Grade 5: Life Science Module

Lesson Sequence 4: Flow of Energy

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Overview

Total Time: 2 hours of instruction (divided into two sections)

In this lesson sequence, students build a basic understanding of the idea of energy. They view demonstrations of energy transformation and complete a close reading of some of the investigations scientists have used to prove theories of energy conservation. They then participate in a Scientists Meeting to build understanding around the idea that energy is the ability to do work and can be transferred between objects and changed from one form to another but not lost—it is conserved.

Lesson Sequence Focusing Question and Big Ideas

How does energy change and flow? How do scientists know this?

- Energy can be transferred. As it is transferred, it can change forms.
- Some forms of energy are thermal energy, chemical energy, kinetic energy, and potential energy.
- Energy cannot be created or destroyed.
- Scientists have this understanding of energy through repeated experimentation.
- The law of conservation of energy is an agreed-upon law of science.

Long-Term Learning Addressed (Based on NGSS)

Construct an argument based on evidence that energy is neither created nor destroyed, but flows throughout living systems. (Based on NGSS 5-PS3-1)

This lesson sequence explicitly addresses:

Science and Engineering Practices:

- **Engaging in Argument from Evidence:** Compare and refine arguments based on an evaluation of the evidence presented. *Students construct their understanding of the law of conservation of energy by observing energy demonstrations and reading about the experiments conducted by historic scientists. Note: This Science and Engineering Practice is not explicitly aligned with* **5-PS3-1**.
- **Obtaining, Evaluating, and Communicating Information:** Read and comprehend grade-appropriate complex texts to summarize and obtain scientific ideas and describe how they are supported by evidence. *Students read and summarize grade-appropriate text about the law of conservation of energy to gather evidence to support their argument. Note: This Science and Engineering Practice is not explicitly aligned with* **5-PS3-1**.

Crosscutting Concepts:

- **Energy and Matter:** Energy can be transferred in various ways and between objects. *Students observe that as energy is transferred between objects, it changes form. They read about investigations by historical scientists to prove that energy is not created or destroyed; it is always conserved.*

Disciplinary Core Ideas:

- **PS3.D: Energy in Chemical Processes and Everyday Life:** The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). *Students build their understanding of energy and how it can flow between organisms through an investigation and reading.*

Lesson Sequence Learning Target

- I can evaluate the argument that energy is neither created nor destroyed, but flows.

Ongoing Assessment

- Scientists Meeting: Building Understanding
- Participation in Back-to-Back and Face-to-Face protocol
- Student science notebook: Flow of Energy entry

Agenda

Total Time: 2 hours of instruction

Section 1

1. **Opening**
   A. Introducing Learning Target and Focusing Question (10 minutes)
2. **Carrying Out Investigation**
   A. Demonstrating Energy (45 minutes)

Section 2

1. **Obtaining Information**
   A. Close Reading: "The Law of Conservation of Energy" (45 minutes)
2. **Engaging in Argument**
   A. Scientists Meeting: Building Understanding (20 minutes)

Teaching Notes

Purpose of lesson sequence and alignment to NGSS standards:

- In this lesson sequence, students build background knowledge on energy and how it is transferred and changes form (a Disciplinary Core Idea).
- In Section 1, students observe a series of demonstrations that show the transfer of energy. They then evaluate whether or not they have enough sufficient and relevant evidence (a Science and Engineering Practice) to argue that energy flows in a system and is not created or destroyed.
- In Section 2, students read an informational text—"The Law of Conservation of Energy"—that clarifies how energy is transferred and changes form but is not created and destroyed (a Crosscutting Concept). They synthesize their learning about energy in a Scientists Meeting.

How it builds on previous work in the Life Science Module:

- Students continue to build background knowledge necessary to understand the cycle of energy and matter in a healthy ecosystem.

How it connects to the CCSS Standards and EL Education's Language Arts Grade 5 Module 2:

- Students study the rainforest in Language Arts Grade 5 Module 2. Tropical rainforests grow where the sunlight has the most direct contact with the earth. This is one of the reasons that there is high degree of biodiversity. There is a lot of solar energy available for plants to capture and make available for animals to use to carry out life functions.
- The student science notebook is an opportunity for students to practice informative writing and gathering evidence (CCSS ELA W.5.2 and W.5.8).
- The close read in Section 1 provides students the opportunity to practice reading informational texts and explaining the relationship between two or more ideas (CCSS ELA RI.5.3).
- The Scientists Meeting in Section 2 provides students the opportunity to practice their speaking and listening skills while collaborating in whole group discussions (CCSS ELA SL.5.1).
- Students may be familiar with the Back-to-Back and Face-to-Face protocol from Language Arts Grade 5 Module 2. This protocol provides students the opportunity to practice speaking and listening skills (CCSS ELA SL.5.1).

