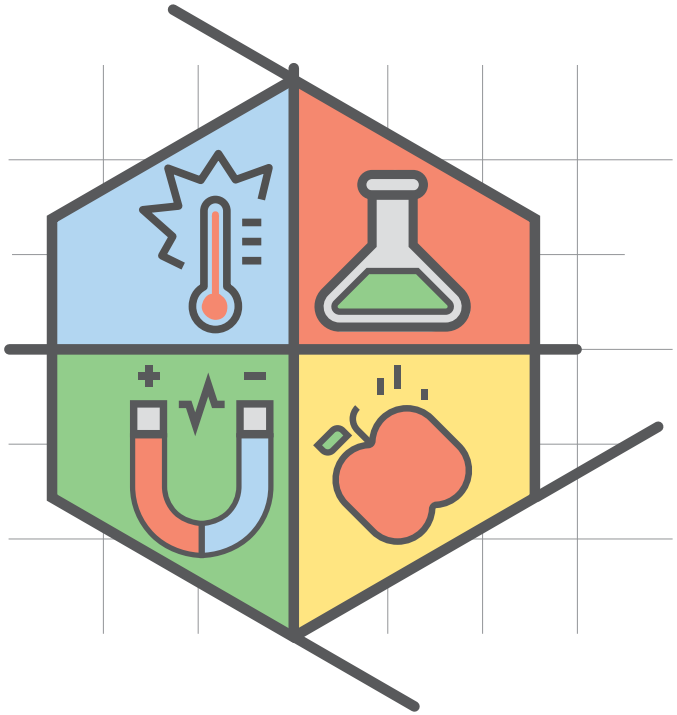

Waves & Energy

4th Grade Physical Science Unit

STEM

A digital copy of this document is available on the STEM Materials Center website at:
http://web3.esd112.org/stem-initiatives/stem-materials-center/physicalkits

STEM
Science
Technology
Engineering
Math

A program of Educational Service District 112 supporting Next Generation Science Standards

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UNIT OVERVIEW

This Unit for the 4th Grade Kit, Waves and Energy, weaves together the various FOSS investigations in the context of an authentic and engaging storyline. Through an imaginary correspondence with a 4th grader who lives in the village of Ghaghara, India, students use FOSS investigations to build their skills and content knowledge in order to solve larger problems being faced by their friend, Parvathi. Students engage in project-based learning while using science and engineering practices to help solve everyday problems in the context of Parvathi's life. Students also use online research and evidence from investigations to construct claims based on evidence which inform and drive their practice of engineering.

UNIT OVERVIEW, Part 1

Part 1: Electricity and Magnetism					
Lesson No.	**Duration**	**Performance Expectations**	**Materials Needed**	**Focus**	**Assessment Options**
1	2 days	4-PS3-4	Read Aloud: *Parvathi's Electric Problem*	**Presenting the Storyline** • Read aloud the email in Parvathi's Electric Problem • Create an initial model of how a flashlight works and discuss where the energy for light the bulb comes from. • Discus other types of energy. • Work in teams to create initial prototype drawing of the flashlight that will be created for Parvathi.	Initial diagrams of prototype
2	4 days	4-PS 3-2	*Parvathi's Electric Problem* Packet FOSS Investigation 2 (all)	**Investigating Circuits** • Connection to Storyline: this lesson will help students explore and understand how circuits work so they can have success building their flashlight for Parvathi. • FOSS investigation 2.1: investigate how to transfer electric energy through a circuit and transform it to light energy. • Foss Investigation 2.2: create a circuit that runs a motor and explore the use of a switch. • FOSS Investigation 2.3: explore which materials are conductors and which are insulators • FOSS Investigation 2.4: figure out the configuration of mystery circuits.	Science Notebook Entries/ Reflections

UNIT OVERVIEW, Part 1 (cont.)

Lesson No.	Duration	Performance Expectations	Materials Needed	Focus	Assessment Options
3	3 days	4-PS3-4	*Parvathi's Electric Problem* Packet FOSS Investigation 3 (all)	**Series vs Parallel** • Connect to storyline: How will students be wiring Parvathi's flashlight? • FOSS Investigation 3.1: build a series circuit that lights more than one bulb. • FOSS Investigation 3.2: Build a parallel circuit. • FOSS Investigation 3.3: Investigate and discuss which better, parallel or series circuit. • Test findings and collect evidence using phet circuit simulation. • Reflect on findings and decide which type of circuit will be used to construct Parvathi's flashlight and why.	Science Notebooks with scientific arguments
4	6 days	4-PS3-4	*Parvathi's Electric Problem* Packet Misc. materials for building flashlights FOSS disposable/ unused materials	**Engineering a Flashlight Challenge** • Discuss the problem being faced by Parvathi. • Brainstorm solutions and design ideas. • Plan and create a detailed diagram with prototype of lighting device • Create actual device using available materials. • Write a letter to Parvathi describing the design features and effectiveness of the device. • Present their device in gallery walk and receive feedback. • Optimize design based on feedback from teacher and peers.	Finished Device, Blueprints of Device, Schematic Diagram, Email to Parvathi

UNIT OVERVIEW, Part 1 (cont.)

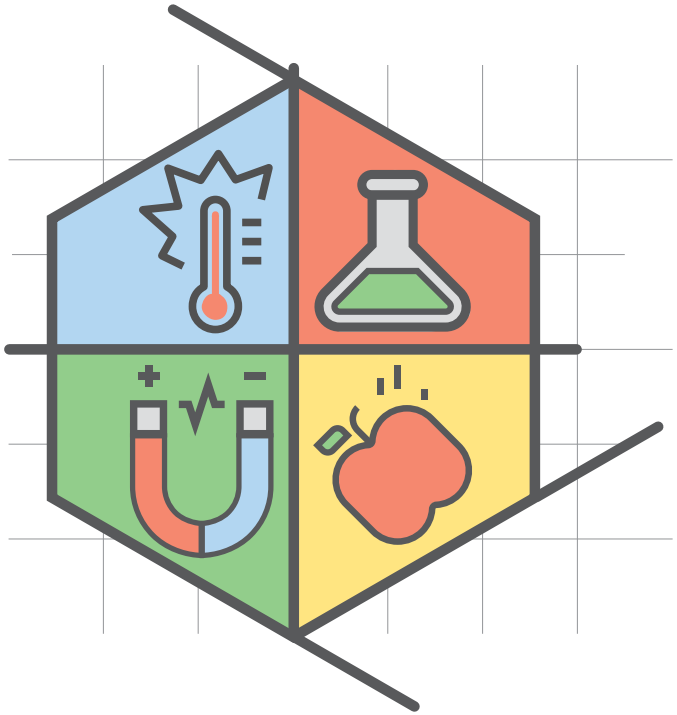
Lesson No.	Duration	Performance Expectations	Materials Needed	Focus	Assessment Options
5	6-7 days	4-PS3-2	FOSS Investigations 4 and 5 (all)	**Extension: Electromagnets in Action** • Read "Transmitting messages" piece about Parvathi's communication glitch with her cousin and discuss potential problems due to the anticipated move. • FOSS Investigation 4.1: build a basic electromagnet and try to find an optimum design for their device. • FOSS Investigation 4.2: experiment with their design and see how the number of coils affects the electromagnet's strength. • FOSS Investigation 4.3: create an investigation to see how other variables can affect the strength of the electromagnet. • FOSS Investigation 5.1: design and build a telegraph using their knowledge of electromagnets • FOSS Investigation 5.2: connect their electromagnet to another team's in order to transmit a message. • Create an owner's manual describing how the telegraphs were built and how Parvathi can use them to communicate with her cousin without a flashlight.	Science Notebooks, Owner's Manual

UNIT OVERVIEW, Part 2

Part 2: Transfer of Energy					
Lesson No.	**Duration**	**Performance Expectations**	**Materials Needed**	**Focus**	**Assessment Options**
1	2-3 days	4-PS3-1 4-PS3-3	Computers with internet access	**The Science of Cooking** • Connect to Parvathi's storyline through the introduction of another letter. • Facilitate a discussion where students elicit their questions and wonderings about how wood stove can be impacting Parvathi's brother. • Study the thermodynamics behind cooking by engaging in a discussion and by collecting evidence through simulation stations. • Record detailed observations in Science notebooks. • Create "Zoom in" boxes showing how particles vary in their movement and how energy is being transferred in the process of cooking. • Work in teams to create a model of how energy is being transferred in a specific everyday phenomenon.	Science Notebooks, Team models, Zoom-in boxes
2	4 days	4-PS3-1 4-PS3-3	FOSS Matter and Energy Investigation 1.1 (all)	**Energy Sources** • Investigate different sources of energy through Lab stations. • Read about other sources of energy (food, fuel, gasoline). • Create a working definition of energy. • Compare renewable to non-renewable resources and create a definition based on consensus of the class. • Connect to storyline and theme: what are different sources of energy that can be used to prepare food? • Predict the types of environmental problems that wood burning might have in the future.	Science Notebooks, Zoom in boxes

UNIT OVERVIEW, Part 2 (cont.)

Lesson No.	Duration	Performance Expectations	Materials Needed	Focus	Assessment Options
3	10-13 days	4-PS3-4	FOSS Matter and Energy Investigation 1.2 (all)	**Energy on the Move** • Investigate different transfers of energy through lab stations. • Create or find a model (video, skit, model with moving parts) of waves transferring energy and causing movement in the real-world. • Research hydroelectric and wind power and how they can be used as a renewable energy source. • Pick one alternate energy source and create visual that compares the impact of both. • Study data from their local PUD and use evidence to write a yelp review for their sustainability. • Write an email to Parvathi inquiring about renewable resources that are in her area and may be helpful in generating energy.	Science Notebook Entries/ Reflections
4	4 days	4-PS3-4 4-ESS3-1	Computers with internet access Research Logs CER Graphic Organizer	**Renewable Energy Sources** • Discuss what the impact of using combustible fuels is on health and the environment after watching videos on air pollution around the world. • Research the causes of air pollution. • Research alternate and more sustainable sources of energy for cooking food. • Synthesize an argument of why one specific source is the best possible renewable energy source for cooking. • Create a "campaign" poster with visuals and evidence for the energy source.	Science Notebooks Research logs CBE sheet Campaign poster
5	5 days	4-PS3-4 4-ESS3-1	Computers with internet access Creating a Cooker Engineering Task Handout	**Creating a Cooker** • Discuss the problem being faced by Parvathi's family. • Brainstorm solutions and design ideas. • Create device using available materials OR develop detailed prototype and explanations for how the device works. • Using evidence, create a brochure or advertisement to market your product to her neighborhood.	Cooking Device Engineering packet Ad for device



Part 1: Electricity & Magnetism

STEM

LESSON 1: Parvathi's Electrical Problem Intro

In this lesson, students will brainstorm how a flashlight works and then create an initial model of a flashlight which will be refined during the course of the Unit.

