Unit 1 Transfer of Energy, Forces, Motion, Waves and Information Processing

Content Area:	**Science**
Course(s):	
Time Period:	**Trimester 1**
Length:	**10-12 weeks**
Status:	**Published**

Summary

Introduction:

In this unit of study, fourth-grade students develop an understanding that energy can be transferred from place to place by sound, light, heat, and electrical currents. Students also obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment. Students are able to use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object, and are expected to develop an understanding that energy can be transferred from object to object through collisions. Students use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object. Students develop an understanding that energy can be transferred from place to place by sound, light, heat, and electrical currents or from objects through collisions. They apply their understanding of energy to design, test, and refine a device that converts energy from one form to another.

Students will also use a model of waves to describe patterns of waves in terms of amplitude and wavelength and to show that waves can cause objects to move. Students use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object. Students develop an understanding that energy can be transferred from place to place by sound, light, heat, and electrical currents or from objects through collisions. They apply their understanding of energy to design, test, and refine a device that converts energy from one form to another.

The crosscutting concepts of patterns;interdependence of science, engineering, and technology; energy and matter; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. Students demonstrate grade-appropriate proficiency in developing and using models, planning and carrying out investigations, and constructing explanations, and designing solutions. Students are also expected to use these practices to demonstrate their understanding of the core ideas.

This unit will be taught utilizing the Energy FOSS program kit.

Revision Date: July 2021

SCI.4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.

MA.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.
	Use evidence (e.g., measurements, observations, patterns) to construct an explanation.
SCI.4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
	Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
	Energy can be moved from place to place by moving objects or through sound, light, or electric currents.
LA.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.
	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.
LA.RI.4.4	Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.
SCI.4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide.
LA.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.
	Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
	Energy can be moved from place to place by moving objects or through sound, light, or electric currents.
SCI.4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
	Apply scientific ideas to solve design problems.
	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.
LA.W.4.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
SCI.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.
SCI.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.
MA.4.MD.B.4	Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots.
	Develop a model using an analogy, example, or abstract representation to describe a scientific principle.

	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. (Note: This grade band endpoint was moved from K–2.)
	Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).
LA.W.4.7	Conduct short research projects that build knowledge through investigation of different aspects of a topic.
SCI.4-PS4-2	Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
LA.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.
MA.4.G.A.1	Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.
LA.W.4.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
	An object can be seen when light reflected from its surface enters the eyes.
LA.SL.4.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.
LA.SL.4.1.C	Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
LA.SL.4.1.D	Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.
	Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.
SCI.4.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.
	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.
	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.
CS.3-5.8.1.5.AP.4	Break down problems into smaller, manageable sub-problems to facilitate program development.
CS.3-5.8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
CS.3-5.8.1.5.DA.5	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
CS.3-5.8.2.5.ED.2	Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.
CS.3-5.8.2.5.ED.3	Follow step by step directions to assemble a product or solve a problem, using appropriate tools to accomplish the task.
CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on

	others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
WRK.K-12.P.1	Act as a responsible and contributing community members and employee.
WRK.K-12.P.4	Demonstrate creativity and innovation.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.9	Work productively in teams while using cultural/global competence.
TECH.9.4.5.CT.1	Identify and gather relevant data that will aid in the problem-solving process (e.g., 2.1.5.EH.4, 4-ESS3-1, 6.3.5.CivicsPD.2).
TECH.9.4.5.CT.4	Apply critical thinking and problem-solving strategies to different types of problems such as personal, academic, community and global (e.g., 6.1.5.CivicsCM.3).

Essential Questions/Enduring Understandings

Essential Questions:

How do we know that energy is present?

How can scientific ideas be applied to design, test, and refine a device that converts energy from one form to another?

How can we solve problems using engineering?

Where do we get the energy we need for modern life?

In what ways does the human use of natural resources affect the environment?

In what ways does energy change when objects collide?

How can we use waves to gather and transmit information?

Enduring Understandings:

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.

Light also transfers energy from place to place.

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.

The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.

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.

An object can be seen when light reflected from its surface enters the eyes.

Digitized information 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.

Objectives

Students will know that energy is present when there is light, sound, heat, and/or movement.

Students will know that energy is transferred by moving objects.

Students will know how collisions cause a change in direction.

Students will know when objects move they have energy.

Students will know that a faster moving object has more energy than a slower moving object.

Students will know that an object, in motion, with more mass will have more energy than an object with less mass.

Students will know that the speed and mass of an object affect how much energy is transfered in a collision.

Students will know that natural resources are finite materials used for energy.