Possible student misconceptions:

- Students may think that energy can be created by sleeping or eating. Energy is not created during these times; instead, energy from food is transferred to body cells and sleeping is a time when the body uses much of the energy for body repair and warmth. Focus students on the understanding that food contains energy because plants are able to convert solar energy into stored energy. Consider asking: "Have you ever woken up and were sweating? This is because your body cells are using lots of energy, and that energy is being transferred to heat energy."

Possible broader connections:

- Connect to students' lives by discussing the role that energy plays in their daily lives as a means for moving, breathing, eating, and staying warm.
- Connect to other sciences by discussing energy conservation and the importance of green energy sources.

Areas where students may need additional support:

- When adding to the "Energy and Matter" column of the Concepts Scientists Think About anchor chart, use one color for information about matter and a different color for information about energy so students will not confuse the two concepts.
- Students will closely read a text in this lesson sequence. Some students may benefit from additional support. Consider these options:
  - For students who are overwhelmed by too much print on a page: Consider copying the text so that there is only one paragraph on each page, with an organized space for recording the gist and meanings of the unfamiliar words on that page.

- For students who may need additional support with paraphrasing: Consider providing running notes on today's text.
- Offer selected shorter passages to specific groups based on the readiness and needs of the group. This gives students an opportunity to read a complex text within the fifth-grade level span but differentiates the length of the text, not the complexity.
- For students who may need additional support staying on pace during the close read: Consider gathering these students in one place in the room to support them quickly and quietly throughout the close-read portion of the lesson. Give prompts to help students stay on task, point out where the class is, or offer sentence frames as needed.
- For ELLs and students who may need additional support with reading and/or writing: Strategically pair them with a peer model.
- For students who may need additional support determining the gist: Consider highlighting or underlining key phrases in their individual copy of the text in advance. This will lift the gist up for them.

Down the road:

- Students will begin drawing their own models in Lesson Sequence 5. Use the demonstration models in the student science notebook as formative assessment and to decide what support your students need to learn this Science and Engineering Practice.
- During Lesson Sequence 5, students will create an ecosystem in a baggie. Gather necessary materials now (see Lesson Sequence 5 materials).

In advance:

- Read each section and complete the Preparing to Teach: Self-Coaching Guide.
- Continue to establish expectations of behavior during group discussions and pair work.
- Gather materials necessary for the energy demonstrations in Section 1:
  - The water and electric kettle should be set up so that students can easily view boiling water.
  - A Newton's cradle. If this is unavailable, search for a video of Newton's Cradle online and prepare technology necessary to play for students. <https://www.youtube.com/watch?v=IT7jOjFSCg4>.
- Review the Back-to-Back and Face-to-Face and Think-Pair-Share protocols (see the Classroom Protocols pack on Curriculum.ELeducation.org).
- Post: Lesson sequence learning target, lesson sequence focusing question, Scientists Do These Things anchor chart, and Concepts Scientists Think About anchor chart.

Optional extensions:

- *Additional Energy Demonstrations:* Show students more energy demonstrations. See <http://www.nuffieldfoundation.org/topic/138/840> for some ideas.

Vocabulary

energy: the ability to do work
evaluate: determine how good, useful, or successful something is
transfer: to move from one thing to another
law of conservation: energy cannot be created or destroyed; it can be transferred
photosynthesis: the process of plants using solar energy to convert water and carbon dioxide into glucose and oxygen

Materials

General Materials

- ☑ Student science notebook (from Lesson Sequence 1; one per student)
  - — Flow of Energy entry (page 16 of student science notebook)
  - — Anchoring Phenomenon entry (from Lesson Sequence 1; page 2 of notebook)
- ☑ Drawing of boiling water (one to display)
- ☑ "Newton's Cradle" (video; play in entirety; optional; see Teaching Notes)
- ☑ Scientists Do These Things anchor chart (begun in Lesson Sequence 2; added to during Section 2; see supporting materials)
- ☑ "The Law of Conservation of Energy" (one per student)
- ☑ Concepts Scientists Think About anchor chart (begun in Lesson Sequence 2; added to during Section 2; see supporting materials)

Science-Specific Materials (gathered by the teacher)

- ☑ Teacher science notebook (from Lesson Sequence 1; for teacher reference)
- ☑ Materials for demonstrating energy (used in Section 1, see Teaching Notes)
  - — Boiling water
  - — Electric tea kettle
  - — Ball (soccer, or smaller)
  - — Newton's cradle (optional; if not available, play "Newton's Cradle" video)

Section 1: Opening

A. Introducing Learning Target and Focusing Question (10 minutes)

- Begin the lesson by providing a transition from the previous lesson sequence. Say:

  "We have discussed matter quite a bit. We started by discussing what matter is and what is made of matter. We are currently doing an experiment to figure out where plants get the matter they need to grow. Plants also interact with another variable, sunlight. Sunlight is not matter; it is energy. To really understand how both plants and ecosystems function, we need to know more about energy."