Strategy: Engage

Materials Needed
Parvathi's Electrical Problem Handout

Read aloud the email from their pen pal Parvathi, who is struggling with daily power-outages that are causing some problems for her and her family.

Facilitate a discussion where students think about the day-to-day struggles that Parvathi is facing as a result of the outages.

Ask students if they have ever experienced a power outage and how that might have felt. Have they ever had to live without electricity? How did that feel? Why did the power outage happen? Why might Parvathi be facing power outages so frequently?

Present students with the design challenge: in this Unit, they will develop their skills and knowledge of electrical energy and circuits to create a flashlight that Parvathi can use for her convenience and safety.

Strategy: Explore

Materials Needed
Flashlight as a prop (optional) Chart paper and markers

Present students with the guiding question: How does a flashlight work?

Ask students to think independently and draw/write their own ideas in their Science notebooks for a few minutes.

Students will then brainstorm in teams and create a visual model of what is inside a flashlight.

- What are the important parts of a flashlight?
- How do they work together to make the flashlight work? (How are they connected?)
- What parts of the flashlight make it easy or convenient to use?

LESSON 1 (cont.)

Strategy: Explain

Ask students to expand their thinking model by asking them to elaborate about the following questions in their teams:

- How is a flashlight able to produce light?
- Where does the energy in the flashlight come from?
- What kind of energy does a battery provide?
- What evidence do you have to back up your claims?

Materials Needed
Flashlight as a prop (optional)
Chart paper and markers

Strategy: Elaborate

Expand the conversation by asking about energy sources other than batteries that might power a flashlight. Are there any flashlights that don't get their energy from batteries? Where do they get their energy from?

Strategy: Evaluate

Students work in teams to create an initial prototype diagram of what their flashlight for Parvathi will look like. Their model must include all of the components that were identified as necessary earlier in the lesson. Also, ask students to include ideas about the components that will make Parvathi's flashlight easier to use.

Ask students to write down ideas/questions/wonderings that they would like to explore or learn more about in order to build their flashlight. Work with students to create a KLEWS Chart (http://static.nsta.org/files/sc1506_66.pdf) to document some of their ideas.

Assess student ideas for misconceptions and basic understanding of electrical energy and circuits so that future instruction can be adjusted.

How Lesson 1 Supports Next Generation Science Standards

4-PS3 Energy

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	• Create a model to illustrate the parts of a flashlight and how they work together to generate light. • Brainstorm sources of energy, besides a battery, that can light a flashlight.
SCIENCE & ENGINEERING PRACTICES	
Asking questions and Defining Problems Developing and Using Models Constructing Explanations and Designing Solutions	• Define Parvathi's problem and identify how their flashlight will help her. • Start the process of designing a solution for Parvathi's power-outage problem. • Develop a model to show what the various parts of a flashlight are and how they work together to function. • Construct an explanation for how a flashlight works and why each part is important.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Observe how a battery produces electric energy which is then converted into light energy in order to light a flashlight. • Discuss other forms of energy that may be converted to electrical energy in order to light a bulb. • Students create a model of a device that they will build to solve Parvathi's problem of nightly power outages.
CROSSCUTTING CONCEPTS	
Cause and Effect Energy and Matter	• Observe that turning a switch in a flashlight causes energy to be converted from chemical to electric and then to light energy. • Energy can be transferred from one object to another (battery to light bulb).

LESSON 2: Investigating Circuits

In this lesson, students investigate the different parts of a circuit and create circuits that convert chemical energy from a battery to electric energy which is then converted to light energy.

Strategy: Engage

Materials Needed
None

This is a skill-building inquiry lesson in which students will aim to learn as much as they can about how circuits work so they can create a highly effective flashlight for Parvathi.

Connect with the storyline:

Discuss the goal of the final project and what they should be aiming to learn in order to be successful in their engineering design mission. What is the end product and how the flashlight will help solve some of Parvathi's problems?

Ask students to reflect on what they still need to know about electrical energy or flashlights in order to tackle this engineering challenge. What do they hope to focus on and learn during these inquiry labs?

Strategy: Explore

Materials Needed
FOSS Investigation 2.1 Lighting a Bulb (see teachers guide for list of materials).

Present student with materials for FOSS Investigation 2.1 where they will investigate how to transfer electric energy through a circuit and transform it to light energy.

Encourage them to use trial and error to create a closed circuit that is able to light up a bulb. What happens when the wires are not completely connected in a loop (closed circuit?). Why does this happen?

Extend student learning by asking: what happens if you use more than one battery? How should you orient them (hint: look at the positive and negative signs, what do these signs mean?).

At the end of the investigation, ask students to use the evidence from this investigation to create a list of what worked and what didn't work in lighting the bulb. Students can return to this list later in the Unit and add what they have learned from other investigations.

Connect with the storyline:

Can students see a scenario where they may have to use more than one battery when building Parvathi's flashlight? In what situation might that happen? How could using more batteries solve a problem? Have students pause and make adjustments to their developing model of the prototype.

LESSON 2 (cont.)

Strategy: Explain

Present students with FOSS Investigation 2.2 and allow them to explore as they work on creating a circuit that runs a motor. They will also explore the use of a switch.

Facilitate a discussion about the transfer of energy. What different forms of energy did they observe when lighting a light bulb in their circuit? What different forms of energy did they observe when running a motor in their circuit? Can they think of examples of how humans use motors in real life?

Connect with the storyline:

Ask students to reflect on how they would use what they learned from this activity when building Parvathi's flashlight. Why might a switch be a helpful addition to Parvathi's flashlight?

Ask students to pause and make adjustments to their developing model.

Ask students to work in teams to create a simple schematic diagram of Parvathi's flashlight in their notebooks.

Materials Needed

FOSS Investigation 2.2 Making a Motor Run (see teachers guide for list of materials).

Strategy: Elaborate

Initiate the lesson by allowing students to "dissect" different wires of household objects so they can observe that the wires are composed of different types of materials. Students should write down all their observations. Ask students to formulate a hypothesis in their notebooks about why these different materials are being used. Why are wires composed of different types of materials? Why is the outside of a wire different than the inside? How can the type of wire being used in a circuit affect the transfer of energy throughout the circuit? Students will be able to test their hypotheses during these investigations.

Present students with FOSS Investigation 2.3 where they will explore which materials are conductors and which are insulators. Is the type of wire in a circuit important after all?

Connect with the storyline:

What type of wire would they want to use for Parvathi's flashlight? Allow students to research online to find evidence for which material would be best. Have students pause and make adjustments to their developing model and take notes in their Science Notebooks.

Materials Needed

FOSS Investigation 2.3 Finding Insulators and Conductors (see teachers guide for list of materials).

Misc wires from old electronic devices/ appliances.

LESSON 2 (cont.)

Strategy: Evaluate

Present students with FOSS Investigation 2.3 materials and where they will apply their understanding of circuits to figure out the configuration of mystery circuits. They are steadily growing their knowledge of how circuits work and should write down (in their Science notebooks) the strategies that are helping them figure out how the mystery circuits are wired.

Assess how well students are able to apply their understanding of the last few investigations.

Facilitate a discussion where students share the strategies they used in order to most easily figure out the configuration of the circuits.

Connect with the storyline:

Ask students how they can use some of the skills and strategies they discovered when building Parvathi's flashlight. Have students pause and make adjustments to their developing model and take notes in their Science Notebooks.

Materials Needed

FOSS Investigation 2.4 Investigating Mystery Circuits (see teachers guide for list of materials).

How Lesson 2 Supports Next Generation Science Standards

4-PS3 Energy

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Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	• Students engage in numerous investigations where they are converting chemical energy to electric energy and then to light energy through the construction of a circuit. • Students continue to use their growing body of knowledge about circuits and energy to modify and improve their plan for Parvathi's flashlight.
SCIENCE & ENGINEERING PRACTICES	
Developing and Using Models Constructing Explanations and Designing Solutions	• 2.1 Students explore simple circuits and draw models of circuits, their parts, and how they connect. • 2.2 Students build circuits and draw schematic drawings of circuits. • 2.3 Students use the evidence they collected from their investigation to refine their model of Parvathi's flashlight. • 2.4 Students explore mystery boards to identify where closed circuits are located and create schematic diagrams to illustrate their understanding.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Observe how a battery produces electric energy which can be conducted through the wires of a circuit and light a bulb (light energy) • Students continue to refine a model of a device that they will build to solve Parvathi's problem of nightly power outages.
CROSSCUTTING CONCEPTS	
Cause and Effect Energy and Matter	• Observe that creating a closed circuit allows for the transfer of energy from one form to another, which can then be used by humans. • Energy can be transferred from one object to another (battery to light bulb, or battery to motor).

LESSON 3: Series or Parallel?

In this lesson, students will connect multiple bulbs in both series and parallel and will use evidence to decide which type of circuit they will build for Parvathi's flashlight.

Strategy: Engage

Set-up two circuits, one in series and one in parallel, each with at least two bulbs. Draw schematic diagrams of both circuits on the board for students to see. Reconnect with previous lessons by discussing with students what electricity is (the flow of energy). Ask students to work in teams to explain how the energy flow will be different in the series and in the parallel circuit. Ask them to write their hypotheses in their Science notebooks. Will bulb brightness be different at all in either one? Why or why not? How is energy flowing differently in both circuits?