Students will know how energy is transferred into different forms.

Students will know that properties of waves can affect energy transfer.

Students will know that a wave can be described in terms of wavelength and amplitude.

Students will know that the amplitude of a wave determines the volume of the sound.

Students will know that the wavelength of a wave determines the pitch of the sound.

Students will know how objects have stored energy depending on their position of situation.

Students will be skilled at...

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information

Learning Plan

Energy, Forces and Motion

FOSS Investigation 4-Energy Transfer

Part 1 Presence of Energy: In this. investigation, students. work in centers to explore evidence of energy when sound, heat, and light are produced, and when objects are in motion. The big idea that students should take away is that energy is present when there is motion, light, sound, or heat. One possible assessment you can do with the students in addition to the I-Checks, you may have students take an object in the classroom and prove how they know that energy is present. For example, the computer has energy because it vibrates(movement), gets warm, the buttons light up, and it sometimes makes a sound.

Gizmo that can accompany lesson: You can tie this in to the lesson with showing how each appliance gives off sound, light, and/or heat as it runs electricity.

Household Energy Usage: Explore the energy used by many household appliances, such as television sets, hair dryers, lights, computers, etc. Make estimates for how long each item is used on a daily basis to get an estimate for the total power consumed during a day, a week, a month, and a year, and how that relates to consumer costs and environmental impact.

BrainPOP:

Students do not need too know everything in this video, but it can be used as an introduction for the students.

Forms of Energy: Feeling energized? Or, maybe you're low on energy today? We use the word "energy" in conversation all the time, and it means something similar in science. Energy is what makes things happen! It comes in many forms, but all of them fall into one of two categories: kinetic or potential. Energy is all around us—and within us! Electrical energy powers our devices, chemical energy fuels our bodies, and light energy floods in from the Sun every day. Press "play" for an energy boost!

Part 2 Rolling Balls Down Slopes: In this investigation, students. will roll steel balls of different sizes down ramps and explore the system's variables. They will construct structured investigations to discover how the variables of starting position om the ramp and ball size (mass) affect the. speed of a rolling ball. The big idea in this investigation that students should know is that a faster moving object has more energy.

Gizmo that can accompany lesson: The Gizmo uses terms the students do not need to know, but it provides ramps students can use to test objects on a ramp.

Inclined Plane - Rolling Objects Observe and compare objects of different shapes as they roll or slide down an inclined plane. Compare the percentages of translational and rotational kinetic energy for each object, and see how this affects how quickly each object moves. The slope of each ramp can be adjusted, and a variety of materials can be used for the objects and ramps

BrainPOP:

Kinetic Energy: What does kinetic energy help us do? Well...everything! In this BrainPOP movie, Tim and Moby discuss why kinetic energy is important. You'll see how this type of energy plays a part in everything from running a race to typing on a computer. Find out how kinetic energy and potential energy both relate to motion, plus the difference between the two. You'll learn about the role that mass and speed play in an object's amount of kinetic energy. Plus, you'll discover how kinetic energy can be transferred in different ways, like in a collision or domino effect, as well as how it can be transformed into electricity! We promise, this movie will really move you!

Part 3 Collisions: In this investigation, students place an obstacle (cork) in the pathway of a steel ball rolling down a ramp, forcing them to collide. They investigate that variables that determine. how far the. cork will move. along the. runway.using controlled experiments, students test the variables of mass and starting position to find out how these. variables affect energy transfer. Focus on having students provide evidence that energy was transferred in a collision. For example, the moving object transferred energy to the other object because it moved, and i heard a sound when they collided. This is also a great opportunity to have students construct a line graph. Have them record the distance the cork traveled when the marble was released from 3 different heights on the ramp. Construct a line graph of the data. The big ideas in this lesson that students should take away is that when objects collide, energy is transferred from one object to another, causing a change in motion. Some energy is transferred to the other object, while some is transferred to the air (heat/sound) Students should also know that a faster moving object has more energy, therefore will transfer more energy to another object during a collision (the cork will move further the higher the starting position because the marble will roll faster). Likewise, an object with more mass has more energy than an object with less mass. (the cork will move farther when a larger marble is used).

Gizmo that can accompany lesson: This might work well after the lesson.

Sled Wars: Explore acceleration, speed, momentum, and energy by sending a sled down a hill into a group of snowmen. The starting height and mass of the sled can be changed, as well as the number of snowmen. In the Two sleds scenario, observe collisions between sleds of different masses and starting heights.

