put students in groups of two. Pair will select a human activity that has a positive or negative effect on biodiversity. (i.e. habitat destruction, poaching, pollution, exotic species, captive breeding, laws and treaties, and habitat preservation) Students will research an activity and use their findings to construct a persuasive essay on how their chosen activity effects biodiversity. Encourage students to take a stand on the issue, supporting the argument with facts from the research. Discuss whether they think the activity is harmful or helpful to the environment and why.
3. Research ways human impact has changed a specific biome and design a pamphlet educating classmates about 3 ways that human impact affects interdependent relationships in the biome based on your research. (include both positive and negative impacts)

Textbook Connections	Standard Connections
SE: Chapter 5 (p 142-159) TE: Lesson Planner (p 144A – 144B; 150A – 150B)	6.LS2.1—Impact of environmental variables on population size 6.LS2.2—Competitive, symbiotic, and predatory interactions 6.LS2.7—Auditory and visual methods of communication for survival

Lesson Resources

Wolves of Yellowstone
Global Climate Change
Ecosystems Change
Brain Pop – Natural Disasters

Where Learning Comes From	Where Learning Goes Next
Grades 1-4	Grade 7

Writing and Speaking

Discuss the effects of a forest fire on an ecosystem, and the possible recovery.

Disciplinary Core Idea: 6.LS4: Biological Change: Unity and Diversity

Standard: 6.LS4.2 Design a possible solution for maintaining biodiversity of ecosystems while still providing necessary human resources without disrupting environmental equilibrium.

Explanation: The living world provides humans with many materials they need, and humans can dramatically reshape the land and interactions between living systems to meet those needs. Without thoughtful consideration, humans can dramatically impact ecosystems through avenues such as habitat destruction and depletion of resources. The subsequent loss of biodiversity can then have negative impacts for humans. Natural resources that can be threatened by disturbing environmental equilibrium include food, energy, and medicines as well as the loss of services provided by ecosystems including water purification and recycling of nutrients by decomposers.

Component Idea: *D. Biodiversity and Humans*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Obtaining, evaluating, and communicating information *Students can communicate technical information about proposed design solutions using tables, graphs, and diagrams*	**Systems and System Models** *Students develop models for systems which include both visible and invisible inputs and outputs for that system.*	Bananas Extinction *Farming practices have decreased the supply of bananas.*

Formative Assessments

1. TE p. lxxx- Research a natural resource, a location where it is found, and a company or individual that focuses on reducing the environmental impact as the resource is obtained. Students will investigate what is being done to protect the environment and ensure the biodiversity of the ecosystem is maintained.
2. TE p. lxxx - Conduct research on a natural resource found in Tennessee and develop solutions to use this resource while preserving the ecosystem and maintaining environmental equilibrium. Create a poster focusing on the key aspects of your research to present to a group.

Textbook Connections	**Standard Connections**
SE: Chapter 5 (p 150-159) and Chapter 10 (p 350-393) TE: Lesson Planner (p 150A – 150B; 350A – 350B; 356A – 356B; 362A – 362B; 368A – 368B; 376A – 376B; 386A – 386B)	6.LS4.1—Changes in biodiversity 6.ETS1.1—Solutions for maintaining ecosystems and biodiversity

Lesson Resources

Biodiversity Guide
Humans and Biodiversity
Video: Human Impact on Biodiversity
Activity: Saving the World One Ecosystem at a time
Design Solutions for maintaining Biodiversity
Future of Global biodiversity

Where Learning Comes From	**Where Learning Goes Next**
Grades 3-5	Grade 8

Writing and Speaking

Give examples of possible solutions for maintaining biodiversity y of ecosystems while still providing necessary human resources.

Disciplinary Core Idea: 6.ETS1: Engineering Design

Standard: 6.ETS1.1 Evaluate design constraints on solutions for maintaining ecosystems and biodiversity.

Explanation: The wording and specificity of an engineering problem is a major factor in the quality of the solutions that may be created for a particular problem. Effective problems should have clear design constraints that incorporate scientific understanding. For example, attempting to eliminate an invasive species may only result in replacing one invasive species with a new invasive species or knowledge of local climate might influence plantings. Examples include comparing recycling programs (deposits, curbside pickup, drop-off centers) and the cost/benefit analysis of recycling solutions. Address engineering design issues centered on water treatment (filtration, chemical treatment, reverse osmosis). Design solutions to minimize soil erosion (forestry practices, farming techniques, construction, and recreation). Examples of design solutions could include scientific, economic, or social considerations.