Connect with the storyline:

Ask students to reflect about what kind of circuit would be better for Parvathi's flashlight. Will they have more than one light bulb? Why or why not? Based on their hypotheses, which type of circuit would be better for Parvathi's flashlight?

In the next series of investigations, students will have a chance to test their hypotheses to see how differently electric energy flows through different types of circuits, and how this affects the effectiveness of a device that transforms energy.

Materials Needed
Series and parallel circuit for intro (constructed by teacher using FOSS materials) FOSS Investigation 3 Kit

Strategy: Explore

Present students with FOSS Investigation 3.1 where they will explore how to build a series circuit.

Ask students to log all their findings in their notebooks. How did the evidence they collected relate to their hypothesis? Did it support or refute their ideas of how a series circuit works? Why was the second bulb dimmer than the first one? Why did they need two batteries?

Connect with the storyline:

Encourage students to expand the investigation, ex. adding a third light bulb. Ask students to write down or draw their ideas in detail, because this qualitative data will be used as evidence to decide which circuit will be best for Parvathi's flashlight.

Ask students to predict and investigate what happens when one of the bulbs is unscrewed. Ask students to explain why they think that the other bulbs cannot function if one goes out. What is happening to the flow of energy? What does electric current need in order to flow?

Materials Needed
FOSS Investigation 3.1 Advanced Connections (see teachers guide for list of materials).

LESSON 3 (cont.)

Strategy: Explain

Materials Needed
FOSS Investigation 3.2 Building Parallel Circuits (see teachers guide for list of materials).

Connect back to the circuits that were created at the beginning of the lesson. Ask students to reflect on how the energy flow in a parallel circuit will be different than a series. How will this affect the lighting of the bulbs? Ask students to make a prediction and write down their thoughts and ideas in their Science notebooks.

Present students with FOSS Investigation 3.2 where they will build a parallel circuit (different groups will have different set-ups). Encourage them to experiment with the number of bulbs and batteries. Ask them to investigate and explain any difference between the brightness of bulbs in this type of circuit vs the series circuit.

Ask students to investigate what happens when one bulb is unscrewed from the circuit. How is this different than what they witnessed in the series circuit? How is the flow of energy different in this circuit?

Ask students to re-visit their hypotheses from the beginning of this lesson. What evidence did they find to support or refute their hypothesis? Is there anything else they want to test?

Connect with the storyline:

After the investigations about the different types of circuits, ask students to reflect on which one they feel would be best for Parvathi's flashlight and students can write a scientific claim based on the evidence explaining why.

Strategy: Elaborate

Materials Needed
FOSS Investigation 3.3 Solving the String-of-Lights Problem (see teachers guide for list of materials). Computers with updated Java to use phet simulation

Students continue their study of circuitry and decide which circuit design (parallel or series) is more effective and practical. Students can use the ideas they gathered in the last investigation and create a hypothesis about which circuit is going to be more effective for the flashlight and why.

Present students with FOSS Investigation 3.3 where they will build a string of lights in both series and parallel and study the pros and cons. Which type of circuit do they predict will be better? Why would they consider this better? Which set-up would they want to use for Parvathi's flashlight and why?

Students will test the validity of their hypotheses using the phet simulation (https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc) to expand their understanding of series and parallel circuits while collecting an additional source of evidence which can be used to justify their decision of which circuit to use for Parvathi's flashlight. Ask students to write down their ideas in their Science Notebooks. Did the phet simulation confirm the data they collected when actually building their circuits?

LESSON 3 (cont.)

Strategy: Evaluate

Connect with the storyline: Ask students to construct a scientific argument about what kind of a circuit they want to use for their flashlight. Ask them to work in their teams to come up with a consensus model of which circuit they want to use. Ask them to provide evidence to back up their claims. Students should be able to describe how the current (energy) is being distributed differently in each type of circuit and why the circuit type they chose is more effective in lighting up the light bulb/s. Focus on asking students to use the data they have collected in past investigations as proof for their argument.

Ask each team to create a poster with a drawing and a schematic diagram of the circuit they plan on building for Parvathi's flashlight.

Facilitate a gallery walk where students are able to present their team's prototype diagram while peers and teacher can give feedback. Teacher can use this time to assess for understanding of concepts and misconceptions.

Materials Needed
Chart paper and markers.

How Lesson 3 Supports Next Generation Science Standards

4-PS3 Energy

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Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	• Students engage in numerous investigations where they are converting chemical energy to electric energy and then to light energy through the construction of a circuit. • Students continue to use their growing body of knowledge about circuits and energy to modify and improve their plan for Parvathi's flashlight.
SCIENCE & ENGINEERING PRACTICES	
Developing and Using Models Constructing Explanations and Designing Solutions Arguing from Evidence	• 3.1-3.2 Students create models to explore how energy flows in a series and parallel circuit. • 3.1-3.3 Students construct explanations for the phenomenon they observe in both types of circuits. • 3.1-3.3 Students use the evidence they collected from their investigations to refine their model of Parvathi's flashlight. • Students will create a scientific argument based on the evidence they collected for which type of circuit would be best for Parvathi's flashlight.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Observe how a battery produces electric energy which can be conducted through the wires of a circuit and light a bulb (light energy) • Students continue to refine a model of a device that they will build to solve Parvathi's problem of nightly power outages.

How Lesson 3 Supports Next Generation Science Standards (cont.)

CROSSCUTTING CONCEPTS	
Cause and Effect Energy and Matter Structure and Function	• Observe that creating a closed circuit allows for the transfer of energy from one form to another, which can then be used by humans. • Energy can be transferred from one object to another (battery to light bulb, or battery to motor). • Electricity needs a conducting material in order to flow and any object that creates resistance in a circuit will reduce the flow of electric energy. • Students compare and contrast the structure of series vs parallel circuits and how this affects their functionality (for better or for worse)

LESSON 4: Engineering Parvathi's Flashlight

In this lesson, students will engage in the actual engineering process for Parvathi's flashlight. They will use all the evidence and data they collected in previous investigations to plan and create their device.

Step 1: Ask

Connect with the storyline:

The challenge is finally here! Students will return to their original design challenge with all skills and knowledge they have acquired and will create a detailed prototype of Parvathi's flashlight.

Students will identify what the problem is. Provide students with a copy of Parvathi's letter and the class's initial brainstorm about the different elements of Parvathi's problem. What is the problem that they are trying to solve? What type of a flashlight will she need? What are the important things to consider when building the flashlight (brightness, durability, etc.)? What are constraints when building the device (cost/time?). Ask students to work in teams to brainstorm their ideas and map out their thoughts (on chart-paper and post-its).

Materials Needed

FOSS Investigation 2-3 Kits

Misc. collected building materials (cardboard, poster paper, paper towel rolls, tape, glue, plastic bags, paper clips, anything else that can be used to build).

Post-its

Chart paper

Step 2: Imagine and Investigate

Students will imagine solutions to the problem: Based on what the students have discovered for the past several weeks, they will brainstorm what their flashlight will look like. In this step of the engineering process, no idea is too "crazy" or "ridiculous." Ask students to draw/write all ideas that come to mind.

Provide students with post-its and ask them to write only one idea per post-it. Students can brainstorm individually for a few minutes before coming as a group to share their thoughts. Ask teams to look at all their ideas and to group them based on similarities and differences. Is there some consensus on what type of flashlight will be built?

Provide students with access to materials so they can test some of their ideas.

Step 3: Plan

In this part of the engineering process, students will design a detailed prototype.

Ask students to go back into their notes and look at the evidence they collected in previous investigations.
Ask students to address the following questions if they are stumped in the planning process.

- What materials will be used for each part of the circuit?
- How many bulbs and batteries will be used?
- What special features will be included to make the flashlight easy to use?
- Will the circuit be wired as a series or parallel?
- What type of wire will be used?
- What material will be used to encase the circuit and hold the device?
- Will the flashlight have a switch?

Ask students to log their ideas in the Engineering Design portion of the packet. Students can also begin to create their prototype design on a large poster for completion in the next step of the engineering process.

Extension: Teacher can provide cost of materials as a reference and have students calculate the cost of making their device. (see/edit table in packet)

Step 4: Create

Students will create their device.

By the end of this part of the lesson, students should have completed the following items:

- Actual functioning device (one per team).
- Detailed blueprints of device on a poster (one per team).
- A schematic diagram of their circuit (one per team)

Step 5: Gallery-walk and Improvements

Gallery Walk: Ask students to elect a docent to stay with their project as other teammates visit other teams and provide feedback. The docent will explain the features of the device and the reasoning behind the team's decisions, while other students will ask questions and give written feedback (on post-its) to other teams.

Optimize: Students will take the feedback from their peers (and teacher) to improve their final model which will be showcased in an area of the classroom.

Ask students to write an email to Parvathi where they can describe how the flashlight works and why it will be an effective solution for her power outage problem. Also, ask them to explain how their device transfers energy from one form to another and lights the bulb.

Teacher can assess student products and explanations, the email to Parvathi can also serve as a summative assessment of student learning outcomes for this Unit.

How Lesson 4 Supports Next Generation Science Standards

4-PS3 Energy

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Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	• Students use their data from numerous investigations to create a device which transfers energy from one place to another. • Students apply engineering practices to plan, build, and improve their device.
SCIENCE & ENGINEERING PRACTICES	
Developing and Using Models Constructing Explanations and Designing Solutions Arguing from Evidence	• Students create a physical model which transfers energy and converts it from one form to another. • Students create a schematic diagram (model) to show how their circuit functions. • Students construct explanations for how their device works and how their flashlight can help solve Parvathi's problem. • Students use the evidence they collected from their investigations to made design decisions an refine their model of Parvathi's flashlight. • Students write a letter which includes a scientific argument explaining the reasoning and evidence behind their design choices.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Observe how a battery produces electric energy which can be conducted through the wires of a circuit and light a bulb (light energy) • Students continue to refine a model of a device that they will build to solve Parvathi's problem of nightly power outages.