BrainPOP:

Potential Energy: Have you got potential? We think so! Potential energy is all around you—and even within you. But all that potential doesn't stay stored away forever. Whenever there's movement, it's because potential energy is being transformed into kinetic energy. Press "play" to find out what it means when something has potential energy, and what gravity has to do with it. There's enough fun in here to make you potentially obsessed!

Investigation 4 I-Check Questions: 1, 2a, 2b, 3, 4, 5, 6, 7, 8, and 9

FOSS Investigation 1- Energy Transfer in a Circuit

Part 1 Lighting a Light Bulb: In this investigation, students are introduced to electricity and energy. They discover how to make a complete circuit using a D-cell, wires, and a light bulb. Upon successfully lighting their light bulbs, students can discuss the electricity's pathway in the circuit and the function of each of the system's components. They also take a closer look at the anatomy of a light bulb. You can make this an inquiry lesson by giving the students the wires, bulb, and battery and seeing if they can find different ways to light the bulb. You can also use their solutions to introduce the concept of a circuit and how it transfers energy. *Students do not need to know the parts of a light bulb. One form of assessment is Notebook sheet 1 “Lighting Bulbs”. The big idea from this investigation is is that energy can move from place to place through sound, light, heat, and electric currents. A circuit is a complete path of and electric current. Students should know that in order to light a bulb, you need a power source, two points of contact on the power source, and somewhere for the energy to go (bulb/buzzer/etc.). They will also know that Energy can transfer in a circuit. It begins in the battery, or power source, and ends at the bulb because it lit.

Gizmo that can accompany lesson:

Circuits: Build electrical circuits using batteries, light bulbs, resistors, fuses, wires, and a switch. An ammeter, a voltmeter and an ohmmeter are available for measuring current, voltage and resistance throughout the circuit. The voltage of the battery and the precision of the meters can be adjusted. Multiple circuits can be built for comparison.

BrainPOP:

Electric Circuits: Electrical circuits are mighty important — but how do they work? In this BrainPOP movie, Tim and Moby introduce you to the basics of what electrical circuits are all about! First you’ll get a working knowledge of the components of a circuit, including the power source, terminals, and switch. You’ll also learn what a current is, what a load is, and how batteries and wall outlets supply electricity to your house. Tim and Moby will also teach you why we use insulated copper wires to conduct electricity, and the difference between static electricity and the electrical currents in our homes. Don’t get shocked if you become an electrical circuit genius after watching this movie!

Part 2: Conductors and Circuits: In this investigation students are. introduced to a switch and a motor to make a circuit that they can turn on and off. Students use a circuit and a collection of objects to determine which materials can complete the pathway (conductors) and which cannot (insulators). After developing the rule that metals are conductors, students consider foil and use evidence to confirm that foils are indeed metal. The big idea that students know its that some materials are conductors and others are insulators. Conductors allow energy to pass through them easily. Insulators do not allow energy to pass through them easily.

Gizmo that can accompany lesson:

Circuit Builder: Create circuits using batteries, light bulbs, switches, fuses, and a variety of materials. Examine series and parallel circuits, conductors and insulators, and the effects of battery voltage. Thousands of different circuits can be built with this Gizmo.

BrainPOP: (Same as Previous)

Electric Circuits: Electrical circuits are mighty important — but how do they work? In this BrainPOP movie, Tim and Moby introduce you to the basics of what electrical circuits are all about! First you'll get a working knowledge of the components of a circuit, including the power source, terminals, and switch. You'll also learn what a current is, what a load is, and how batteries and wall outlets supply electricity to your house. Tim and Moby will also teach you why we use insulated copper wires to conduct electricity, and the difference between static electricity and the electrical currents in our homes. Don't get shocked if you become an electrical circuit genius after watching this movie!

Science and Engineering: At the end of the circuit investigations, you can have the students complete some sort of engineering design challenge to create an alarm system for their bedroom. They would need to consider how the buzzer or bulb will go off to let them know that someone has opened their door. In this case, the door acts like a switch to open and close the circuit. Another STEM idea is **Project Circuitry** created by the Pathways to Excellence team (Linked on this curriculum)

Investigation 1 I-Check Questions: 1a, 1b, 3, 4, 5, 6, 7, and 8

Waves and Information Processing

Investigation 5 -Waves

Part 1: Forms of Waves: In this investigation students experience waves through firsthand experiences using ropes, demonstrations with waves in water, spring toys, and a sound generator. They also use videos, animations and readings to gather information. Through these experiences, students learn that waves are repeating patterns of motion that transfer energy from place to place. They analyze compression waves (sound waves) to learn the general properties of waves-amplitude, wavelength, and frequency. The big ideas students should take away from this investigation are A wave is a regular pattern of motion. Or, the movement of energy through something (matter).