Component Idea: *A. Defining and Deliminating and Engineering Problems*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Asking questions (for science) and defining problems (for engineering) *Students define design problems, invoking scientific background knowledge to define multiple criteria and constraints for solutions.*	**Systems and System Models** *Students develop models for systems which include both visible and invisible inputs and outputs for that system.*	Spray grass for soil erosion *Cover crops or fast-growing plants can be used to prevent soil erosion.* Erosion and soil demo: design possible solutions from info learned in showing first 4:55 of video *Land with plants growing in the soil help to hold the soil in place and prevent erosion.* The Ocean Clean Up Project *Technology developed with a floater and a screen are used to concentrate debris and lead it into a collection system.*

Formative Assessments

1. (TE p. xc) Write an evidence-based account of what causes water pollution. Sketch and describe a Design of a water filtration system that cleans a sample of polluted water. Explain how water pollution should be considered within your design.
2. Make an argument for how the ocean clean-up project is maintaining biodiversity. Students will generate ideas about additional evidence needed to support the claim they are arguing.
3. Students will write an explanation for tagging technologies and how they work using research. Students will cite evidence explaining why tagging technologies are important for species conservation.
4. Make a model that shows the benefits of sustainable land management and conservation, and explains some actions people can take to prevent or repair land deprivation. Students research different ways of land reclamation and engage in argument about which way is best.

Textbook Connections	**Standard Connections**
SE: Chapter 5 (p 150-159) and Chapter 10 (p 362-392) TE: Lesson Planner (p 362A – 362B; 368A – 368B; 376A – 376B; 386A – 386B)	6.LS2.3—Food webs and energy pyramids 6.LS2.5—Invasive species in TN 6.LS2.6—Ecosystems change over time 6.LS4.1—Changes in biodiversity 6.LS4.2—Maintaining biodiversity 6.ESS3.3—Impact of Human Activity

Lesson Resources

Great Pacific Garbage Patch
Humans and Biodiversity
Good "Greef" The Corals are dying
Save the World: One Ecosystem at a Time

Where Learning Comes From	**Where Learning Goes Next**
Grades k-5	Grades 7-8

Writing and Speaking

Brainstorm ideas and give examples of ways to maintain ecosystems and biodiversity.

Disciplinary Core Idea: 6.ESS3: Earth and Human Activity

Standard: 6.ESS3.1 Differentiate between renewable and nonrenewable resources by asking questions about their availability and sustainability.

Explanation: In fourth grade, students were introduced to several specific examples of renewable and nonrenewable resources. Discussions included general descriptions of where resources were located on earth, how they are obtained, and the effects these processes have on the earth. Students should now develop a full, working distinction between these sets of resources. Renewable resources can be replenished during a human lifetime. However, non-renewable resources can be exhausted or, in the case of a living species, complete eliminated. Geologic processes which create some natural resources result in isolated pockets with large accumulations of a specific resource (e.g., oil deposits in the middle east, coal deposits in the western United States, gold deposits in California, the use of Tennessee waterways for hydroelectric power generation.)

Component Idea: *A. Natural Resources*

Science and Engineering Practice	Crosscutting Concept	Phenomenon
Obtaining, evaluating, and communicating information *(Observe) Students can evaluate text, media, and visual displays of information with the intent of clarifying claims and reconciling explanations. Students can communicate scientific information in writing utilizing embedded tables, charts, figures, graphs*	**Systems and System Models** *Students evaluate the sub-systems that may make up a larger system.*	Earth's Resources (Picture of Earth) *The earth has many natural resources that can be renewed in our lifetime, however, many cannot.* How it Looks (Wind vs Nuclear) *Earth's resources can have a different effect on the ecosystem.*

Formative Assessments

1. Create a Venn Diagram to compare and contrast the availability and sustainability of renewable and nonrenewable resources. Students will select a nonrenewable resource and construct an explanation describing how it effects the environment and come up with possible solutions for alternative resources.
2. Research 2 forms of renewable energy available in Tennessee. Using the evidence, students will engage in an argumentative debate on the different forms of renewable energy researched answering the question which would best be utilized in Tennessee? Focus on the availability and sustainability. (i.e. nuclear, solar, wind, hydropower, geothermal, biomass, biofuels)
3. The student is a city utility engineer tasked to research the depletion of coal and a possible viable resource replacement option that they will then present to the city council (e.g. oral, Power Point, Prezi, debate, etc.). They must identify the potential impacts once it is depleted and the logical options for energy replacement. They must identify the different possible sources of energy production (hydroelectric, wind, geothermal, solar, natural gas, petroleum, nuclear, etc.). They must choose a replacement resource, justify their choice, and justify why they did not choose at least three other sources of energy. They must include sustainability of their choice, renewable or non-renewable energy, and geographical availability.

Textbook Connections	Standard Connections
SE: Chapter 6 (p 172- 193) TE: Lesson Planner (p 178A – 178B; 188A – 188B) Scenario-based Invest. Some Resources are Worth Saving- Pg.25	6.ESS3.2—Technology and Renewable/Alternative Energy 6.ESS3.3—Impact of Human Activity

Lesson Resources

10 Examples of Nonrenewable and renewable resources
Renewable vs Nonrenewable
Key differences in natural resources
Interactive Renewable and nonrenewable
Energy Webquest
Lessons from the Tennessee Department of Education – Obtaining, evaluating, and communicating information

Learning Comes From	Where Learning Goes Next
Grades K,3,4	Grades 7-8

Writing and Speaking

We use a variety of natural resources in our everyday lives. Some of these resources are considered renewable. What is a renewable resource that you use daily, and how do you know it is renewable?