How Lesson 4 Supports Next Generation Science Standards (cont.)

CROSSCUTTING CONCEPTS	
Cause and Effect Energy and Matter Structure and Function	• Observe that creating a closed circuit allows for the transfer of energy from one form to another, which can then be used by humans. • Energy can be transferred from one object to another (battery to light bulb, or battery to motor). • Electricity needs a conducting material in order to flow and any object that creates resistance in a circuit will reduce the flow of electric energy. • Students compare and contrast the structure of series vs parallel circuits and how this affects their functionality (for better or for worse)

LESSON 5: Electromagnets and Secret Codes

In this lesson, students will extend their understanding of circuits and transfer of energy to build electromagnets that will then be used to create telegraphs and transmit information.

Strategy: Engage

Materials Needed
Internet connection

Connect with the storyline:

Present students with another email that they just received from Parvathi where she describes her ingenious method of using a flashlight to send messages (via a secret code) to her cousin who lives next door. Ask students to identify the problem that Parvathi and her cousin will have when Parvathi's cousin moves a couple of houses down on the block.

Present students with the design challenge: How can Parvathi send messages without using light? Ask students to talk with their teams to brainstorm ways that people are able to transmit information without physically seeing each other.

Show students a video of the history of telegraphs and tell them that they will be applying their circuit building skills and create an electromagnet which then can be used to transmit a message. https://www.youtube.com/watch?v=RNhinA8ajoI&t=14s

Strategy: Explore

Materials Needed
FOSS Investigation 4.1 and 4.2 (see teachers manual for complete list)

Connect to previous lesson where students saw a telegraph, which uses electricity to generate a magnetic field. Ask students to reflect about what they think the word "electromagnet" means. What is an electromagnet?

Show them the following videos of large electromagnets:
https://www.youtube.com/watch?v=nvyL5s6hLjk&t=74s
https://www.youtube.com/watch?v=XBWy9gzGGd4

Present students with FOSS Investigation 4.1 and 4.2 where they will build a basic electromagnet and try to find an optimum design for their device. Ask students to make observations in their Science notebooks and to create a drawing showing how energy is transferred from one form to another in their device. Ask students to write a statement describing how the number of coils affects the strength of their electromagnet. Also, ask students to discuss how energy is being transferred in their device.

Extension: If you wish to extend this investigation by having students collect data for the strength of their electromagnet using Magnetic Field Sensor Probes, the "go-link" connectors may be requested from the SMC. The probes cannot be connected to a device without the go-link probe.

Connect with the storyline:

Ask students of some ways that the technology of an electromagnet can be used to make daily life easier. How could Parvathi and her family use electromagnets to make life easier?

LESSON 5 (cont.)

Strategy: Explain

Students expand their understanding of electromagnets by FOSS Investigation 4.3: create an investigation to see how other variables can affect the strength of the electromagnet.

Ask students to share: what are some of the factors that allowed them to create the most effective electromagnet? What advice would they give to someone who is building their own electromagnet? Have students log their ideas and share with the whole class.

Extension: If you wish to extend this investigation by having students collect data for the strength of their electromagnet using Magnetic Field Sensor Probes, the "go-link" connectors may be requested from the SMC. The probes cannot be connected to a device without the go-link probe.

Materials Needed
FOSS Investigation 4.3 (see teachers manual for complete list)

Strategy: Elaborate

Connect with the storyline:

Students will be constructing telegraphs that Parvathi should be able to use. Students start building their telegraphs with FOSS Investigation 5.1.

Present students with FOSS Investigation 5.2 and challenge students to connect their telegraph with another team's and see if they can transmit a message. Will Parvathi be able to communicate with her cousin who now lives two houses down the street instead of next door?

Materials Needed
FOSS Investigation 5.1 and 5.2 (see teachers manual for complete list)

Strategy: Evaluate

Connect with the storyline:

Ask students to work with their team to create an owner's manual that 1) describes how their telegraph was built and what the different parts are, 2) how energy was being transferred and transmitted, 3) instructions for how the device is used, and 4) how Parvathi could use a modified version of her flashlight-code to communicate with her cousin. Students can create the owner's manual on a poster or create a smaller brochure. Also, ask students to consider: Are there any limitations of the device (ex. wires will have to be very long if Parvathi will be using it to communicate with her cousin who lives a few houses down on the street).

Gallery Walk: Have students share their owner's manuals and devices in a gallery walk, where the teacher and students give feedback. Provide students with the opportunity to make improvements and/or changes.

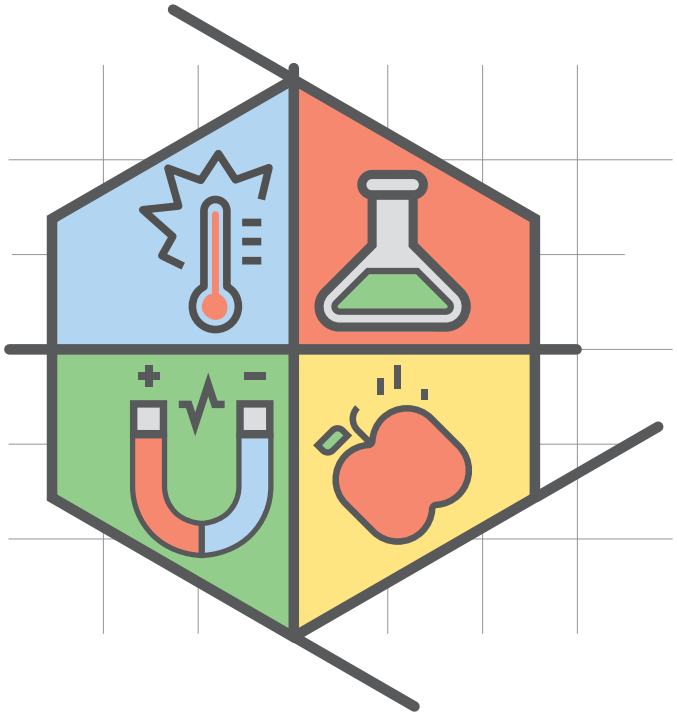
Materials Needed
Poster, markers, art supplies.

How Lesson 5 Supports Next Generation Science Standards

4-PS3 Energy

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.	• Students use their data from numerous investigations to create a device which uses electrical energy to generate a magnetic field. • Students apply engineering practices to plan, build, and improve their device. • Students create a telegraph machine which uses an electromagnet to transfer information.
SCIENCE & ENGINEERING PRACTICES	
Developing and Using Models Constructing Explanations and Designing Solutions Arguing from Evidence	• Students create a physical device which transfers energy and converts it from one form to another. • Students construct explanations for how their device works and how their telegraph machine can Parvathi communicate with her cousin. • Students use the evidence they collected from their investigations to made design decisions an refine their model of Parvathi's telegraph machine • Students write an owner's manual which includes a scientific explanation and the reasoning and evidence behind their design choices.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Observe how the energy from an electric current can produce a magnetic field. • Create a device that uses the principles of electromagnetism to help Parvathi communicate (without light) to her cousin who lives two houses away.



Part 2: Transfer of Energy

STEM

LESSON 1: The Science of Cooking

In this lesson, students will investigate the science of cooking by exploring several simulations and collecting evidence to study the impacts of wood burning on health and the environment.

Strategy: Engage

Materials Needed
Parvathi's Letter

Connect with the storyline:

Present students with Parvathi's new email where she discusses the dilemma her family is facing in their kitchen with the negative impacts of the wood burning stove on her younger brother's health.

Facilitate a discussion first in small groups and then as a whole class where students can share and document their own "wonderings" and questions about why Parvathi's brother might be having these health issues. Create a KLEWS Chart (http://static.nsta.org/files/sc1506_66.pdf) to document some of their ideas. Focus on having students illicit specific questions and look for questions like the following: Why did Parvathi's brother have trouble breathing? What was the cause of the specific environmental condition? Was it caused by people or was it a natural phenomenon? Why was the wood burning bad for his health? What did it put into the air?

Strategy: Explore

Materials Needed
Computers with internet and updated java

Engage students in simulation stations where they are able to collect data from the simulations and answer overarching questions. Facilitate a discussion where students brainstorm how they will collect and organize their data for each simulation. What are the factors that will be important to take note of? How can the data be organized to make sense. Students' responses may differ which is fine.

Key Questions for simulations: How does the movement of particles affect their temperature? What is the relationship between the movement of particles, the amount of energy they carry, temperature, and what happens during collisions? How is energy being transferred from one particle to another?

1. Phet simulation about applying heat: https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html
2. Molecular Workbench: mixing a hot liquid with a cold solid.
3. Suggested simulation: Explore Learning Gizmo: Boiling water

Strategy: Explain

Materials Needed
Set of Index cards with words for each group (wood stove, wood, cooking pot, water, and rice) written on them.

Students should be collecting data from each station (above) and logging it in their Science notebooks. Diagrams of particles and indications of movement are encouraged.

LESSON 1 (cont.)

Connect with the storyline:

Students will then make sense of the data they collected and relate it to Parvathi's example of a wood-burning stove. Their focus question is: How is energy transferred in the process of cooking food? Give each group index cards with the words "wood stove," "wood," "cooking pot," "water," and "rice" written on them. Have students work in their teams to sequence the objects in the order that the energy is being transferred in the process of cooking. Ask students to lay the cards out in the correct order and to use arrows to indicate the transfer of energy from one thing to another. You can also have students tape/glue the cards on a poster in the correct order and write more detailed explanations of what is happening to the particles in each part.

Strategy: Elaborate

Materials Needed
None

Connect with the storyline:

Students will take their ideas from the previous parts of the lesson and create a picture with three "zoom in" boxes to illustrate what is happening when food is being cooked in Parvathi's wood burning stove. Each drawing can have more than one zoom out box showing the movement and concentration of particles in different parts of the system.