- Direct students' attention to the posted lesson sequence learning target and select a volunteer to read it aloud while other students follow along, reading silently in their heads:
  - — "I can evaluate the argument that energy is neither created nor destroyed, but flows."

- Underline the word *energy*.
- Using a total participation technique, invite responses from the group (1):

  "How would you define* energy*? What are some examples of energy?" (Responses will vary, but may include: Energy is the ability to do work, and examples of energy are heat, light, chemical, and mechanical energy.)
- Underline the words *created*, *destroyed*, and *flows* and define as needed.
- Underline the phrase *evaluate the argument*. Say:

  "Let's look at the phrase* evaluate the argument*. What does it mean to evaluate something?" (*Evaluate *means to determine how good, useful, or successful something is.)
- Tell students that their job today is to determine if the claim that energy isn't created or destroyed but that it moves around is a good claim that can be supported with strong evidence.
- Invite students to open their **student science notebook** to the **Flow of Energy entry** and find the "Opening" section.
- Tell students that they are going to write down their own claim about energy. Explain that they will return to this statement throughout the lesson sequence to edit and add to as they build their understanding of energy.
- Invite students to record their own evidence and reasoning to their claim. Assure students they will be collecting a lot more evidence throughout the lesson sequence.

Preparing to Teach: Self-Coaching Guide

1. This is a good chance to formatively assess students' background knowledge of energy. How can I track how students respond? Are there specific students I want to check in with?

Section 1: Carrying Out Investigation

A. Demonstrating Energy (45 minutes)

- Tell students that they are going to view a few demonstrations about energy to gather evidence that supports or challenges the claim that energy is not created or destroyed, but only flows (1).
- Invite students to open their student science notebook to the Flow of Energy entry and put their finger on the "Carrying Out Investigations" section.
- Explain that as they view each demonstration, they should record their observations of what they see happening and where the energy is coming from for each action that happens in the demonstration (2).
- Begin the first demonstration by heating boiling water in an electric tea kettle and then lifting the lid to show students the bubbles. Be extremely careful with the boiling water as it has the potential of burning.
- Using a total participation technique, invite responses from the group (3):

  "What do you see happening?" (Bubbles are rising to the surface.)

  "What do you think allows this to happen?" (The water is really hot.)

"What energy do you think is causing this to happen?" (Electricity is passed to the electric kettle and then the kettle heats up, which then heats up the water.)

"What can we name these types of energy?" (electrical energy and heat energy)

- Put the boiling water away.
- Show students how to draw a model of the energy transferred during the boiling water demonstration. See the **drawing of boiling water** as an example.
- Ask students to help revise the drawing. Consider asking:

  "Where did the energy come from? Where do you think the energy is going? How can we explain that in our model?" (label the energy and add arrows)

  "How would someone know what this is? (by reading labels)

  "How would someone know which way this is going?" (by following arrows)

  "The energy is doing different things to the bottom of the kettle and to the water. How can we explain this?" (add bubbles to show the water is boiling; add explanations)
- Begin the second demonstration by asking for a volunteer to stand up and kick or throw a ball across the classroom.
- Using a total participation technique, invite responses from the group:

  "What did you see happening?" (The ball flew across the room.)

  "What do you think allows this to happen?" (the force from the student's leg/arm)

  "What energy do you think is causing this to happen?" (Energy stored in the student's muscles allows them to move, and then the ball has energy as it moves across the room.)

  "What can we name these types of energy?" (stored energy and movement energy)
- Invite students to draw a picture of the action that they just observed in their student science notebook and to add appropriate labels based on the class discussion [4].
- Circulate to check the notebooks for drawings of the demonstration with labels from class discussion.
- Refocus whole group.
- For the third demonstration, instruct students to quickly rub their hands together for about 30 seconds.
- After 30 seconds, instruct students to stop and put their hands on their cheeks.
- Using a total participation technique, invite responses from the group:

  "What do you notice? What do you feel?" (hands got warmer)

  "What do you think caused this to happen?" (the friction of hands moving)

  "What energy do you think allowed this to happen?" (Energy stored in the human body allows for muscles to move the hands.)