Disciplinary Core Idea: 6.ESS3: Earth and Human Activity

Standard: 6.ESS3.2 Investigate and compare existing and developing technologies that will utilize renewable and alternate energy sources.

Explanation: Utilization of natural resources involves weighing environmental, economic, and oftentimes political conversations. Environmental discussions should include models which help to predict effects and gains of using a natural resource on the environment. Economic considerations include the amount of energy which can be harvested for the cost. For example, the economy of installing residential photovoltaic systems depends on the availability of sunlight in a person's location or on their property. Political conversations are impacted by considering global distributions of energy sources. As technologies progress, energy harvesting becomes less expensive and more efficient such that conversations regarding the utilization of renewable and alternate energy sources may shift over time.

Component Idea: *A. Natural Resources*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Engaging in argument from evidence *Students critique and consider the degree to which competing arguments are supported by evidence.*	**Energy and Matter** *Students track energy changes through transformations in a system.*	Project sunroof: solar savings estimator *Using and harnessing solar energy can be more cost effective and cleaner than burning fossil fuels.*

Formative Assessments

1. Students research to develop a report and use that information to create a two-column chart. The chart should contain pros and cons for the chosen renewable energy source including the benefits of renewable energy sources and their impacts on the environment and ecosystems.
2. Students will place their charts on the walls and students will do a gallery walk to analyze results and make comments on their classmates' data.
3. Mini Sail Car Using Wind Energy Test Worksheet

Textbook Connections	**Standard Connections**
SE: Chapter 10 (p 350-361, 376- 392) TE: Lesson Planner (p 350A – 350B; 356A – 356B; 376A – 376B; 386A – 386B) Scenario-based Invest.: Light Bulbs Can't Use Much Energy- Pg. 16	6.ESS3.1—Renewable and nonrenewable resources 6.ESS3.3—Impact of Human Activity

Lesson Resources

Mini Sail Cars Using Wind Energy
- Mini Sail Car Using Wind Energy Test Worksheet

Environmental Impacts of Renewable Energy Technologies
Alternative Energy for Transportation
Calculate your human footprint lesson
Alternative Energy Timeline

Where Learning Comes From	**Where Learning Goes Next**
Grades K,3,4	Grades 7-8

Writing and Speaking

Sunny Florida! You do not have to worry much about heating your house if you live in Florida, but you do have to stay cool! Florida's resources include different kinds of energy; not the usual oil or gas. What are two alternative energy resources used in Florida?

Disciplinary Core Idea: 6.ESS3: Earth and Human Activity

Standard: 6.ESS3.3 Assess the impacts of human activities on the biosphere including conservation, habitat management, species endangerment, and extinction.

Explanation: Human activities have greatly altered rates of change to Earth's surface. As humans develop land and build roads, large amounts of natural habitat are lost, affecting the species indigenous to that habitat. Students can obtain and evaluate evidence that increases in human populations or increases in the amount of energy consumed per person also increase negative effects but engineered solutions can mitigate some of these negative effects. For example, development of low energy consumption lightbulbs (such as LED) can reduce the amount of energy used in a home. The processes listed specifically address measures offset the effects of human changes to the Earth's surface. Assessments of human activities should include models which can assist in making predictions for the efficacy of conservation efforts with competing interests.

Component Idea: *C. Human Impacts of Earth Systems*

Science and Engineering Practice	**Crosscutting Concept**	**Phenomenon**
Developing and Using Models *Students create models which are responsive and incorporate features that are not visible in the natural world but have implications on the behavior of the modeled systems and can identify limitations of their models.*	**Cause and Effect** *Students use cause and effect relationships to make predictions.*	Smart Moths have evolved to fly away from city lights *Urban moths have evolved to avoid artificial lights. This means they are more likely to survive and reproduce but are less mobile and pollinate plants less often.* The Ocean Clean Up video clip Cleaning up the ocean is one way to conserve the different habitats in the ocean.

Formative Assessments

1. Make a list of different techniques (including practices that are already in use, becoming developed, or may not exist yet) we employ (or could employ) to reduce our impact on the environment and lessen the habitat destruction. Ask students to sketch or describe a design approach that develops a possible solution to the problem, such as costs and benefits associated with these practices.
2. Students will use multiple forms of scientific texts to write a letter as a concerned resident in an area where a local coal company is about to mine the area of land on the outskirts of your town. Explain the advantages and disadvantages of the coal mine moving to the area, with evidence to support or refute the claim.

Textbook Connections	**Standard Connections**
SE: Chapter 10 (p 362-393) TE: Lesson Planner (p 362A – 362B; 368A – 368B; 376A – 376B; 386A – 386B) STEM activity: Water Under the Dam pg. 17	6.ESS3.1—Renewable and nonrenewable resources 6.ESS3.2—Technology and Renewable/Alternative Energy

Lesson Resources

Extinction Prevention
Marine Population decreasing
Six ways human activity is changing the planet

Where Learning Comes From	**Where Learning Goes Next**
Grades K,3,4	Grades 7-8

Writing and Speaking

Explain how humans might contribute to the extinction of a species.