Ask students to consider the following ideas in their models:

- How are the particles moving in each part of the system?
- How is energy being transferred?
- What are other ways that energy is being released into the environment (heat, smoke)?

For the teacher: video of "zoom out" boxes being used in the classroom:
https://www.teachingchannel.org/videos/students-learn-from-students-nsf#video-sidebar_tab_video-notes-tab

Strategy: Evaluate

Materials Needed
Posters, post-its, and art supplies.

Write a variety of phenomenon on little strips of paper. Have each group of students pick one piece of paper. Ask them to create a scientific model showing the steps of energy transfer in this example. Encourage them to use "zoom in" boxes as a tool to help explain their phenomenon. A scientific model should explain what is happening during the phenomenon and why.

Some resources for using models in the classroom:
NSTA guide for Developing and Using Models: http://ngss.nsta.org/Practices.aspx?id=2
Teaching Channel resource: https://www.teachingchannel.org/blog/ausl/2015/05/04/explanatory-models-a-highly-effective-way-to-support-science-learning-ngss-and-mbi/

List of possible phenomena: frosty the snowman melting in the sun (or ice melting), a marshmallow being toasted in a campfire, making a cup of tea, baking a cake, making pancakes, a crayon melting in the sun.

How Lesson 1 Supports Next Generation Science Standards

4-PS3 Energy

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object. 4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	• Students use evidence from the simulations to relate the speed of particles to their temperature and energy. • Students collect evidence and create a model showing energy being transferred from place to place in the process of cooking.
SCIENCE & ENGINEERING PRACTICES	
Developing and Using Models Arguing from Evidence	• Students create a model of how a wood stove transfers energy in order to cook food. • Students collect and integrate evidence to develop their model of wood burning and the negative implications of this practice on health and the environment.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Observe how energy is transferred from objects that carry a lot of energy (and are moving faster) collide into objects that carry less energy (are moving slower). • Energy and fuels that humans use are derived from natural sources and have have multiple effects on the environment. • Students are starting to define the problem (consequences of using a wood burning stove) that they will be engineering a solution to throughout this part of the Unit.
CROSSCUTTING CONCEPTS	
Cause and Effect Energy and Matter	• Observe how increasing the temperature of a fluid causes transfers heat energy to the particle and causes them to move faster. • Collect evidence about how burning wood can cause health and environmental problems. • Observe how energy can be transferred from object to another.

LESSON 2: Energy Sources

In this lesson, students will further their understanding of energy transfer by engaging in inquiry labs where they experiment with different sources of energy.

Strategy: Engage

Materials Needed
None

Pre-lesson homework: Ask students to go home and investigate what type of energy source their family uses to cook their meals. Give students these questions to ask their parents: What type of energy do we use to cook our food? Where does this energy come from? Make sure that the discussion includes the most common sources to cook food: gas and electricity.

Facilitate a discussion where students can share their ideas about the following questions: What are other energy sources at your home or school? Where does this energy come from?

Strategy: Explore

Materials Needed
FOSS Investigation 1.1 Energy Sources (see teachers guide for list of materials).

Connect with the storyline:

Parvathi's family uses wood to fuel their stove. In this investigation, students will be exploring different energy sources. Ask students to think about whether any of these energy sources can be helpful to them once they are building a cooking device for Parvathi's mom.

Present students with Investigation 1.1 Energy Sources where they will investigate different sources of energy and the use of batteries, a candle, and a solar cell.

Students are focused on collecting data to answer the following questions: Where is the energy coming from and where is it going in each of the energy stations? Where can energy be stored? What are some different sources of energy? Students will focus mostly on qualitative data collection and write down their observations.

Strategy: Explain

Materials Needed
None

Students use their growing understanding to write a working definition of energy based on the data they have collected throughout this part of the Unit. Their focus question is: What is energy? Students answer this question by creating a claim based on evidence. Students can work in teams to write out their claims. The teacher can provide graphic organizers and sentence starters to help students write their claims.

Resource for Graphic organizers from Tacoma Public Schools:

Sentence starters: http://classrooms.tacoma.k12.wa.us/tps/k5stem/documents (then search for Claims-Evidence-Reasoning Sentence Starters)

LESSON 2 (cont.)

Have students use their working definition of energy to describe exactly what happens when something is being cooked. Where is the energy coming from? Where is it going? Have students pause and look back at the energy transfer models they created in the first lesson and allow them to modify this model.

Students will then read about alternate sources of energy (FOSS student booklet). Which sources of energy that they read about can actually be used to cook food?

Strategy: Elaborate

Connect with the storyline:

Ask students what some of the negative effects of a wood burning stove might be. Students can research and deepen their understanding of the health consequences of burning wood. Additionally, what is the impact of burning wood on the plants and animals that live in the environment?

Connect students back to the storyline, they will be using the information they find when writing a response to Parvathi.

Discuss the difference between renewable and non-renewable energy sources. Ask students to work in teams to make a list of sources of energy that are renewable and sources that are non-renewable. Bring the class back together and have students share their ideas. There will most likely be disagreement—facilitate a discussion where students are able to debate about certain points.

Come up with a consensus as a class and write a definition for renewable energy sources and non-renewable energy sources.

Links for teachers about renewable vs non-renewable:
http://renewablegreen.net/%EF%BB%BFrenewable-vs-nonrenewable-energy-pros-cons/
https://www.ck12.org/earth-science/renewable-vs.-nonrenewable-energy-resources/
https://instituteforenergyresearch.org/topics/encyclopedia/renewable-energy/

Materials Needed
None

Strategy: Evaluate

Connect with the storyline:

Ask students to think of Parvathi's family and their methods for cooking. Is using a wood stove renewable or non-renewable? What problems might Parvathi and her family face in the future? How might the community be affected? How could the nearby forest and animals that live in the forest be effected? Ask students to create a "zoom out" box where they draw at least 3 boxes showing the impact that wood burning can have on larger systems (examples: Parvathi's family, the community, and the ecosystem).

How Lesson 2 Supports Next Generation Science Standards

4-PS3 Energy

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	• Students collect evidence and create a model showing energy being transferred from place to place in the process of cooking.
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems Developing and Using Models Arguing from Evidence	• Students inquiry about different sources of energy, analyze their availability and impact on the environment, and question the feasibility of using certain energy sources to cook food. • Students improve their model of how a wood stove transfers energy in order to cook food. • Students collect and integrate evidence to develop their model of wood burning and the negative implications of this practice on health and the environment (specifically because it is non-renewable).
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Energy and fuels that humans use are derived from natural sources and have multiple effects on the environment. • Students are starting to define the problem (consequences of using a wood burning stove) that they will be engineering a solution to throughout this part of the Unit. • Students begin to identify alternate sources of energy and the implications of their use.
CROSSCUTTING CONCEPTS	
Cause and Effect Energy and Matter	• Collect evidence about how wood is a non-renewable resources and therefore not a sustainable source of energy for cooking. • Observe how energy can be transferred from object to another and improve their original • model of how energy is transferred in the process of cooking.

LESSON 3: Energy on the Move

In this lesson, students will investigate the phenomenon of energy on the move through FOSS Lab Stations. Then, they will create or adapt a model of waves transferring energy and causing movement in the real-world.

Strategy: Engage

Connect with the storyline:

Show students the video that Parvathi sent of her rickshaw ride. Ask students: Do you observe any signs of energy being used? Do you observe any cases of energy on the move? What types of movement do you see and what is causing them? Where does a car get its energy? What forms of energy are involved in the system? What energy is being transferred? What energy is being conserved? What energy is dissipating?

Ask students to work in teams to think of the difference between stored energy, and energy that is moving. Ask students to log their ideas in their Science Notebooks. What are some examples of energy that is being stored (for later use)? What are some examples of energy that is moving through something?

Links for teachers about kinetic (moving) and potential (stored) energy:
http://science.jrank.org/kids/pages/50/KINETIC-VS-POTENTIAL-ENERGY.html
http://www.physicsclassroom.com/class/energy/Lesson-1/Potential-Energy
http://www.physicsclassroom.com/class/energy/Lesson-1/Kinetic-Energy

Materials Needed

Parvathi's Video

Computers with internet access.

Supplies for creating posters (chart paper and markers).

Strategy: Explore

Have students take another look at some of the interactions they recorded from Parvathi's video of energy on the move. In this investigation, they will be studying different types of energy transfer caused by energy on the move.

Present students with Investigation 1.3 Energy on the Move (suggestion: skip Investigation 1.2 Converting Energy) and ask students to log their observations and ideas in their Science notebooks.

Materials Needed

FOSS Investigation 1.3 Energy Sources (see teachers guide for list of materials).

Strategy: Explain

Ask students to expand on and explain the following ideas from their previous lab (Investigation 1.3): how could you observe that energy was on the move? What was the source of the energy? Which direction was the energy causing the object to move?

Ask students to pick one of the stations and create a model (video, skit, diagram) illustrating their analysis of energy of the move. How was the energy moving? What was happening to the objects that were interacting with the energy that was moving? Can they use their model to make a prediction about what might happen if another object was brought into the system where energy was on the move?

Materials Needed

None

LESSON 3 (cont.)

Strategy: Elaborate

Materials Needed
Computers

Facilitate a discussion: are there any ways that moving things can generate energy? If particles are moving fast vs slow, how will that effect the amount of energy they carry?

Ask students to think about ways that energy on the move can be used by humans. Have they experienced or seen moving energy being used by people? Facilitate a discussion and write student ideas on the board.

Ask each group to pick one renewable energy source and read about it on these websites:
https://www.eia.gov/kids/energy.cfm?page=renewable_home-basics
http://www.alliantenergykids.com/EnergyandTheEnvironment/RenewableEnergy/000625

Students can focus on answering two questions: how do humans use this as a source of energy? What affects does it have on the environment? The teacher can assign or allow students to pick: hydroelectric energy, wind energy, or solar energy.