Here's a good visual: https://www.acs.psu.edu/drussell/demos/waves/wavemotion.html

They should also understand that when we hear, it is because energy has moved through the air and into our ears. They will know that our brain interprets this as sound. Students should know that a wave diagram is used to help study the differences in energy waves. Amplitude refers to how much energy a wave has. A wave with more energy will be taller than a wave with less energy. So, amplitude refers to the height of the wave. For sound waves, the amplitude affects how loud or soft the sound is. More amplitude=louder sound. Wavelength refers to the distance between the peaks of a wave. For sound waves, this affects the pitch. The shorter the wavelength, the higher the pitch. The longer the wavelength, the lower the pitch.

Gizmo that can accompany lesson: Students do not have to know ALL of the vocabulary in this Gizmo.

Waves: Observe and measure transverse, longitudinal, and combined waves on a model of a spring moved by a hand. 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.

This one is a stretch, but shows sound waves

Doppler Shift: Observe sound waves emitted from a moving vehicle. Measure the frequency of sound waves in front of and behind the vehicle as it moves, illustrating the Doppler effect. The frequency of sound waves, speed of the source, and the speed of sound can all be manipulated. Motion of the vehicle can be linear, oscillating, or circular.

BrainPOP:

Waves: Ready to make some waves? In this BrainPOP movie, Tim and Moby discuss all types of waves--from the kind that travel through the ocean to the kind that travel through outer space! You'll learn how water, sound, light and even earthquakes travel in waves, and also about the characteristics between them that we can measure and observe. You'll also find out how to determine how much energy each wave carries and how we use time and frequency to measure different types of waves, whether they're electromagnetic or mechanical. All this talk of waves is enough to make someone want to surf and listen to the radio all at the same time!

Part 2: Light Travels: In this investigation students use mirrors to experience reflecting light. They start by using mirrors outdoors to see objects behind them and to reflect a bright image of the SUN onto walls. In the classroom, they determine that a mirror can be used to reflect light. Students can use flashlights, mirrors, and water to observe light in numerous ways, reinforcing the idea that light can reflect and refract. Students build a conceptual model about how light travels. One misconception students often have is that we see because light enters our eye, then we see the object. That is not the case. The light must first reflect off of a surface and then into our eye. Let them know light must be present in order for us to see. Meaning, if you are in a totally dark room, your eyes will never “adjust”. (This is another common misconception.) The mirror challenges are a great way for students to investigate these concepts. The big ideas that students should take away from this investigation is that light travels in straight lines. They will also learn that light reflects, or bounces off, of different surfaces. In order for us to see something, light reflects off of an object and into our eye.

BrainPOP:

Light: Wanna know about light? You’ve come to the right place! In this BrainPOP movie, Tim and Moby will teach you all about artificial light sources and visible light. You’ll learn about the two ways in which artificial light can be created, and how fast light can go. Whether you prefer to light your surroundings with a light bulb or a candle, you'll discover enough about each light source to understand how they work! You'll also gather info on natural sources of light — like from the sun and even some animals! Plus, Tim and Moby explain how the electromagnetic spectrum and reflected light help your eyes to see. How enlightening!

Standard not in FOSS

This whole standard:
PS4.C: Information Technologies and Instrumentation Digitized information 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)

To meet this standard, you can have students design a flashlight code, or some other system of transferring information from one place to another. This can serve as an engineering design challenge as well.

Assessment

Formative: teacher observation, student responses during lessons, exit tickets, science notebook questions/observations

Summative: investigation response sheets, science notebooks, quizzes, Survey/Posttest Questions: 1a, 1b, 2a, 2b, 3a, 3b, 4, 5, 7, 9, 10,

Benchmark: iChecks Science Notebook

Alternative: oral presentation with visual model such as a Google slideshow to demonstrate understanding of concepts, drawing models, FOSS extensions

Materials

Core Book List

FOSS kit- Unit 1: Energy

Discovery Education/BrainPOP

Science notebook for assessment and journaling

Gizmos (grades 3-5) See learning plan for which Gizmo supports each investigation/concept.

Brain Pop

Integrated Accommodations and Modifications

https://docs.google.com/spreadsheets/d/1ivmYc4cqSjzCUCsZZkB5876Nnt42FhFxq92_3Tx8TOg/edit?usp=sharing