  "What can we name these types of energy?" (heat energy, moving energy)
- Direct students to draw a picture of the action that they just observed in their student science notebook and to add labels and arrows based on the class discussion.
- For the final demonstration, show students the **Newton's cradle** in action or play the **"Newton's Cradle"** video.
- Using a total participation technique, invite responses from the group:

  "What do you see happening?" (The ball on the end is bouncing out and then hitting the rest of the balls to cause the ball on the other end to bounce out.)

"What do you think allows this to happen?" (A human's energy started the first ball moving and then all the other balls keep bouncing back and forth, passing their energy back and forth.)

"What energy do you think is causing this to happen?" (Energy stored in the human's muscles causes the first ball to move and then the energy keeps getting passed back and forth among all the other balls.)

"What can we name these types of energy?" (stored energy and movement energy)

- Direct students to draw a picture of the action that they just observed in their student science notebook and to add labels based on class discussion.
- Circulate to check notebooks for drawings of the demonstration with labels and arrows from class discussion.
- Refocus whole group and direct students' attention to the "Engage in Argument" column of **Scientists Do These Things anchor chart**.
- Invite students to turn and talk [5]:

"Do we have enough 'sufficient and relevant evidence' to support or challenge the claim that energy cannot be created or destroyed, but flows?"

- Guide students to recognize that so far they have evidence from only one source, their own observations. Scientists must collect evidence from multiple sources or have many scientists replicate the same experiments many times in order for the evidence to be sufficient.

Preparing to Teach: Self-Coaching Guide

1. What do my students already know about energy?
2. After previewing the demonstrations, what are the potential problems? How will I avoid these problems?
3. I should allow students to come up with their own names for energy. Although movement energy is actually called kinetic energy, at this point the scientific term is less important than the concept.
4. These models can help me see how much experience my students have with modeling. They will create a model for the summative assessment. How can I use these models for formative assessment?
5. What experience do my students have with evaluating evidence? What examples can I bring in to demonstrate the difference between sufficient and insufficient evidence?

Section 2: Obtaining Information

A. Close Reading: "The Law of Conservation of Energy" (45 minutes)

- Refocus students whole group. Tell them they will now continue to gather information to be able to evaluate the claim that energy is neither created nor destroyed, but flows.
- Distribute **"The Law of Conservation of Energy."**
- Tell students that they will work hard as readers now to collect more evidence to challenge or support the claim that energy cannot be created or destroyed, but flows.

- Remind students that when they read complex texts, they often need to read the text multiple times. Tell them that it's okay if they do not understand everything the text says the first time. Reiterate that generally, each reading is for a different purpose. For example, the first reading is generally to get the gist or an idea of what the text is about and to identify unfamiliar vocabulary. Then, additional readings are done to glean details and a better understanding of what the text is saying explicitly and implicitly [1].
- Remind students of some of the close reading routines they use in their Language Arts lessons:
  - Read small chunks of the text slowly and think about the gist.
  - Talk with my partner or group about the text.
  - Circle or underline words I don't know.
  - Write notes or answer questions about the text.
- Refer students to the "Obtaining Information" section of the Flow of Energy entry in their student science notebook. Let students know they are going to have the opportunity to independently read the text. Tell them to stop after each paragraph during this first read and jot the gist of that paragraph and any unfamiliar vocabulary in their notebook. Review and model finding the gist as necessary.
- Ask students to begin reading. Circulate and support students as they read and determine the gist [2].
- After 10 minutes, ask students to turn to and talk to an elbow partner:

  "What gist notes or vocabulary words did you write down? What similarities and differences are there between our notes?"
- After 3 minutes, refocus whole class. Point out to students that their job is to learn everything they can about scientists' argument that energy is neither created nor destroyed, but flows. Explain that they should gather as many *facts, definitions,* and *details* as they can as they read. Clarify these terms as needed.
- Tell students they are going to read the text again. This time, they should read closely for details to add to the "Obtaining Information" section of their science notebook.
- Consider doing a brief guided practice, as necessary.
- Ask students to begin reading. Circulate and support them as they read.
- After 15 minutes, invite students to Think-Pair-Share:

  "What is one piece of evidence that supports or challenges the claim that energy is neither created nor destroyed, but flows?" (Energy from a bow and arrow changes forms when the arrow is released.)
- Draw students' attention to the "Engage in Argument" column of the Scientists Do These Things anchor chart.
- Explain that in order for scientists to make these arguments, they had to determine if the evidence they collected was good enough to convince other scientists to agree with their argument.
- Ask:

  "Do you think you have observed enough sufficient and relevant evidence in the article and in the demonstrations to make the claim that energy is neither created nor destroyed, but is transferred?"