After students have researched the energy source and discussed its impact in their groups, ask them to create a diagram or chart comparing and contrasting the renewable energy source with the burning of wood or fossil fuels. Students can look back at their ideas from their last lesson and can look at their "zoom out" boxes for reference.

When discussing with their groups and creating their graphic organizers ask them to consider:

What are the environmental impacts of both? If we weigh the pros and cons of each, which one has a lesser impact on the environment? Students can then create an argument based on their findings and illustrate (using evidence) which one has a lesser negative impact on the environment and why and present to their classmates.

Strategy: Evaluate

Students are provided with data (and can do additional research) about the Utility company in their region and the sources of energy that are used to provide their communities with electricity. What types (and what percentages of the different types) of energy are being used? Are they sustainable or non-sustainable? Is their county doing a good job of reducing impact to the environment or not?

Clark County Statistics (look in "Fast facts about Clark Public Utilities")
https://cdn5.clarkpublicutilities.com/wp-content/uploads/2016/08/2015-Owner-Manual2.pdf
https://www.clarkpublicutilities.com/about-cpu/public-documents/integrated-resource-plan/

LESSON 3 (cont.)

Skamania: https://www.skamaniapud.com/wp-content/uploads/JUNEJULY2015.pdf
Klickitat: http://www.klickitatpud.com/news/kpudNews/fuelReport.aspx

Ask students to become "yelp" reviewers and to use data to make a claim and assign a rating to their Public Utility company out of 5 stars (5 being an excellent job and 1 being not so good). They should use the ideas they discussed about sustainable and non-sustainable practices to write their reviews. Why does their PUD earn that specific star rating? There may be disagreement between students' ratings which is encouraged. Teacher can facilitate a discussion where students justify their star ratings and read their reviews to the class.

Connect with the storyline:

Now, students write an email to Parvathi and inquire about the natural resources in her area that have energy on the move and can be used to harness energy. How could some of the sources and examples of energy on the move help in creating Parvathi's cooking device? What additional questions would you want to ask Parvathi before you decide if any of these sources will work for her family based on their location (near a river, windy area, sunny weather?).

How Lesson 3 Supports Next Generation Science Standards

4-PS3 Energy

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	• Investigate different transfers of energy through lab stations. • Create a model (video, skit, model with moving parts) of waves transferring energy and causing movement in the real-world. • Students research hydroelectric and wind power and how they can be used as a sustainable energy source.
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems Developing and Using Models Arguing from Evidence	• Students inquiry about different sources of energy, analyze their availability and impact on the environment, and question the feasibility of using certain energy sources to cook food. • Students improve their model of how a wood stove transfers energy in order to cook food. • Students collect and integrate evidence to start the process of engineering a renewable energy device for Parvathi. • Students ask questions to check the availability of resources in Parvathi's environment.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Energy and fuels that humans use are derived from natural sources and have multiple effects on the environment. • Students are ask questions while analyzing Parvathi's problem (consequences of using a wood burning stove) and ask questions that will help them engineer a renewable cooking device. • Students identify and research alternate sources of energy (ex. wind and water) and the implications of their use.

How Lesson 3 Supports Next Generation Science Standards (cont.)

CROSSCUTTING CONCEPTS	
Cause and Effect Systems Energy and Matter	• Collect evidence about how wood is a non-renewable resources and therefore not a sustainable source of energy for cooking. • Observe and collect evidence on how certain energy sources can affect ecosystems. • Observe how energy can be transferred from object to another and improve their original model of how energy is transferred in the process of cooking. • Research and study other sources of renewable energy.

LESSON 4: Renewable Energy Research Project & Campaign

In this lesson, students will further expand their understanding of energy by reading, researching, and discussing the impact of burning combustible fuels on human health and the environment. They will then use their research to start the process of planning an alternate energy cooking device for Parvathi and her family.

Strategy: Engage

Materials Needed
Computers

Part 1 Research focus: How can burning fuel negatively impact people, plants, and animals?

Show students a series of videos about air pollution around the world.
www.wsj.com/video/this-is-how-bad-new-delhi-air-pollution-is/290523ED-B714-4BA6-BD1F-9DE41AEAB6B0.html
www.youtube.com/watch?v=S27ycsxUtRM

Ask students: What are the consequences to using certain sources of energy for fuel? How does this affect people, plants, and animals? How serious is the damage? What are the different consequences (health problems, acid rain, destruction of ecosystems, etc.)? Have students brainstorm their ideas in teams and compile their ideas in small groups using a KWL chart.

Then, have students research the following websites to gather information that they can log in their science notebooks. Provide students with the handout that will help guide their research task.

Effects of air pollution on health:
http://www.yourarticlelibrary.com/air-pollution/effects-of-air-pollutants-on-human-health/19785/
https://www.atsdr.cdc.gov/general/theair.html

Effects of air pollution on environment:
http://eschooltoday.com/pollution/air-pollution/effects-of-air-pollution.html

Ask students to complete their research log handout and to work in groups to add to their KWL chart, which they will be coming back to throughout the research project.

Some articles for the teachers use:
https://energypedia.info/wiki/Renewable_Energy_for_Food_Preparation_and_Processing_-_WISIONS
http://blogs.ei.columbia.edu/2013/05/15/of-cow-dung-cook-stoves-and-sustainability-in-practice/
https://www.iea.org/publications/freepublications/publication/cooking.pdf

LESSON 4 (cont.)

Strategy: Explore

Materials Needed
Computers

Part 2 Research focus: What are the causes of air pollution?

Students explore this website and read information to answer the focus question. Their goal is to collect data on that they will be able to then analyze and use as evidence later.

Ask students: What are some of the causes of air pollution? What types of energy sources create pollution?

Then, have students research the following websites to gather information that they can log in their science notebooks. Provide students with the handout that will help guide their research task.
http://eschooltoday.com/pollution/air-pollution/causes-of-air-pollution.html
http://eschooltoday.com/pollution/air-pollution/common-examples-of-air-pollutants.html
http://www.eschooltoday.com/energy/non-renewable-energy/what-is-non-renewable-energy.html

Ask students to complete their research log handout and to work in groups to add to their KWL chart, which they will be coming back to throughout the research project.

Strategy: Explain

Materials Needed
Computers

Part 3 Research focus: What are some other, less harmful sources of energy?

Ask students: what sources of energy are there out there which do not have such a negative impact on the environment? Are they renewable? Why are renewable sources of energy better for the environment than non-renewable sources?

Then, have students research the following websites to gather information that they can log in their science notebooks. Provide students with the handout that will help guide their research task.
http://www.alliantenergykids.com/EnergyandTheEnvironment/RenewableEnergy/
http://www.kids.esdb.bg/newenergy.html
https://www.greenmountainenergy.com/why-green/renewable-energy-101/#solar

Ask students to complete their research log handout and to work in groups to add to their KWL chart, which they will be coming back to throughout the research project.

Strategy: Elaborate

Materials Needed
Computers

Part 4 Synthesizing an Argument:

Connect with the storyline:

After all the research that they did, which energy sources seem like they might be good for cooking? Where do these energy

LESSON 4 (cont.)

sources come from (plants, animals, the earth?)? How easy or difficult are these sources to obtain? How effective are these sources in cooking food? Are there any health or environmental impacts of using this type of energy to cook food? Which resources does Parvathi's family have access to that could be helpful to them?

Have students discuss their findings in groups and decide on one source of energy they would like to focus on as the energy source of their cooker. Why would this be a good energy source? What evidence do they have to support that argument? Ask students to work with their teams to create a claim based on evidence to justify their decision. Provide them with the graphic organizer to help organize their thinking.

Have students share their claims and receive feedback in a gallery walk.

Strategy: Evaluate

Connect with the storyline:

Students will then design a campaign poster to create public awareness in Parvathi's village about the energy source that they have chosen. On their poster/advertisement, they can include pictures of how their source of energy is harnessed and used by people, and numerous pieces of evidence that justify why their resource is a preferred source of energy.

Materials Needed
Computers, poster paper, art supplies.

How Lesson 4 Supports Next Generation Science Standards

4-PS3 Energy

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	• Students research the impacts of fuel burning on the environment and specifically study how it contributes to air pollution. • Students research about alternate sources of energy that can be used for cooking. • Students create an advertisement for one renewable source of energy that they feel will be helpful for Parvathi's family.
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems Analyzing data Developing and Using Models Arguing from Evidence	• Students inquire about different sources of energy, analyze their availability and impact on the environment, and question the feasibility of using certain energy sources to cook food. • Students collect data about the causes and contributors of air pollution. • Students collect and integrate evidence to start the process of engineering a renewable energy device for Parvathi. • Students create a poster which contains an argument for why the renewable energy source.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Energy and fuels that humans use are derived from natural sources and have multiple effects on the environment. • Students are ask questions while analyzing Parvathi's problem (consequences of using a wood burning stove) and ask questions that will help them engineer a renewable cooking device. • Students research the impacts of air pollution on health and the environment. • Students identify and research alternate sources of energy which one would be most feasible to use for Cooking for Parvathi's family.

How Lesson 4 Supports Next Generation Science Standards (cont.)

CROSSCUTTING CONCEPTS	
Cause and Effect Systems Energy and Matter	• Collect evidence about how wood is a non-renewable resources and therefore not a sustainable source of energy for cooking. • Observe and collect evidence on how certain energy sources can affect ecosystems. • Research and study other sources of renewable energy. • Design an advertisement for one of the sources of sustainable energy and how this resource has limited impact on the environment.

LESSON 5: Creating the Sustainable Cooker

In this lesson, students will engineer a sustainable cooking device for Parvathi's family using the engineering process of asking questions, defining the problem, imagining a solution, planning/ creating a solution, and improving/communicating. The SMC has Solar Energy and wind energy investigation kits available for teachers to use in conjunction with this lesson.

Step 1: Ask

Connect with the storyline:

Direct students back to the storyline and provide the original letter from Parvathi if necessary. What is the problem Parvathi and her family are facing? What is their design challenge? Are there any requirements or limitations that they have to be aware of (temperature, materials, and resources)? Provide access to all of Parvathi's letters and videos.