- Tell students they are going to respond to this question using the Back-to-Back and Face-to-Face protocol. Remind them that they used this protocol in Lesson Sequence 3, and review as necessary. Refer to the Classroom Protocols pack on Curriculum.ELeducation.org for the full version of the protocol [3].
- Guide students through the protocol, repeating with new partners as time allows. As students share, circulate to take notes on student conversations in the teacher science notebook.
- Invite students to return to their seats.
- Add "The law of conservation of energy has sufficient and relevant evidence to convince others" to the "Engage in Argument" column on the Scientists Do These Things anchor chart.

Preparing to Teach: Self-Coaching Guide

1. Will my students be familiar with close reads from the Language Arts module?
2. How can I support my readers who need additional support? Perhaps there is a small group I should work with at this time.
3. Are my students familiar with the Back-to-Back and Face-to-Face protocol? Do they need more time here?

Section 2: Engaging in Argument

A. Scientists Meeting: Building Understanding (20 minutes)

- Ask students to bring their science notebooks and gather for a Scientists Meeting.
- Using a total participation technique, invite responses from the group:

  "What are the norms of a Scientists Meeting?" (take turns talking, build on one another's ideas, disagree respectfully, ask questions to clarify information)
- Remind students that a Scientists Meeting is a conversation where they speak to one another as scientists and not just to the teacher.
- Share with students that the goal of today's meeting is to build consensus about whether or not energy can be created and/or destroyed or if it can be transferred and whether they have enough evidence [1].
- Invite students to open their student science notebooks to the Flow of Energy entry and find the "Engaging in Argument" section.
- Encourage students to use the other information recorded in this entry as evidence for their evaluation of scientists' claim that energy can be neither created nor destroyed, but can be transferred.
- Clarify student thinking by asking questions such as:

  "Why do you think...?"

  "What is your reason...?"

  "What is your evidence for saying that...?"

  "What made you change your explanation?"
- If conflicting information arises, help students challenge one another's ideas respectfully. Consider asking questions such as [2]:

  "Why do you think you have different conclusions?"

"What in 'John's' argument do you disagree with?"

"What evidence do you have?"

"What points do you agree on?"

- Draw students' attention to the "Energy and Matter" column on the **Concepts Scientists Think About anchor chart**.
- Ask students to turn and talk with an elbow partner:

  "What are some examples of energy changing or being transferred that we saw or read about?" (Insert examples from the reading and demonstrations.)

  "Can you think of possible examples of energy being transferred in the ecosystem we have been discussing?" (sunlight to food for plants; from plants to animals)

  "Can you think of examples where energy seems to be created or destroyed? What transfer may have happened?" (Animals eat food for energy, and some of that energy is transferred to the atmosphere as heat energy. It isn't captured and used by anything, but it isn't "lost.")
- Summarize for students: "Energy can be transferred various ways and between objects."
- Add this example to the "Matter and Energy" column on the Concepts Scientists Think About anchor chart.
- Remind students that in Lesson Sequence 1 they viewed the Assessing the Health of an Ecosystem slideshow to see pictures of the Olympic National Forest ecosystem. Their job is to assess the health of that ecosystem [(3)].
- Ask:

  "What might you see in an ecosystem where the energy is flowing?" (plants using sunlight to grow; animals eating the plants; animals eating other animals)

  "How might energy flowing be important to a healthy ecosystem?" (Energy is necessary for all organisms to survive. There is only a finite amount of usable solar energy converted by plants. So it needs to be passed from plants to animals and then from animals to other animals.)
- As students share out, capture their thinking in the teacher science notebook [(4)].
- Invite students to turn to the **Anchoring Phenomenon entry** in their student science notebook and put their finger on the "Scientists Meeting" section.
- Ask students to revisit their initial thinking about the health of an ecosystem and then add evidence based on information from the demonstration, reading, and conversations in this lesson sequence [(5)].
- Invite students to return to their seats.

Preparing to Teach: Self-Coaching Guide

1. The focus of this exercise is evaluating evidence. How can I further reinforce my students' understanding of this important part of the argument process?
2. What sentence stem may be helpful for my students as they politely disagree?
3. What are some examples, perhaps from the slideshow in Lesson Sequence 1, which may make this principle more clear?
4. Students will add this thinking to the Criteria for Healthy Ecosystems anchor chart during the Scientists Meeting in Section 3 of Lesson Sequence 3.
5. How can I encourage my students to return and revise their notebook from time to time?