Materials Needed
Parvathi's letters/videos

Step 2: Imagine

Provide students with chart paper and whiteboards so they can start to sketch.

What renewable energy source did they want to use?

1. Students will create a detailed diagram of their prototype (a drawn plan) .
2. Students will explain the "why" behind their design.
3. How is the device transferring energy?

Materials Needed
Chart paper, whiteboards, markers.

Step 3: Plan/Create

Provide students with materials they can experiment with to plan how to build their cooker and allow them to actually create their device. Some groups that come up with more elaborate ideas (ex. hydroelectric power) may choose to further develop their blueprints instead of actually building their cooking device. This part of the lesson can be modified so students just further develop their plans if teacher does not have the resources to allow students to build. Provide students with large chart paper or poster paper for their prototype design so they can create a large image.

You can also chose to provide more structure to students and have them focus on one type of energy source (ex. creating a solar oven if this Unit is being taught later in the school year). For actual cooking devices, provide students with thermometers so they can check temperature and see if it is adequate for cooking.

Materials Needed
Misc Materials (cardboard, aluminum foil, plastic/foam cups, saran wrap, popsicle sticks, straws, etc.)

LESSON 5 (cont.)

Step 4: Present/Improve

After students have finished creating their blueprints/device, ask them to elect a docent to stay with their exhibit as other teammates visit other teams and provide feedback. The docent will explain the features of their cooking device and the reasoning behind the decisions the team made, while other students will ask questions and give written feedback (on post-its) to other teams.

Optimize: Students will take the feedback from their peers (and teacher) to optimize their final model which will be showcased in an area of the classroom.

Teacher can assess student products and explanations

Materials Needed

Misc Materials (cardboard, aluminum foil, plastic/foam cups, saran wrap, popsicle sticks, straws, etc.)

Computers

Step 5: Evaluate

Creating an Advertisement for their Product

Ask students to think about how they would market their product to people living in Parvathi's village. How does the product use renewable energy to cook? How could it be helpful to them? Why is it better than using a wood stove? What are the benefits of using this product?

Students can create a brochure, poster, or skit/commercial to market their product to people in Parvathi's village while using evidence to back up their claims. They can use their campaign poster as an accompanying text for their advertisement or they can also use it as a prop if they are creating a skit, or commercial.

Materials Needed

Computers, poster paper, art supplies, cell phone (for taking video of skit)

How Lesson 5 Supports Next Generation Science Standards

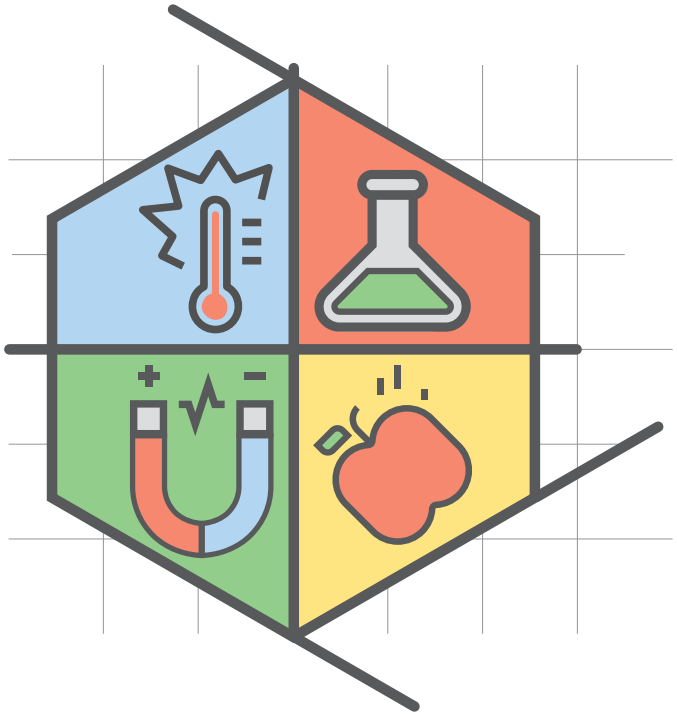
4-PS3 Energy

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity,** *Students:*
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	• Students identify the design problem and create a device which uses a renewable energy source to cook food. • Students explain how their device uses a natural resource that is renewable and not damaging to the environment.
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems Communicating Information Developing Models Using Mathematics Arguing from Evidence	• Students inquire about different sources of energy, analyze their availability and impact on the environment. • Students collect and integrate evidence to engineer a renewable energy device for Parvathi. • Students develop a blueprint or model for how energy is transferred in their device to allow it to cook. • Students create a brochure, advertisement, or commercial arguing how their product can be helpful to people in Parvathi's village.
DISCIPLINARY CORE IDEAS	
PS3.B: Conservation of Energy and Energy Transfer • Energy can be converted from one form to another (electrical to light) ETS1.A Defining Engineering Problems	• Energy and fuels that humans use are derived from natural sources and have multiple effects on the environment. • Students are ask questions while analyzing Parvathi's problem (consequences of using a wood burning stove) and ask questions that will guide the type of device they create. • Students create a device that transfers energy from one form to another. • Students describe the transfer of energy within their device.

How Lesson 5 Supports Next Generation Science Standards (cont.)

CROSSCUTTING CONCEPTS	
Cause and Effect Systems Energy and Matter	• Create a device which uses a renewable source of energy to cook and has minimal environmental impact. • Describe the transfer of energy from one form to another within their device. • Explain the impact that their device has on the surrounding ecosystem.



Teacher Resources & Handouts

STEM

Part 1: Parvathi's Electrical Problem

Your pen pal Parvathi, who writes to you every month, has just sent you a new email:

Dear Room ___,

I hope you all are doing well. I am doing great. I have been learning a lot of interesting things in school and I have really been enjoying my Science class. We are learning about living things right now. We have been studying how plants get energy from the sun to make food, and how animals like us eat plants to get some of that energy. My brother and sister are also doing well, everything is great!

Actually, now that I think of it, there is one thing that has been bugging me a bit. It seems like our power outages have been getting worse and worse. Sometimes the electricity goes out in the evening around 5 p.m. and it does not come back until the early morning. It is hard to do just about anything with the power out. I am getting behind on reading my new book since there is no electricity and reading by candlelight makes my head hurt.

It is also really dangerous to walk around, especially outside, since you never know what could be lurking in the shadows. One time, my cousin was playing with his friends outside in the dark and he stepped on a snake and got bitten! We had to rush him to the hospital. He's ok now. I hope that the situation with electricity gets better soon, because it is becoming a real problem for me.

Anyway, how are you guys doing? What have you been learning in class? I hope I hear from you soon!

Sincerely,

Parvathi

P.S. I attached a picture of me with my friends. I am the one all the way on the bottom right.

Image by: Michael Foley; https://www.flickr.com/photos/michaelfoleyphotography/2393959597

Parvathi's Flashlight Engineering Project

Your Task:

Your job is to work with your teammates to create a flashlight that will help solve Parvathi's electricity problem.

Parvathi's Flashlight Engineering Project

Ask:

What is the problem that Parvathi is dealing with?

What type of flashlight will she need? What are important things you will consider when building the flashlight?

What types of materials are available to you that you would want to use?
Are there any limitations?

Parvathi's Flashlight Engineering Project

Imagine & Investigate:

Use this space to imagine what your device will look like. Remember that no idea is too "crazy!" Then work with your team to make sense of your ideas. Do you have ideas that are similar? Can you agree on what type of flashlight you will build?

Parvathi's Flashlight Engineering Project

Plan:

Use the space below to create a detailed drawing of your flashlight.

- Make sure you label all the parts of your drawing.
- Once you are done, ask your teacher for a checklist.

Parvathi's Flashlight Engineering Project

Calculating Costs:

How much will your device cost? It is important to consider how much the device costs in case Parvathi wants to build her own one day.

Use the chart below to calculate the cost of your device:

Material	Cost for One
Light Bulb	$ 0.75
Wire	$ 0.50 per 1 ft
Flat Cardboard	$ 1.00 each
Paper roll	$ 1.00 each
Aluminum Foil	$1.00 per square ft

Parvathi's Flashlight Engineering Project

Create!

1. It is time for you to build your flashlight. Go ahead and create! :)
2. On a poster, create a detailed diagram of your prototype. These are the blueprints that you will use to present your device to the class.

Parvathi's Flashlight Engineering Project

Gallery Walk & Improvements

Pick one person from your team to be the "docent" who will explain the device to guests that visit your table. The rest of the team will visit other teams and give them feedback on post-its.

Feedback Protocol	
Warm feedback "I like that you included..." "I appreciated the design of..." "It was interesting that you..."	***Cool Feedback (what can you improve)*** "I'm still confused about..." "Would you consider adding..." "I would have liked to have seen/heard..."

Now work with your group to optimize your design based on feedback.

Parvathi's Flashlight Engineering Project

Write Parvathi an Email

Parvathi will be so excited to receive her flashlight! You know how interested Parvathi is in Science and you really want her to understand how her flashlight works and why you chose to make it this way. Work independently to write Parvathi an email explaining how the flashlight works any why your group choose to build it that way. Look in the list below for some ideas on what to talk about. Be sure to use scientific evidence to backup your ideas. :

- Where does the energy for the light bulbs come from?
- What type of circuit did you build? What evidence convinced you to build this kind of a circuit?
- What type of materials did you use and why?
- What are some ways that the flashlight will help to solve the problems that Parvathi told you about in her email?

Parvathi's Flashlight Engineering Project

You've Got Mail!

You just received another message from Parvathi:

Hi guys!

Thank you so much for my flashlights! They have been very helpful during power outages at night. I have also been able to read again at night before bed, and my eyes do not hurt at all. Well done, really!

I wanted to tell you that I gave one of the flashlights to my cousin who lives next door to us. We have been using Morse Code to talk to each other at night since we don't have cell phones yet. Yes, communicating takes a while, but we keep our conversations simple. It's more of a game really, but it can be useful sometimes. I am a little sad, her family is moving one house over on the block, so she won't be able to see my window at night anymore and our cool game will be over. :(

Besides that, I've been doing great overall. School has been really fun! I really love learning about ecosystems and how energy flows through the ecosystem when an animal eats another animal (or plant). It is nice how we all have been learning about energy but in different ways. You guys have been doing cool things with electrical energy and we have been learning about how important energy is for organisms. I wonder if there is a connection between the two.

I hope you guys are doing well and I hope I hear from you soon.

Sincerely,

Parvathi

P.S. here's the video that gave us the idea about using the flashlights to communicate

https://www.youtube.com/watch?v=dHUjOL3hGJg

Parvathi's Flashlight Engineering Project

Creating an Owner's Manual for Parvathi

Work with your team to create an owner's manual that:

1. Describes how you built the telegraph and what the different parts are.
2. Shows how energy was being transferred and transmitted.
3. Includes instructions for how the device is used.
4. Gives ideas about how Parvathi can use a modified version of her flashlight-code to communicate with her cousin.

Parvathi's Flashlight Engineering Project

Checklist for Flashlight Design

- ☐ What materials will you use for each part of the flashlight (wires, body, bulb)
- ☐ How many bulbs and batteries will be used?
- ☐ Will the circuit be wired as a series or parallel?
- ☐ Will you have a switch? If so, where will it be located?
- ☐ What special features will be included to make the flashlight easy for Parvathi to use?
- ☐ What type of wire will be used?
- ☐ What material will be used to encase the circuit and hold the device?
- ☐ Will the flashlight have a switch?

Teacher's Tips *for* Parvathi's Flashlight Engineering Project

Ask	Help students look at Parvathi's email again to identify her problem. What type of device must they create? What will Parvathi be using the flashlight for? Help students to understand the limitations that they may have in building the device (materials).
Imagine	Emphasize that no idea is too crazy in the imagining phase, as engineers do not rule out ideas in the initial brainstorming phase. You can start by having students work independently to write their ideas on post-its, one idea per post-it. Then teams can come together to share ideas and categorize them. Even the "silly" ideas may have some value and these post-its should be saved for later reference.
Plan	Have students plan their drawings and provide them with a checklist once their idea is developed and they are starting to draw. You can also have students calculate the cost of building their device. Feel free to add additional materials and costs to the table on that page.
Create	Start collecting supplies for this project at least a few weeks in advance. Put aside recyclable materials and ask students/parents to collect toilet paper and paper towel rolls. Make sure that students create detailed diagrams that show how their device works. Ask them to create large drawings on poster that can easily be seen.
Optimize	After students have gotten feedback via the gallery walk, give them some time to come together as a group and analyze the feedback they received. Give them option to optimize their design. Ask them to reflect on the purpose of receiving feedback? Why is important to scientists and engineers?

Part 2: Crisis in the Kitchen

You have just received another email from your pen pal Parvathi:

Dear Room ___,

Thank you so much for my telegraph machine! The kids on the block have been having a lot of fun trying to send messages back and forth. We even invented our own code language to send messages!

I hope you guys are doing well. Everything is pretty much the same here. My brother will be starting school this year, he is really excited. We actually had to take him to the doctor because he was coughing a lot, the doctor said that he has asthma. It was a very bad surprise for us. I always heard stories about people getting asthma from pollution, but we don't have that many cars here and it seems like there isn't a lot of pollution. I think his breathing trouble might have happened because he likes to watch my mom cook, and our wood stove produces a lot of smoke. I always get mad at him for being in the kitchen when mom is cooking but he is just too stubborn! He loves to go out into the jungle area and collect wood and then come back and watch mom put it in the fire. Finding wood is becoming more of a problem these days since there are so many people who need it to cook, so we might stop using it soon anyway.

On another note, my sis and parents are doing great. My birthday was this past weekend and we went to the city to spend time with my grandparents. I like the city, but it gets a little crazy sometimes. I took a video of us in a rickshaw (a carriage being driven by a person, like a bicycle) that I thought you might find interesting. https://www.youtube.com/watch?v=Z2Hu5MBL0uQ

Anyway, I hope you guys are doing well and I hope to hear from you soon!

Sincerely,

Parvathi

P.S. here is a picture of my mom cooking.
She is an amazing cook.

Image by: Meera Subramanian; https://www.nature.com/news/global-health-deadly-dinners-1.15286

Renewable Cooking Engineering Project

You've Got Mail!

Parvathi just sent you another email answering some of your questions:

Hi again,

I am happy to hear back from you so soon. Wow, I did not know that you would have so many questions for me about where I live. I think it is nice of you to help me out with this wood stove situation, maybe with your help, I will be able to convince my parents to buy something different for our kitchen.

So, to answer your questions, yes, we do live close to a river called Ghaghara. My town is called Turtipar and the river is about a fourth of a kilometer away from our house. It takes me a few minutes to walk there. It isn't very far at all. During certain times of the year, especially in the late summer during monsoon season, the flow is very high and it can become very dangerous to swim in there. Our river is really nice, it usually has flowing water throughout the year and doesn't dry up like some other rivers I've seen.

Hmm, I am not sure how to answer your question about the wind. I don't really feel like it's windy here at all in the summer. We get more wind in winter, but I'm not sure how fast it exactly, I might have to research that and get back to you.

I suspect you guys are cooking another surprise for me! I hope I hear from you soon.

Sincerely,

Parvathi

Renewable Cooking Engineering Project

Ask:

What is the problem that Parvathi and her family are dealing with?

What are some important things we have to consider when making our cooker?

What types of materials are available to us that we can use? Are there any limitations?

What type of renewable energy will we be using?

Renewable Cooking Engineering Project

Imagine & Investigate:

Use this space to imagine what your device will look like.

Use the questions to help guide your team's discussion:

- What will be the energy source in our cooking device?
- What will our device look like?
- What materials will we use?

Renewable Cooking Engineering Project

Plan:

On a separate sheet of paper, plan a detailed drawing of your prototype. When you are done with your plan, ask your teacher for a planning checklist.

Make sure you label:

1. What materials you are using for each part.
2. How is energy being transformed to produce heat in your prototype?
3. What extra features does your prototype have that will make it effective for Parvathi's mom to use?

Create:

Work with your team to create and test if your device works. Write your procedures, observations and data in your Science Notebook.

Renewable Cooking Engineering Project

Gallery Walk & Improvements

Pick one person from your team to be the "docent" who will explain the device to guests that visit your table. As a group, make sure the docent is prepared to answer the following questions: *What is the source of energy for your cooker? Why did you use this energy source? How does the device work?*

The rest of the team will visit other teams and give them feedback on post-its.

Feedback Protocol	
Warm feedback "I like that you included..." "I appreciated the design of..." "It was interesting that you..."	***Cool Feedback (what can you improve)*** "I'm still confused about..." "Would you consider adding..." "I would have liked to have seen/heard..."

Now work with your group to optimize your design based on feedback.

Renewable Cooking Engineering Project

Pitching your idea to the village:

Work with your team to create an advertisement to market your product to Parvathi's Village.

First, think about the following questions and be sure to use the evidence you have written in your Science Notebooks:

Why would your product be helpful or beneficial for them?

Why is it better than a wood stove?

What is the source of energy for your device?

How does it work?

Then, create a brochure, poster, or skit/commercial to market their product to people in Parvathi's village while using evidence to back up their claims.

Renewable Cooking Engineering Project

Device Planning Checklist

- ☐ It is easy to use.
- ☐ It uses renewable energy to cook.
- ☐ It does not create air pollution that is harmful to health.
- ☐ We have access to the materials that we need.

Teacher's Tips *for* Renewable Cooking Engineering Project

Ask	What is the problem Parvathi's family is dealing with? What type of cooking device will they have to design to solve her problem?
Imagine	Emphasize that no idea is too crazy in the imagining phase, as engineers do not rule out ideas in the initial brainstorming phase. You can start by having students work independently to write their ideas on post-its, one idea per post-it. Then teams can come together to share ideas and categorize them. Even the "silly" ideas may have some value and these post-its should be saved for later reference.
Plan	Have students plan their drawings and provide them with a checklist once their idea is developed and they are starting to draw. You can also have students calculate the cost of building their device. Feel free to add additional materials and costs to the table on that page.
Create	If you wish to focus on solar or wind energy, the SMC has investigation kits on these topics. If you chose to give students a more open-ended task, start collecting supplies for this project at least a few weeks in advance. Put aside recyclable materials and ask students/parents to collect toilet paper and paper towel rolls. Make sure that students create detailed diagrams that show how their device works. Ask them to create large drawings on poster that can easily be seen.
Optimize	After students have gotten feedback via the gallery walk, give them some time to come together as a group and analyze the feedback they received. Give them option to optimize their design. Ask them to reflect on the purpose of receiving feedback? Why is important to scientists and engineers?

Renewable Cooking Engineering Project

Research Log

What is your guiding question?
Name of the website:
Important information that helps to answer the guiding question:
How helpful was this source in answering the guiding question (circle one): 

Teacher's Tips *for* Creating a yelp review for your local PUD

In today's highly interconnected and informed world, the internet has provided a platform for individuals to share their views and opinions with others. Websites like "yelp" allow individuals to review and rate places. The intent of this lesson is to help students think critically about the practices of their PUD and to use evidence to assess the impact that they are having on the environment.

Present the task to students.

Ask students to look at the "fuel mix" for their PUD to see how they are generating their energy.

Ask students to look at each energy source and assess whether or not it is a renewable source. Allow them to make sense of the data and take notes in their own Science notebooks.

Ask students to pause so the class can discuss how they will rate the PUD. What do the stars stand for? What is the difference between 1 star and 5 stars? What is the distinction between 2, 3, and 4 stars? Give groups a chance to talk, then share with the class. Use students' ideas to create a very general consensus on the star rating system.

Ask students to work in groups to look at their evidence and reasoning and to create a claim that supports their star rating. The star rating and claim (review) can be written on a large poster and then shared with classmates.